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Emilio J. Puantedura PT, DPT, PhD & Timothy Flynn PT, PhD

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Combining manual therapy with pain neuroscience education in the treatment of chronic low back pain: A narrative review of the literature

Emilio J. Puentedura, PT, DPT, PhD, and Timothy Flynn, PT, PhD

ABSTRACT
Teaching people with chronic low back pain (CLBP) about the neurobiology and neurophysiology of their pain is referred to as pain neuroscience education (PNE). There is growing evidence that when PNE is provided to patients with chronic musculoskeletal pain, it can result in decreased pain, pain catastrophization, disability, and improved physical performance. Because the aim of PNE is to shift the patient’s focus from the tissues in the low back as the source of their pain to the brain’s interpretation of inputs, many clinicians could mistakenly believe that PNE should be a “hands-off,” education-only approach. An argument can be made that by providing manual therapy or exercise to address local tissue pathology, the patient’s focus could be brought back to the low back tissues as the source of their problem. In this narrative literature review, we present the case for a balanced approach that combines PNE with manual therapy and exercise by considering how manual therapy can also be incorporated for interventions with patients with CLBP. We propose that as well as producing local mechanical effects, providing manual therapy within a PNE context can be seen as meeting or perhaps enhancing patient expectations, and also refreshing or sharpening body schema maps within the brain. Ideally, all of this should lead to better outcomes in patients with CLBP.

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Introduction
According to a report from the Institute of Medicine, the financial toll of chronic pain, of which chronic low back pain (CLBP) is the leading condition, is estimated to cost between $365 and $560 billion per year (Committee on Advancing Pain Research, Care and Education, 2011). CLBP is a highly prevalent condition, which imposes an enormous economic burden on today’s society. The suffering associated with CLBP can reduce a person’s quality of life and lead to long-term disability, absenteeism from work, and excessive healthcare utilization (Gore et al., 2012; Ibrahim, Tleyjeh, and Gabbar, 2008; Melloh et al., 2008).

The first clinical practice guideline for the management of low back pain was published in 1987 by the Quebec Task Force (Spitzer, 1987). Since then, there has been exponential growth in research in this area, with over 2500 clinical trials and more than 32 systematic reviews evaluating interventions for low back pain reported in the Cochrane database (Koes et al., 2010). A review of the latest clinical practice guidelines for CLBP finds consistent recommendations for supervised exercises, cognitive behavioral therapy and multidisciplinary treatment, but shows some discrepancies for recommendations regarding spinal manipulation (manual therapy) and drug treatment (Delitto et al., 2012; Koes et al., 2010).

A relatively new and promising approach in the management of CLBP has focused on teaching people about the neurobiology and neurophysiology of pain, which is referred to as pain neuroscience education (PNE) (Butler and Moseley, 2013; Louw, Diener, Butler, and Puentedura, 2011; Puentedura and Louw, 2012). Several randomized controlled trials and two recent systematic reviews have reported favorable outcomes following PNE in patients with chronic pain in terms of reduced pain, pain catastrophization, disability, and improved physical performance (Clarke, Ryan, and Martin, 2011; Louw, Diener, Butler, and Puentedura, 2011; Moseley, 2002; Moseley, 2003a; Moseley, 2003b; Moseley, Nicholas, and Hodges, 2004). The focus of PNE is reconceptualization of pain by teaching patients more about the neurobiological and neurophysiological processes involved with their pain experiences versus focusing solely on tissue pathology. In the patient with CLBP, this pain reconceptualization attempts to help them understand that pain and tissue injury are different constructs (Moseley, 2004a, Moseley, 2005; Moseley, Nicholas, and Hodges, 2004).
Through their training and education, most manual therapy clinicians are educated in the biomedical model of pain (Kaltenborn and Lindahl, 1969; Maitland, 1973; Nijs et al, 2013). Underlying this traditional model of pain is the assumption that there is a direct link between the amount of local tissue damage and the pain experienced by the patient (Haldeman, 1990). Following this biomedical model, manual therapy clinicians might conclude that addressing the underlying pathology (presumed biomechanical fault) should result in a reduction of symptoms and subsequent recovery of normal function by the patient. In the case of acute low back pain, where nociception from tissues in the low back is the dominant pain mechanism, this approach seems appropriate and has been shown to provide significant benefit when provided early in the course of care (Childs et al, 2015; Fritz et al, 2015; Rhon and Fritz, 2015). However, in the case of CLBP, there is often little to no adherence to this biomedical model of pain, and the local application of manual therapy alone is rarely followed by any lasting reduction in symptoms and improvement in function (Delito et al, 2012; Gore et al, 2012; Rubinstein et al, 2011).

Manual therapists may therefore be left with a conundrum when treating patients with CLBP. Current evidence suggests that PNE can be effective, with the objective being to de-emphasize the tissues of the low back as the dominant source of the problem and emphasize a deeper understanding of the pain experience as the means to eventual recovery (Clarke, Ryan, and Martin, 2011; Louw, Diener, Butler, and Puenteledura, 2011). On the surface, this might suggest a “hands-off” approach to therapeutic interventions. An extension of this argument is that any application of manual therapy interventions to the low back would re-focus the patient on their tissues (back) as the source of their chronic pain, and thereby undo any progress expected with PNE and exercise/activity. This “hands-off” approach may be seen as “swinging the pendulum” too far from the biomedical model of pain (Jull and Moore, 2012).

The objective of this narrative is to review the literature supporting the inclusion of manual therapies in the therapeutic management of CLBP by re-thinking the value of “hands-on” interventions in combination with PNE and supervised exercise. We propose the need to balance PNE with manual therapy in the treatment of CLBP to meet patient expectations and beliefs which may enhance the treatment with an improved brain body schema.

**How does manual therapy work?**

Manual therapy can be defined as the provision of mobilization/manipulation techniques to address musculoskeletal pain and dysfunction (American Physical Therapy Association, 2004). The American Physical Therapy Association (APTA) defines manual therapy techniques as “skilled hand movements and skilled passive movements of joints and soft tissue and are intended to improve tissue extensibility; increase range of motion; induce relaxation; mobilize or manipulate soft tissue and joints; modulate pain; and reduce soft tissue swelling, inflammation, or restriction” (American Physical Therapy Association, 2014). Prevailing thoughts on the mechanisms of manual therapy propose a mix of three mechanisms—biomechanical, neurophysiological, and/or placebo effects (Bialosky et al, 2009; Bialosky, Bishop, George, and Robinson, 2011; Bishop, Bialosky, and Cleland, 2011). It is suggested that a transient, mechanical stimulus (spinal manipulation) may create a chain of local biomechanical effects and neurophysiological effects mediated through the peripheral nervous system, spinal cord, and higher centers. Traditionally, manual therapy interventions are thought to be dependent upon bottom-up-mediated factors like stimulus intensity, but in recent years greater attention has been drawn to top-down-mediated factors like the patient’s expectations (Gifford, 2013; Tiemann et al, 2015).

If we take the case of a patient with low back pain receiving a manual therapy intervention to their lumbar spine, the mechanical stimulus is theorized to cause movement at the spinal motion segments, which may improve segmental motion, decrease local tissue inflammatory factors, and facilitate local muscular control (Colloca et al, 2006; Hsieh et al, 1995; Teodorczyk-Injeyan, Injeyan, and Ruegg, 2006). Providing joint mobilization to the lumbar spine can be viewed as a “bottom-up” approach because the therapist can be said to be providing input into the nervous system in order to change output from the brain (i.e., pain). In other words, the therapist’s intent is to decrease nociceptive input into the system and thereby modulate the pain experience. But we should also consider the “top-down” effects, i.e., the brain and its integral role in producing a pain experience (Figure 1).

There is very little evidence that manual therapy performed under anesthesia is effective for CLBP (Digiorgi, 2013; Gordon, Cremata, and Hawk, 2014) and perhaps this is because we need to “manipulate” the brain, and not just the joints and other peripheral tissues, to bring about a change in the pain experience. Traditional thoughts about the mechanisms underlying manual therapy have alluded to the gate control theory of pain (Nathan, 1976), whereby one sensory modality (joint mobilization) can modulate another (back pain). Additionally, the provision of rhythmic oscillations to lumbar motion segments in varying grades of depth can
also be seen as graded exposure; however, these concepts fail to consider the importance of the patient’s brain’s interpretation of the input and the changes that might be induced through the input of manual therapy.

**Manipulating the brain**

**Enhancing patient expectations**

There is ample evidence linking patients’ expectations for recovery and health outcomes (Auer et al., 2016; Iles, Davidson, Taylor, and O’Halloran, 2009). A patient that expects a particular treatment will help their pain is more likely to experience improvement than a patient with lower expectations (Bishop, Bialosky, and Cleland, 2011; Puentedura et al., 2012). The positive expectation of benefit from a particular treatment intervention is often termed the placebo effect or placebo response (Benedetti, 2013; Bialosky, Bishop, George, and Robinson, 2011). A more nuanced view of placebo is that it represents the limit point of our current understanding of the mechanisms behind the observed treatment effect. Thus, many factors may contribute to the placebo response, such as the patient-therapist relationship, the patient’s expectations and needs, the patient’s personality and psychological state, the severity and discomfort of the symptoms, the type of verbal instructions, the treatment preparation characteristics, and the clinical environmental milieu (Ross and Buckalew, 1985). This suggests that whenever a treatment is given to a patient, it is not done so in a vacuum, but in a complex set of psychological states that vary from patient to patient and from situation to situation (Benedetti and Amanzio, 2013). That is, “placebo” treatment is not necessarily “no treatment” or a true control.

When manual therapy is provided to a patient with CLBP, it is administered along with a complex set of physical and psychological stimuli (including, but not limited to tactile, verbal and non-verbal cues) which imply to the patient that a clinical improvement should be occurring shortly. These physical and psychosocial stimuli represent the context around the therapy and the patient, and such a context may be as important as the specific effect of the intervention. The contextual factors that might affect the therapeutic outcome can be represented by the characteristics of the treatment (hand contact, direction of movement, force), the patient’s and therapist’s characteristics (treatment and pain beliefs, status, gender), the patient–provider relationship (suggestion, reassurance, and compassion), and the healthcare setting (clinic and room layout) (Di Blasi et al., 2001).

An argument could be made that when a patient with CLBP consults a manual therapist, they would expect their painful area (back) to be touched/pal-pated/treated. Adopting a “hands off” PNE approach may not necessarily meet those expectations and could arguably induce a nocebo effect, thereby inducing negative expectations and negative outcomes (Benedetti, 2013). Do expert manual therapists enhance the positive recovery expectations of their patients, either consciously or not? A study which examined the characteristics of 12 therapists who were classified as either “expert” or “average,” based on the outcomes of their patients, found that the “expert” therapists where not distinguished by years of experience (Resnik and Jensen, 2003). Instead, “expert” therapists had a patient-centered approach to care, characterized by collaborative clinical reasoning and promotion of patient empowerment (Resnik and Hart, 2003; Resnik
and Jensen, 2003). In other words, they showed they really cared about their patients; they listened to them, they empathized, and they worked with them to achieve goals set by their patients. Expert manual therapists demonstrate confidence in their manual skills and when observed performing manual therapy, they are well-balanced, smooth in their movements, quick to localize treatment levels, and gentle in their delivery of manual therapy techniques (Edwards et al, 2004; Hartman, 2014; Resnik and Hart, 2003; Wainwright, Shepard, Harman, and Stephens, 2011).

Somatosensory cortex—manual therapy as a means to refresh body schema maps

There are many terms that define how the brain recognizes the self as “self.” These include body schema, image, identity, ownership, awareness, self-perception, etc. (Holmes and Spence, 2004; Makin, Holmes, and Ehrosson, 2008), and these terms are often used in distinct ways by different disciplines. Neurologist Sir Henry Head (1861–1940) conducted pioneering work into the somatosensory system (Head, 1920) and coined the term “body schema” as the brain’s dynamic representation of the body which is sculpted by exteroceptive and interoceptive experiences. But it was Wilder Penfield (1891–1976) who is credited with establishing the “map” of the human body (homunculus) in the sensory and motor cortices (Penfield and Rasmussen, 1950). Current evidence suggests that these representational body maps are dynamically maintained in the brain (e.g., neuroplasticity) and are negatively influenced by neglect, decreased movement, and pain (Maihöfner, Handwerker, Neundörfer, and Birklein, 2003).

Recent research has shown that people with chronic pain demonstrate impairments in laterality judgements (identifying a body part as being oriented to the left or right), which is considered dependent on an intact body schema in the sensorimotor areas of the cortex (Bowering, Butler, Fulton, and Moseley, 2014; Bray and Moseley, 2011; Elsig et al, 2014; Moseley, 2004b). Furthermore, body image is disrupted, and tactile acuity is decreased in the area of usual pain in patients with CLBP (Moseley, 2008). This phenomenon has been referred to as “smudging” of the sensorimotor homunculus (Louw and Puentedura, 2013), and it is thought that retraining laterality and tactile discrimination can “sharpen” or “refocus” the homunculus and lead to decreased pain (Moseley and Wiech, 2009; Moseley, Zalucki, and Wiech, 2008) (Figure 2).

Getting patients with CLBP to make judgments about which direction a trunk is facing in multiple images, and having them localize light touch sensations in discrete sections of their low back can be seen as a “top-down” approach. An argument could also be made that the skillful delivery of manual therapy to the low back motion segments, as long as they do not evoke a pain response, can assist in re-establishing tactile discrimination (e.g., assist in “localization” of the spinal motion segment) and thereby “sharpen” or “refocus” the homunculus related to the low back. Consider that the skillful delivery of manual therapy involves constant communication between the patient and therapist—“how does this feel here?”; “this is your L4 spinous process”; “what if I push it this way?”; “how about here at L5?” It could be argued that the application of manual therapy in such a manner could link sensory and proprioceptive neural circuits within the brain and help to refresh its representational body maps.

In a recent case series (Louw et al, 2015), researchers reported that a brief tactile intervention associated with brain remapping resulted in immediate improvements in pain and spinal flexion range in 16 patients with CLBP. Patients were shown a picture of the homunculus and told that it was a map of their body’s representation in the brain. They were also taught that when persistent pain is present, the map can become “less sharp” as those body parts are moved and used less, and that sharpening or refocusing the map could reduce their pain. By touching the back in various areas and sharpening their attention to where they were being touched with a pen, the therapy would aim to “sharpen” the map. They used a 9-block grid and randomly stimulated the 9-blocks while asking for continuous feedback as to the localization of the stimulus (Figure 3) and found that mean pain rating (0–10 scale) decreased by 1.91 (range 0–6) and forward flexion improved by a mean of 4.82 cm (range –1 to 21). The study demonstrated that an intervention “devoid of physical movement and associated with cortical reorganization” (Louw et al, 2015) could decrease pain and cause an immediate increase in lumbar flexion range in patients with CLBP.

Emerging evidence suggests coupling PNE and movement therapies

Finally, the systematic review of the efficacy of PNE for pain, function, disability, psychosocial factors, movement, and healthcare utilization in individuals with chronic musculoskeletal pain was recently updated (Louw, Zimney, Puentedura, and Diener, 2016). In their review of 13 studies, the authors found five were
education-only approaches, whereas the remaining eight combined PNE with a movement-based strategy such as exercise/activity and/or manual therapy. Outcomes appeared to favor the combination of PNE with movement, either passive (manual therapy) and/or active, suggesting that “hands-on” approaches resulted in more favorable responses.

Figure 2. The intact body schema in the sensorimotor cortex is dynamically maintained and it is postulated that areas of the body image can be disrupted, leading to “smudging” or the body image in the brain becoming “out of focus.” In the top image, the smudging of the cortical region associated with the lower back is thought to lead to decreased tactile acuity and body awareness, and perhaps persistent low back pain. The lower image shows the intact (sharp or “in focus”) body schema, where tactile acuity and body awareness are not compromised and, hence, pain may not be an issue.

Figure 3. 9-Block localization treatment grid used in the case series by Louw et al. (2015).

Conclusion

There is growing evidence that PNE can be effective in the management of chronic musculoskeletal pain. The emphasis of PNE is to have patients reconceptualize their pain and to understand that pain and tissue injury are different constructs. It may, therefore, seem counterintuitive to include an intervention such as manual therapy along with PNE, as it would appear to be addressing a presumed tissue problem. This narrative review makes the case for a balanced approach in the therapeutic management of chronic musculoskeletal pain by re-thinking the value of “hands-on” interventions in combination with PNE and supervised exercise/movement activities. Finally, an updated systematic review of randomized controlled trials of PNE suggests that an education-only approach is not as effective as those that combined pain education with manual therapy and supervised exercise.

Declaration of interest

Authors report no conflict of interest. The authors alone are responsible for the content and writing of the paper.
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