Immediate effects of sensory discrimination for chronic low back pain: a case series

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ABSTRACT

Can a brief tactile intervention associated with brain remapping improve pain and spinal movement in patients with chronic low back pain? A convenience sample of patients with chronic low back pain completed various pre-intervention measurements including low back pain (Numeric Pain Rating Scale), fear-avoidance (Fear Avoidance Beliefs Questionnaire), disability (Oswestry Disability Index) and spinal flexion (fingertip-to-floor). A 5-minute localisation of tactile stimuli treatment was administered to the low back, followed by immediate post-intervention measurement of pain and spinal flexion. Sixteen patients (female = 12; mean age 48.2 years) with chronic low back pain (median duration 10 years) presented with a mean low back pain of 5.56 out of 10, moderate disability (mean Oswestry Disability Index 34.38%) and high fear-avoidance associated with physical activity (average 17.25). Immediately following treatment, the group's mean pain rating for low back pain decreased by 1.91, while forward flexion improved by 4.82 cm. The results from the case series indicate that following a brief tactile discrimination intervention, patients with chronic low back pain exceeded minimal detectible change for forward flexion. Being able to improve movement, without using physical movement, may provide an added benefit for patients with chronic low back pain afraid to move.

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INTRODUCTION

Various epidemiological studies have shown an increase in the prevalence of chronic low back pain (CLBP) (Goldberg and McGee 2011, Johannes et al 2010, Parthan et al 2006, van Hecke et al 2013). Current best-evidence suggests a combination of education, movement and pharmacological agents is effective in decreasing pain and disability in chronic musculoskeletal conditions, including CLBP (Busch et al 2007, Ferreira et al 2007, Goldenberg 2009, Mistiaen et al 2012, Nijs et al 2010). Therapeutically, in recent years increased activity in the field of education has culminated in the increased utilisation of, and evidence for, pain neuroscience education (Louw et al 2011, Louw et al 2014, Moseley et al 2004, Moseley 2002). In line with current best-evidence treatments utilising movement, such as aerobic exercise, are being proposed to treat patients with CLBP (Ferreira et al 2007, Mistiaen et al 2012, Nijs et al 2012). It is proposed that these treatments help patients with pain by enhancing various endogenous mechanisms (Bialosky et al 2009a, Bialosky et al 2009b, Nijs et al 2012).

The correlation between pain, range-of-motion (ROM) and function is not well understood (Moseley 2004a). It has been shown that limited spinal movement is correlated to decreased function, with the American Medical Association (AMA) viewing loss of spinal ROM as an impairment and used for disability ratings (Archer et al 2014, Nijs et al 2013, Vlaeyen et al 1995). This loss of spinal ROM has thus become the target of various therapeutic interventions, especially in chronic pain as a means to decrease disability (Archer et al 2014, Nijs et al 2013, Vlaeyen et al 1995). One such treatment may be the reduction of pain (Moseley 2004a). Pain intensity however has shown very little correlation to fear of movement, thus questioning strategies to ease pain intensity (Vlaeyen et al 1995). Despite the limited evidence for a reduction in pain intensity improving ROM, various authors have tested treatments aimed at reducing pain issues such as pain intensity, pain-related fear and cognitions of pain to assess its effect on movements (Daly and Bialocerkowski 2009, Louw et al 2011). For example, pain neuroscience education has shown an immediate clinically meaningful improvement in spinal movements including spinal flexion, straight leg raise and cervical extension in chronic whiplash associated disorders (Moseley 2004a, Moseley et al 2004, Van Oosterwijck et al 2011). For low back patients, spinal flexion is often seen as a particularly fearful movement and often associated with pain (Barrett et al 1999, George et al 2009, Schnebel et al 1989). This poor understanding of pain and limited ROM leaves spinal patients and clinicians in a precarious position since it is well established patients with CLBP display all three of these elements of limited ROM, high levels of pain and decreased function (Angst et al 2006, Louw et al 2011, Moseley 2004b). Adding to the complexity, emerging advances in neuroscience and brain imaging studies have shown that decreased movement of the lumbar spine leads to functional changes in the brain (Flor et al 1997, Wand et al 2011). It is well established that the physical body of a person is represented in the brain by a network of neurons, often referred to as a representation of that particular body part in the brain (Flor 2000, Penfield and Boldrey 1937, Stavrinou et al 2007, Wand et al 2011). This representation refers to the pattern of activity that is evoked when a particular body part is stimulated. The most famous area of the brain associated with representation is the primary somatosensory cortex (S1) (Flor 2000, Penfield and Boldrey 1937, Stavrinou et al 2007, Wand et al 2011). From a physiotherapy perspective it is important to understand that these neuronal representations of body parts are dynamically maintained (Flor et al 1997, Flor et al 1998, Lotze and Moseley 2007, Maihofner et al 2003, Moseley 2005a, Moseley 2008). It has been shown that patients with pain display different S1 representations than people with no pain (Flor et al 1997, Flor et al 1998, Lotze and Moseley 2007, Maihofner et al 2003, Moseley 2005a, Moseley 2008). The interesting phenomenon associated with cortical restructuring is the fact that the body maps expand or contract, in essence increasing or decreasing the body map representation in the brain. Various authors have drawn a correlation between the changes in shape and size of body maps and increased pain and disability (Flor et al 1997, Lloyd et al 2008). Although various factors have been linked to the development of this altered cortical representation of body maps in S1, it is believed that issues such as neglect and decreased use of the painful body part (Marinus et al 2011) may be a significant source of the altering of body maps (Beggs et al 2010, Flor et al 1997). Various authors have postulated that a viscious cycle may emerge between decreased movement, cortical reorganisation and increased pain (Flor 2000, Moseley et al 2012b).

Based on these neuroplastic changes, physiotherapy has focused on strategies to help normalise these altered cortical representations of body maps. One approach is graded motor imagery (GMI) (Bowering et al 2013, Daly and Bialocerkowski 2009, Moseley 2004b, Moseley 2006). GMI is a collective term describing various "brain exercises" including normalising laterality (left/right discrimination of body parts), motor imagery (visualisation), mirror therapy, sensory discrimination, sensory integration and graphaesthesia (Daly and Bialocerkowski 2009, Moseley 2004b, Moseley 2006). Various studies have shown that these GMI strategies are able to positively influence pain and movement (Bowering et al 2013, Daly and Bialocerkowski 2009, Moseley 2004b, Moseley 2006), however in line with CLBP, the correlation remains poorly understood. Most research, however, has focused on Complex Regional Pain Syndrome (CRPS) of the extremities with little information on its potential to help patients with CLBP (Daly and Bialocerkowski 2009, Moseley 2004b, Moseley 2006).

This case series aimed to further explore the relationship between pain intensity and movement. The main goal was to determine if patients with CLBP who received tactile acuity training to their lower back in the absence of movement, experience any advantageous therapeutic effect in regards to pain intensity and/or spinal flexion.

METHODS

Patients

A convenience sample of patients with CLBP currently attending physiotherapy for rehabilitation was invited to participate in the study. Four patients from each of four physiotherapy clinics in a large metropolitan area were recruited for the study. Internal review board (IRB)/Ethics approval was obtained. Upon obtaining informed consent, patient demographic data were collected. Patient intake forms, including medical history, were reviewed for any items thought to predict a higher risk of serious pathology and warrant referral for further diagnostic testing, making patients ineligible for the study. Patients were excluded if they could not read or understand the English language, were under age 18 (minor), had undergone spinal surgery, had any skin or medical condition preventing them from receiving tactile stimuli on the lower back or had specific movement-based precautions, e.g. no active spinal flexion. Patients had to present with back pain and patients presenting with leg pain only, or neurological deficit only in the lower extremity were additionally excluded.

Measurements

Patients were asked to complete various outcome measures prior to treatment intervention:

Pain: Low back pain at rest was measured using a Numeric Pain Rating Scale (NPRS), as it is commonly used in various spinal pain studies (Moseley 2003, Moseley 2005b, Moseley 2002). The minimal detectable change (MDC) for the NPRS is reported to be 2.1 (Cleland et al 2008a).

Function: Perceived disability was measured using the Oswestry Disability Index (ODI) which has good evidence for its reliability and validity as a measure of functional limitations related to LBP (Deyo et al 1998, Fritz and Irrgang 2001, Hakkinen et al 2007). A change of 5 points (10%) has been proposed as the MDC (Ostelo et al 2008).

Fear avoidance (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 sub-scales 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 (Cleland et al 2008b, Grotle et al 2006, Poiraudeau et al 2006). 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 (Burton et al 1999, Fritz and George 2002).

Lumbar flexion: Active trunk forward flexion, measured from the longest finger on the dominant hand to the floor (Moseley 2004a, Moseley et al 2004, Zimney et al 2014). This method was chosen as it is commonly used in pain science studies (Louw et al 2012, Moseley 2004a, Moseley et al 2004, Zimney et al 2014). MDC for active trunk forward flexion utilising this method has been reported as 4.5 cm (Ekedahl et al 2012).

Immediately following the treatment intervention, low back pain (NRS) and lumbar flexion were re-measured to determine the immediate therapeutic effect of the proposed intervention. Pre- and post-treatment measurements were performed by the therapists who provided the GMI interventions (LW, JU, KM and MW). Upon completion of the trial (pre-tests, tactile stimulation and post-test), the attending therapists continued with their usual therapy treatments based on their current plan of care.

Intervention

Various strategies have been proposed to help patients develop an increased acuity of faulty body maps, including two-point discrimination, graphaesthesia and sensory discrimination (Daly and Bialocerkowski 2009, Moseley 2004b, Moseley 2006, Moseley et al 2008b). For this study, based on previous CLBP research (Luomajoki and Moseley 2011, Wand et al 2011) it was decided to use localisation of tactile stimuli. Prior to localisation, patients were provided with an explanation of the proposed treatment and aim of the study. They were shown a picture of the brain map (homunculus) and taught how, when people are in pain, the map becomes "less sharp" since it's not being moved and it is believed that when the map is sharpened, it may help 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. Patients were treated in a private treatment room; their backs were exposed and they were seated in a comfortable position, allowing access to the lower back. A 9-block grid was designed and shown on a body chart to the patient. Corresponding with the patient viewing the body chart and 9-block grid, the patient was taught via tactile stimulus with the back of a pen where each block was in relation to their lower back, thus familiarizing them with the 9-block grid (Figure 1) (Luomajoki and Moseley 2011, Wand et al 2011). Subsequently, the therapist randomly stimulated the 9-blocks asking for continuous verbal feedback as to the location of the stimulus; this was done for 5 minutes in total. With a correct identification of the area, the therapist proceeded to the next block for identification. In the event of an incorrect answer, the area was re-stimulated and the therapists would teach the patient which grid was touched, in essence helping the patient develop a greater ability to identify the stimulated grid. The stimulation of the grids was at random and decided upon per discretion of the clinicians. Forward flexion and low back pain were assessed immediately after the intervention.

RESULTS

Patients

This case series comprises data from 16 patients (12 female; mean age 48.2 years) attending outpatient physiotherapy for CLBP (median duration 10 years; range 6 months – 30 years), mean LBP 5.56 out of 10 on a NPRS, moderate disability (mean ODI 34.38%) and high fear-avoidance associated with physical activity (mean 17.25). Patient demographics can be found in Table 1.

Figure 1: Localisation treatment grid

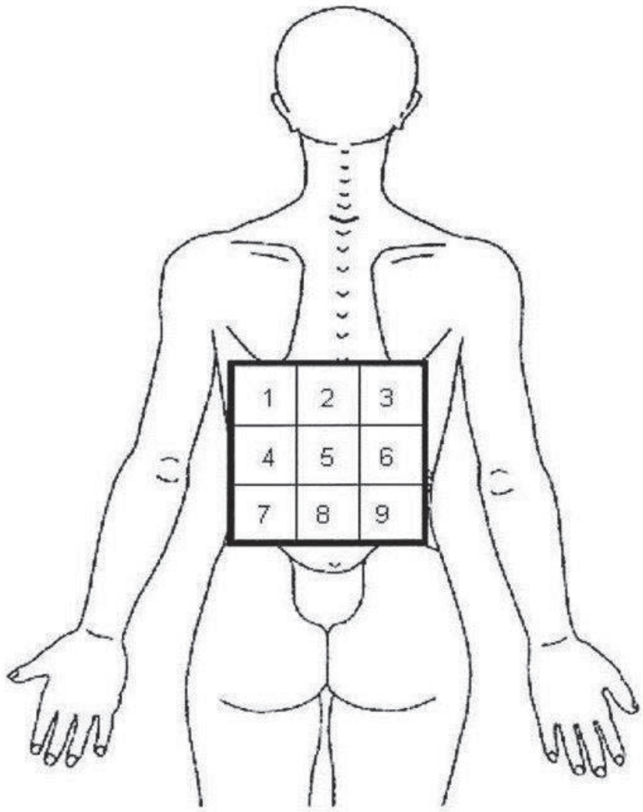


Table 1: Case series patient demographics

Variables	Results
Age (years)	48.19 (range 20.7 – 71.7)
Females (n = 12)	75%
Height (meters)	1.73
Weight (kilograms)	88.85
Body Mass Index (BMI)	30.63
Duration of symptoms (years)	Mean 11.9 (range 6 months – 30 years) Median 10.0
FABQ – Physical Activity	17.25
FABQ – Work	18.38
ODI	34.38%
NPRS low back	5.56
Flexion (cm)	25.73

Post-treatment Measurements

The immediate changes in NRS for LBP and forward flexion for each patient can be found in Figures 2 and 3. Immediately following treatment, the mean pain rating for LBP decreased by 1.91 (range 0-6), while forward flexion improved by a mean of 4.82cm (range -1 to 21).

DISCUSSION

The results from this case series show that a treatment devoid of physical movement and associated with cortical reorganisation immediately increased lumbar flexion for patients with CLBP. Movement is key in the recovery of patients with CLBP (Bray and Moseley 2011, Moseley et al 2012b). Apart from limited

Figure 2: NPRS of LBP before and after treatment. (*) indicates patients who obtained a MDC

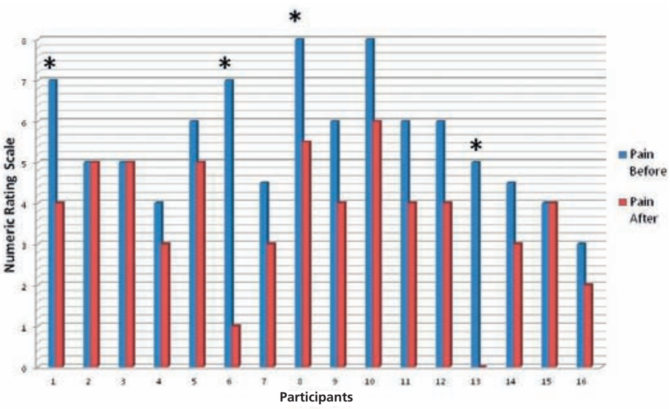
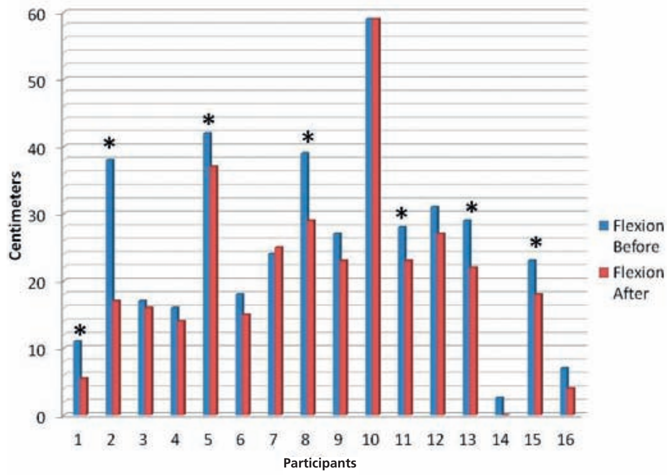


Figure 3: Lumbar flexion before and after treatment. (*) indicates patients who obtained a MDC



spinal movement being correlated to decreased function (Archer et al 2014, Nijs et al 2013, Vlaeyen et al 1995), therapeutic treatments associated with a hypoalgesic effect (aerobic exercise; manual therapy) require movement (George et al 2006, Nijs et al 2012, Vicenzino et al 1998). In some patients with CLBP, however, movement based strategies such as exercise and manual therapy in themselves may pose a threat (Louw et al 2012). If patients correlate movement to pain and vice versa, clinicians are faced with a clinical dilemma (Moseley 2007, Moseley et al 2008a). Various authors, however, have proposed a series of techniques prior to physical rehabilitation (pre-habilitation) to prepare the affected body part for rehabilitation, including visualisation, left/right discrimination and graphaesthesia (Daly and Bialocerkowski 2009, Moseley 2004b, Moseley 2006, Moseley et al 2008b). It is believed that these strategies access the premotor cortex and in essence, facilitate preparation for and execution of motor cortex activation (movement) (Daly and Bialocerkowski 2009, Moseley 2004b, Moseley 2006, Moseley et al 2008b, Tsao et al 2008, Tsao and Hodges 2007). The treatment provided in this case series, albeit a brief intervention, resulted in a MDC in forward flexion, similar to pain science education studies aimed at altering pain cognitions (Moseley 2004a, Moseley et al 2004, Stavrinou et al 2007). Furthermore, the findings of this case series concur with CRPS studies utilising various tactile interventions (localisation and two-point discrimination) aimed at cortical reorganisation of affected body maps to help ease pain and disability and improve movement (Daly and Bialocerkowski 2009, Moseley 2004b, Moseley 2006, Moseley et al 2008b).

To the best of our knowledge, to date, this is the first study utilising this approach in a CLBP population. The ability to improve movement, without physical movement, especially in the early phase of rehabilitation, is important. This pre-habilitation reorganisation of an affected body map may be especially important for the more severely afflicted patients with CLBP. Pain, limited movement and function are often closely associated with high levels of fear-avoidance, which has been shown to be a significant predictor of disability and especially of an inability to return to work (Burton et al 1999, Fritz and George 2002), Louw et al 2011, Moseley 2004b). In this case series, the patients presented with a median CLBP duration of 10 years and a mean FABQ-PA score of 17.25, well over the threshold associated with a higher likelihood of not returning to work (Burton et al 1999, Fritz and George 2002). By not engaging in painful and/or fearful therapeutic movements and utilising treatments that provide an immediate positive effect on pain and movement, it may indeed facilitate a faster recovery. Future studies will need to explore if this immediate change in pain and spinal movement leads to an expedited return to function.

The case series failed to provide an overall MDC of pain ratings in patients with CLBP (1.91 versus 2.1). Care should be taken in regards to the interpretation of pain ratings in a case series with eight patients failing to produce a MDC for pain. In line with the search for the association of pain, limited ROM and function, four patients, however, did obtain such positive changes. Apart from collectively being close to MDC, it is worthy to highlight the fact that the intervention was brief (5 minutes) and only utilized one of the proposed GMI techniques ("localization"). In a clinical setting it has been proposed and taught that patients with chronic pain, including CLBP, should receive a more comprehensive GMI approach, in addition to pain science education (Moseley et al 2012a). Pain science education alone has shown immediate improvements to physical movements such as spinal flexion (Moseley 2004a, Moseley et al 2004, Stavrinou et al 2007). The pain reduction in this case series warrants further investigation into the clinical application of a GMI programme with/without pain science education in patients with CLBP.

This case series has limitations. First, by its nature, a case series does not offer a control group for comparison and the design did not allow patients to serve as their own controls. Second, the intervention was chosen arbitrarily based on previous studies, and no attempt was made to determine if such impairments were in place and in need of intervention. Additionally, no attempt was made to examine if accuracy of localisation did occur, and if it correlated to improved movement and/or reduced low back pain. The fact that the pre-tests, post-tests and treatments were performed by the same treating clinicians infer bias which cannot be ignored in the interpretation of the findings.

CONCLUSION

A brief intervention helping patients with CLBP identify the location of tactile stimuli in their lower back led to immediate changes in forward flexion. This case series provides preliminary evidence warranting larger controlled trials of GMI for patients with CLBP or LBP in general, and whether specific sub-groupings need to be considered. Finally, the results provide a potential for clinicians to impact movement for patients with CLBP prior to a movement-based approach such as exercise and/or manual therapy.

KEY POINTS

- Treatments involving movement may increase fear and pain-related fear in patients with chronic low back pain.
- Decreased localisation of tactile stimuli is associated with chronic pain and may impact movement itself.
- Strategies aimed at improving tactile stimulus localisation may help decrease pain and improve movement.
- Cortical reorganisation strategies may provide a pre-habilitation strategy to enhance movement without movement.

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PERMISSIONS

Ethics

This study was approved by the Internal Review Board (IRB)/ Ethics at Southwest Baptist University. Patients provided written and verbal consent to participate in the study.

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