CASE REPORT

Moving without moving: immediate management following lumbar spine surgery using a graded motor imagery approach: a case report

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Abstract

Representational body maps are dynamically maintained in the brain and negatively influenced by neglect, decreased movement and pain. Graded motor imagery (GMI) utilizing various tactile and cognitive processes has shown efficacy in decreasing pain, disability and movement restrictions in musculoskeletal pain. Limited information is known about the cortical changes patients undergo during lumbar surgery (LS), let alone the therapeutic effect of GMI for LS. A 56-year-old patient underwent LS for low back pain, leg pain and progressive neurological deficit. Twenty-four hours prior to and 48 h after LS various psychometric, physical movement and tactile acuity measurements were recorded. Apart from predictable postoperative increases in pain, fear-avoidance, disability and movement-restrictions, pressure pain thresholds (PPT), two-point discrimination (TPD) and tactile acuity was greatly reduced. The patient underwent six physiotherapy (PT) treatments receiving a GMI program aimed at restoring the PPT, TPD and tactile acuity. The results revealed that GMI techniques applied to a patient immediately after LS caused marked improvements in movement (flexion average improvement/session 3.3 cm; straight leg raise average 8.3 cm/session) and an immediate hypoalgesic effect. GMI may provide PT with a non-threatening therapeutic treatment for the acute LS patient and establish a new role for PT in acute LS patients.

Keywords

Brain, imagery, lumbar, mapping, pain, surgery

Introduction

Current epidemiological data indicates that 10–40% of patients following lumbar surgery (LS) struggle with persistent pain and disability following surgery (Findlay et al., 1998; Keskimaki, Seitsalo, Osterman, and Rissänen, 2000; Loupasis et al., 1999; Yorimitsu, Chiba, Toyama, and Hirabayashi, 2001). From a physiotherapy (PT) perspective, postoperative rehabilitation (consisting mainly of exercise) is often prescribed to help decrease disability and facilitate return to regular activities (Danielsen, Johnsen, Kibsgaard, and Hellevik, 2000; Dolan, Greenfield, Nelson, and Nelson, 2000; McGregor, Dicken, and Jamrozik, 2006). To date, however, postoperative rehabilitation has shown little long-term benefit for patients following LS (Donaldson et al., 2006; McGregor et al., 2011), which suggests that some patients may suffer long-term pain and disability following LS for radiculopathy. Various reasons have been provided for the potential persistent pain and disability following LS, including: failed surgery (Rodrigues, Dozza, de Oliveira, and de Castro, 2006); unrealistic expectations of patients (Toyone et al., 2005); limited pain knowledge of both patients and clinicians (Louw, Diener, Landers, and Puentedura, 2014; Moseley, 2003a; Nijss et al., 2013); and inadequate referral to postoperative rehabilitation (Louw, Butler, Diener, and Puentedura, 2012).

Emerging advances in neuroscience and brain imaging studies; however, argues that another potential reason for persistent pain after LS may be functional changes in the brain (Flor, Braun, Elbert, and Birbaumer, 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 well-known 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 PT perspective, it is important to understand that these neuronal representations of body parts are dynamically maintained (Flor, Braun, Elbert, and Birbaumer, 1997; Flor et al., 1998; Lotze and Moseley, 2007; Maihofner, Handwerk, Neudorfer, and Birke, 2003; Moseley, 2005a, 2008). It has been shown that patients with pain display different S1 representations than people without pain (Flor, Braun, Elbert, and Birbaumer, 1997; Flor et al., 1998; Lotze and Moseley, 2007; Maihofner, Handwerk, Neudorfer, and Birke, 2003; Moseley, 2005a, 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. Furthermore, these changes in shape and size of body maps seem to correlate to increased pain and disability (Flor, Braun, Elbert, and Birbaumer, 1997; Lloyd, Findlay, Roberts, and Nurmikko, 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 (Begg, Liu, Kwan, and Salter, 2010; Flor, Braun, Elbert, and Birbaumer, 1997). Although most recent pain research has focused on the S1 reorganization, it is also important from a rehabilitation perspective to realize changes occur in the primary motor cortex (M1) as well (Tsao, Galea, and Hodges, 2008; Tsao and Hodges, 2007). For example, in spinal stabilization exercises it is found that the cortical representation of contraction of the transversus abdominus muscle was shifted and enlarged in patients with recurrent low back pain and both the location and size of the map volume are associated with slower onset of transversus abdominus as part of the postural adjustment associated with rapid arm movement (Tsao, Galea, and Hodges, 2008). People with low back pain (LBP) also exhibit an expanded area of cortical activity in preparation for arm movement and a decrease in specific cortical responses in relation to observed delayed onset of deep abdominal muscles (Jacobs, Henry, and Nagle, 2010).

Based on these neuroplastic changes, PT has focused on strategies to help normalize these altered cortical representations of body maps, primarily S1. One approach is graded motor imagery (GMI) (Bowering et al, 2013; Daly and Bialocerkowski, 2009; Moseley, 2004a, 2006). GMI is a collective term describing various “brain exercises” and includes: normalizing laterality (left/right discrimination of body parts), motor imagery (visualization), mirror therapy, sensory discrimination, sensory integration and graphesthesia. Various studies have shown that these GMI strategies are able to influence pain (Bowering et al, 2013; Daly and Bialocerkowski, 2009; Moseley, 2004a, 2006). Most research has focused on complex regional pain syndrome (CRPS) with little information on its potential to help patients with LBP.

The purpose of this case report is to examine if GMI could help the recovery of a patient with postoperative LBP following surgery for lumbar radiculopathy. To date, no such studies have been conducted.

**Case description**

**Patient history**

The patient was a 56-year-old lady (5 foot, 6 inches and 155 pounds) scheduled to undergo an L5/S1 laminectomy and discectomy in 24 h. The patient was well known to the therapists (AL and CL) as she attended outpatient PT seven times for LBP and L5/S1 radiculopathy. The patient developed LBP and radiculopathy since undergoing a knee replacement a year ago, especially upon return to work with prolonged sitting as an account manager. Her LBP and leg pain was constant, variable with increased pain early mornings and sitting more than 30 min at a time. The radicular symptoms radiated to the left lower back, posterior left thigh and all the way down to the dorsum and lateral posterior left thigh and all the way down to the dorsum and lateral border of the left leg and foot. She also presented with intermittent, progressive neurological deficit (L5/S1)—decreased strength in ankle eversion and big toe extension. Her magnetic resonance imaging (MRI) test revealed “significant” L5 herniated disc with accompanying foraminal stenosis. The patient also reported intermittent sleep disturbance due to the pain and numbness. Her clinical intake forms revealed low back and leg pain rating 6/10 (Numeric Pain Rating Scale: NPRS) (Cleland, Childs, and Whitman, 2008) and Oswestry Disability Index (ODI) of 22% indicating moderate disability (Häkkinen et al, 2007). Over a period of seven PT visits she received patient education, spinal mobilization, neural tissue mobilization and exercises. Despite increased spinal range of motion (ROM), decreased NPRS of 3/10 for LBP and leg pain, and subjective reports of improved sleep, the patient’s neurological symptoms remained unchanged. Two epidural steroid injections (ESI) were performed, resulting in no significant change, which lead to a meeting with a spine surgeon and ultimately scheduling the pending LS (L5 discectomy and laminectomy). The patient was enrolled in a randomized controlled trial (RCT) of preoperative neuroscience education (Louw, Diener, Landers, and PuenteDura, 2014), and due to her proximity to the clinic and familiarity with her case, it was recommended that the patient participate in GMI. The preoperative neuroscience educational session was a one-time visit (30 min) for an educational-only session, involving no physical treatment, or any follow-up sessions after surgery, thus not impacting the proposed GMI treatments of the postoperative period. The surgeon’s office approved the protocol and the patient completed a written consent to participate. The patient was asked to present at PT 24 h prior to surgery; 48 h after surgery and subsequently twice a week for 3 weeks, culminating in her scheduled return to the surgeon for the postoperative re-check.

**Examination**

Various psychometric and physical measurements were taken 24 h prior to LS and repeated 48 h post-LS (Table 1). The choice of measurements were determined based on the goals of intervention, known measurements associated with surgical outcome studies and as a guide to determine the most appropriate GMI strategies.

**Pain**

LBP and leg pain were measured using NPRS, as has been used in various spinal pain studies (Moseley, 2002, 2003b, 2005b). The minimal detectable change (MDC) for the NPRS is reported to be 2.1 (Cleland, Childs, and Whitman, 2008).

**Function**

Perceived disability was measured using the 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; Häkkinen et al, 2007). A change of five 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: (i) a 7-item scale to measure fear-avoidance beliefs

<table>
<thead>
<tr>
<th>Test</th>
<th>24 h preoperative</th>
<th>48 h postoperative</th>
</tr>
</thead>
<tbody>
<tr>
<td>LBP (NRS)</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Leg pain (NRS)</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>Function (ODI)</td>
<td>28%</td>
<td>44%</td>
</tr>
<tr>
<td>FABQ: work</td>
<td>16</td>
<td>24</td>
</tr>
<tr>
<td>FABQ: physical activity</td>
<td>6</td>
<td>23</td>
</tr>
<tr>
<td>Lumbar flexion (cm)</td>
<td>20</td>
<td>46</td>
</tr>
<tr>
<td>Straight leg raise (SLR) (°)</td>
<td>62</td>
<td>45</td>
</tr>
<tr>
<td>PPT lumbar spine (lbs/cm²)</td>
<td>12.2</td>
<td>5.8</td>
</tr>
<tr>
<td>PPT thoracic spine (lbs/cm²)</td>
<td>14.3</td>
<td>16.5</td>
</tr>
<tr>
<td>PPT hand (lbs/cm²)</td>
<td>11.1</td>
<td>9.7</td>
</tr>
<tr>
<td>PPT leg (lbs/cm²)</td>
<td>4.9</td>
<td>4.2</td>
</tr>
<tr>
<td>TPD lumbar (mm)</td>
<td>65</td>
<td>75</td>
</tr>
<tr>
<td>TPD cervical (mm)</td>
<td>50</td>
<td>62</td>
</tr>
<tr>
<td>Localization accuracy (%)</td>
<td>80</td>
<td>50</td>
</tr>
<tr>
<td>Lumbar laterality accuracy (%)</td>
<td>100</td>
<td>92</td>
</tr>
<tr>
<td>Lumbar laterality speed (s)</td>
<td>1.55</td>
<td>1.8</td>
</tr>
<tr>
<td>Cervical laterality accuracy (%)</td>
<td>96</td>
<td>100</td>
</tr>
<tr>
<td>Cervical laterality speed (s)</td>
<td>1.61</td>
<td>2.14</td>
</tr>
</tbody>
</table>
about work and (ii) 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 (Cleland, Fritz, and Childs, 2008; Grotle, Vollestad, and Brox, 2006; Poiraudreau 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, Waddell, Tillotson, and Summerton, 1999; Fritz and George, 2002).

Lumbar flexion

Active trunk forward flexion, was measured from the longest finger on the dominant hand to the floor (Moseley, 2004b; Moseley, Nicholas, and Hodges, 2004; Zimney, Louw, and Puentedura, 2014). MDC for active trunk forward flexion has been reported as 4.5 cm (Ekedahl, Jonsson, and Frobell, 2012).

Straight leg raise

We used the straight leg raise (SLR) as a neurodynamic measurement rather than a test of hamstring length. In line with updated research, showing significant sensitization to movement pre- and postoperatively due to a herniated disc, the SLR was chosen as a physical movement to assess the sciatic nerve’s sensitization to movement (Herrington et al, 2008; Moseley, Nicholas, and Hodges, 2004; Zimney, Louw, and Puentedura, 2014). With disc herniation, inflammatory and immune responses and demyelination, it is now well accepted that even with removal of the physical disc material in surgery, the adjacent nerve root can remain sensitive to movement and a significant source of pain and disability (Franson, Saal, and Saal, 1992; Ozaktay, Kallakuri, and Cavanaugh, 1998; Saal et al, 1990; Takebayashi et al, 2001). Various authors have called for the SLR to be seen as a test of sensitization versus only a true measurement rather than a test of hamstring length. In line with Herrington et al (2008) and Walsh and Hall, 2009), With disc herniation, sensitization to movement (Coppieeters et al, 2005; Walsh and Hall, 2009)). SLR was measured with an inclinometer placed on the tibial plateau 5 cm distal to the inferior border of the patella on the most affected leg (Moseley, Nicholas, and Hodges, 2004; Moseley 2004b; Zimney, Louw, and Puentedura, 2014). MDC for SLR has been reported as a 5.7° difference (Ekedahl, Jonsson, and Frobell, 2012).

Pressure pain thresholds

Pressure pain thresholds (PPT) followed standardized protocols (Fernandez-de-las-Penas et al, 2009, 2010; Mendez-Sanchez et al, 2012) and was measured using a pressure pain algometer at the web space of the dominant hand, adjacent to the L3 spinous process on the affected side, adjacent to the T3 spinous process on the affected side and posterior knee of the affected leg (Moseley, Nicholas, and Hodges, 2004; Moseley 2004b; Zimney, Louw, and Puentedura, 2014). Twenty areas were stimulated and a score of percentage correct was calculated (Luomajoki and Moseley, 2011; Wand et al, 2011). No data is available on the normative values for localization, nor MDC (Luomajoki and Moseley, 2011; Wand et al, 2011).

Two-point discrimination (TPD)

Two-point discrimination was used to test tactile acuity (Catley, Tabor, Wand, and Moseley, 2013; Moseley, Nicholas, and Hodges, 2008) in the lumbar and cervical spine. Catley, Tabor, Wand, and Moseley (2013) reported 55.5 mm as normal TPD for the lumbar spine and 45.9 mm for the cervical spine. Very little is known about the MDC for TPD with Catley, Tabor, Wand, and Moseley (2013) reporting 15 mm to be beyond measurement error for the low back and 24 mm potentially as MDC for the neck.
knee (15%). In the thoracic spine PPT increased by 15%. Both lumbar and cervical TPD were on the fringes of normal values prior to surgery and increased following LS. Localization was decreased considerably, which was expected due to cutting of the superficial nerves and scar (tape and bandages were removed for postoperative testing). Laterality (accuracy and speed) of both cervical and lumbar spine showed no meaningful change from the preoperative measurements, which were within the normal values.

The immediate postoperative data showed various expected psychometric and physical changes (pain, fear-avoidance, disability and limited ROM), along with a series of noteworthy tactile changes, indicative of functional changes in the brain maps of the affected body parts. The surgery site particularly showed increased sensitization of the nervous system (PPT), expansion of the TPD and a decrease in localization accuracy. It could be argued that these changes are normal and to be expected following LS, but no LS study to-date have reported on this. The clinical question at this point was: If these tactile changes could be improved, would the outcomes translate to improvements in pain and ROM? GMI provided a logical intervention consistent with the proposed theoretical framework. At each appointment LBP, leg pain, flexion, SLR, TPD, Localization and PPT was to be tested before and immediately after treatment to determine immediate effects of the GMI program.

**Intervention**

The patient was scheduled for outpatient PT twice a week for 3 weeks with an average treatment session lasting 30 min. The preoperative and immediate postoperative data, along with the surgical precautions and limitations, were used to determine the most appropriate GMI program for this patient. GMI sequencing often starts with laterality retraining, ensuring a patient has an adequate sense of left and right of the affected body part (Moseley, 2004a, 2006). Since this patient displayed normal values of laterality (Bray and Moseley, 2011), it was deemed unnecessary to perform laterality training as part of the sequence. The patient’s training would therefore consist of the following interventions.

**Localization retaining**

The same protocol as the test was used (Luomajoki and Moseley, 2011; Wand et al, 2011). The patient was shown the nine squares for the back (Figure 1), tactile verbal confirmation of the location of the squares and then subsequently asked to identify the squares. Verbal feedback and correction was provided to aid in the training of the localization. Localization training lasted 5 min.

**Graphesthesa**

Graphesthesa training was administered by drawing various letters, numbers and symbols on the patient’s low back with the back of a pen (Byl and Melnick, 1997; Drago et al, 2010). The patient was asked to try and identify the corresponding letter, number or symbol. Initial training started with numbers only between zero and nine. This was followed by the first five letters of the alphabet A–E; capitalized followed by non-caps. As the patient progressed, the alphabet was expanded, followed by interspersing numbers, letters and symbols. In the event of an inaccurate report, the same stimulus was repeated along with verbal correction in an attempt to teach the patient the correct answer. Graphesthesa training lasted 5 min.

**Two-point discrimination**

A caliper was set to the patient’s low back TPD post-LS (75 mm). By alternating the skin pressure between one and two point stimulation, the patient was tasked to determine if she felt and report on feeling one or two points (Catley, Tabor, Wand, and Moseley, 2013; Moseley 2008). This was alternated throughout the session. As the patient progressed, the caliper distance was diminished to advance the training. TPD training lasted 5 min.

**Sensory discrimination**

To facilitate sensory discrimination the patient’s low back was stimulated either with a pen (dull) or sharp end of a paperclip (sharp) (Moseley and Wieck, 2009). This sequence was repeated at various intervals all over the low back. The sensory discrimination lasted 5 min.

**Motor imagery**

One of the steps of GMI is motor imagery or visualization (Moseley et al, 2008; Moseley, Butler, Beames, and Giles, 2012). The premise of visualizing non-threatening movements or parts of movements, while physically not performing the activity, is to allow movement maps (i.e. flexion) be ‘exercised’, refined and solidified while not physically stressing the involved body part (de Lange, Roelofs, and Toni, 2008; Moseley, 2004a, 2006; Moseley et al, 2008). For this exercise, the patient was asked to provide a list of 10 activities she would like to return to after LS. Pictures of similar activities were collected and printed out. These were used as visual cues. The patient then viewed the image, closed her eyes and visualized herself performing the same task for 10 s. The tasks identified by the patient included: walking, sitting at a desk, working in the garden, travel, shopping, cooking, sweeping the floor, sitting in a soft couch, doing the laundry and sitting through a movie. Three of the pictures resulted in an increased pain and stress experience (soft couch, laundry and sweeping) and was initially taken out. As the patient progressed, the images were added. Motor imagery lasted 5 min.

The patient was additionally provided with a detailed home exercise program (HEP). All of the localization, graphesthesa, TPD and sensory discrimination were repeated at home twice a day, each 5 min similar to outpatient PT, with the help of her husband. The patient’s husband attended the original preoperative, immediate postoperative and first treatment session to be educated on the HEP. The patient also repeated the motor imagery at home.

**Outcomes**

The patient’s overall outcome in regards to pain rating, ODI and FABQ was tracked for 1-year post-LS (Figure 2). Similar to the cohorts in the RCT she showed steady progression towards recovery (Louw, Diener, Landers, and PuenteDurada, 2014).

The outcomes of LBP, leg pain, flexion, SLR, TPD, localization and PPT are found in Table 2. To determine the overall effect of the treatment, changes in scores were calculated for each session, and then averaged over six therapy sessions utilizing GMI. In reviewing the average changes, neither LBP (0.33) nor leg pain (0.17) decreased considerably from pre- to post-treatment during the six PT visits, thus not meeting MDC. In regards to physical movement, forward flexion improved on average 3.3 cm from pre-treatment measurement to post-treatment measurements (Figure 3), with Session 1 and 6 exceeding the MDC of 5.7 cm. PPT changes at each session are depicted in Figure 5. No meaningful changes were observed for the PPT of the thoracic spine (3.8%)
Figure 2. One year outcomes following LS.

Table 2. Per-visit changes during GMI treatment.

<table>
<thead>
<tr>
<th>Measure</th>
<th>Visit 1 pre-Rx</th>
<th>Visit 1 post-Rx</th>
<th>Visit 2 pre-Rx</th>
<th>Visit 2 post-Rx</th>
<th>Visit 3 pre-Rx</th>
<th>Visit 3 post-Rx</th>
<th>Visit 4 pre-Rx</th>
<th>Visit 4 post-Rx</th>
<th>Visit 5 pre-Rx</th>
<th>Visit 5 post-Rx</th>
<th>Visit 6 pre-Rx</th>
<th>Visit 6 post-Rx</th>
</tr>
</thead>
<tbody>
<tr>
<td>LBP (NPRS)</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Leg pain (NPRS)</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Flexion (cm)</td>
<td>42</td>
<td>36</td>
<td>38</td>
<td>41</td>
<td>37</td>
<td>33</td>
<td>31</td>
<td>30</td>
<td>36</td>
<td>33</td>
<td>27</td>
<td>22</td>
</tr>
<tr>
<td>SLR (°)</td>
<td>43</td>
<td>55</td>
<td>50</td>
<td>56</td>
<td>62</td>
<td>62</td>
<td>60</td>
<td>72</td>
<td>50</td>
<td>60</td>
<td>61</td>
<td>71</td>
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<tr>
<td>PPT lumbar (lbs/cm²)</td>
<td>5.4</td>
<td>10.7</td>
<td>8.1</td>
<td>9.8</td>
<td>12.7</td>
<td>14.4</td>
<td>15.5</td>
<td>18.1</td>
<td>11.6</td>
<td>15.6</td>
<td>14.4</td>
<td>21.6</td>
</tr>
<tr>
<td>PPT thoracic (lbs/cm²)</td>
<td>14.7</td>
<td>14.5</td>
<td>15.2</td>
<td>14.5</td>
<td>20.4</td>
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<td>25</td>
<td>22.5</td>
<td>22.8</td>
<td>22</td>
<td>21.2</td>
<td>19.8</td>
</tr>
<tr>
<td>PPT hand (lbs/cm²)</td>
<td>10.3</td>
<td>10.3</td>
<td>7.8</td>
<td>6.8</td>
<td>9</td>
<td>9.2</td>
<td>10.9</td>
<td>11.1</td>
<td>10.9</td>
<td>12.3</td>
<td>12.9</td>
<td>11.16</td>
</tr>
<tr>
<td>PPT leg (lbs/cm²)</td>
<td>5.5</td>
<td>11.8</td>
<td>5.6</td>
<td>6.1</td>
<td>5.2</td>
<td>6.5</td>
<td>9.9</td>
<td>6.3</td>
<td>8.7</td>
<td>6.9</td>
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<td>13.9</td>
</tr>
<tr>
<td>TPD lumbar (mm)</td>
<td>75</td>
<td>75</td>
<td>55</td>
<td>80</td>
<td>75</td>
<td>70</td>
<td>87</td>
<td>70</td>
<td>75</td>
<td>75</td>
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<tr>
<td>TPD cervical (mm)</td>
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<td>55</td>
<td>50</td>
<td>90</td>
<td>90</td>
<td>50</td>
<td>40</td>
</tr>
</tbody>
</table>

Figure 3. Changes in forward flexion at each visit. *Visit 1 and 6 resulted in immediate changes exceeding MDC.
and hand (2.5%) (neither reaching clinical significant change). PPT in the low back and leg increased on average by 24.5 and 7.3% respectively, with both lumbar and leg obtaining clinical significant changes in five of the six treatment sessions. TPD on average improved 1.17 mm for the lumbar spine in each session, while cervical TPD improved by an average of 5 mm per session. The patient’s localization improved from Visit 1 (50%) to 100% after Visit 4 and remained so until discharge.
Discussion

To the best of our knowledge, this is the first reported case of utilizing GMI for an immediate post-operative LS patient. Although care should be taken to interpret the findings of a single case, this report does; however, provide some interesting findings.

Following LS patients routinely recover between 3 and 4 weeks after surgery, followed by a consultation with the spine surgeon (McGregor, Burton, Sell, and Waddell, 2007; McGregor et al, 2012; Ostelo et al, 2003). During the acute postoperative period, movement, loading and function is often limited to allow for tissue healing and as means to prevent potential postoperative complications (Ostelo et al, 2003; McGregor, Burton, Sell, and Waddell, 2007; McGregor et al, 2012). Body maps in the brain, however, are dynamically maintained and significantly impacted by limited movement (Flor, Braun, Elbert, and Birbaumer, 1997; Flor et al, 1998; Lotzze and Moseley, 2007; Maihofner, Handwerker, Neudorfer, and Birklein, 2003; Moseley, 2008, 2005a) and the presence of pain (Flor, Braun, Elbert, and Birbaumer, 1997; Flor et al, 1998; Lotzze and Moseley, 2007; Maihofner, Handwerker, Neudorfer, and Birklein, 2003; Moseley, 2008, 2005a). Furthermore, these changes in shape and size of body maps seem to correlate with increased pain and disability (Flor, Braun, Elbert, and Birbaumer, 1997; Lloyd, Findlay, Roberts, and Nurmiikko, 2008). Our case report suggests that such mechanisms may be involved in the immediate acute post-LS patient. It has been shown that these changes occur in as short periods as 30 min (Stavrinou et al, 2007). PPT in the low back (surgery site) increased 53%, often cited as an increased sensitization of the nervous system and associated with pain (Fernandez-de-Las-Penas, Cuadrado, Arendt-Nielsen, and Pareja, 2008; Fernandez-de-Las-Penas et al, 2010; Slater, Arendt-Nielsen, Wright, and Graven-Nielsen, 2006). Tactile changes in the low back occurred, including localization decreasing by 37% and TPD increasing. The purpose of this case report was to describe these changes and their potential association with meaningful changes in pain and movement. The pre- and immediate post-treatment measurements of flexion, SLR and PPT would suggest this possible association. Although the effect of recovery time and healing has to be considered, the key finding of this report is that non-physical-movement GMI techniques applied to the lumbar spine seemed to cause marked improvements in movements and an immediate hypoalgesic effect of the lumbar spine. By addressing issues known to be associated with cortical changes of a body map, our patient demonstrated several measurements that exceeded MDC, including average SLR increase of 8.33° and average PPT of the low back increasing by 24.5%. Although lumbar flexion improved by 3.3 cm and thus not reaching MDC (4.5 cm), it is noteworthy that MDC values are from non-surgical LBP patients, suggesting the increased flexion may in fact be potentially meaningful in an acute post-operative LS patient. These results concur with previous studies linking movement changes to PPT measurements (Moss, Sluka, and Wright, 2007; Sterling, Jull, and Wright, 2001; Vicenzino, Collins, Benson, and Wright, 1998). With increased pain and fear, as demonstrated by the patient’s immediate postoperative increase in FABQ, it can be expected for PPT to increase. A heightened sensitization of the nervous system has been correlated to decreased ROM, pain and dysfunction (Coppiters et al, 2005; Nee and Butler, 2006; Nee, Jull, Vicenzino, and Coppiters, 2012). Conversely, altering sensitivity of the nervous system has been correlated to improved ROM (Moss, Sluka, and Wright, 2007; Nee et al, 2012; Sterling, Jull, and Wright, 2001; Vicenzino, Collins, Benson, and Wright, 1998), similar to this case report. All of the improved movements, however, should be seen in light of both LBP (0.33) and leg pain (0.17) failing to obtain meaningful improvement in the acute postoperative period. Pain protects, and it is argued pain after surgery is needed to protect a patient from moving too much or too soon (Louv, Butler, Diener, and Puenteledura, 2013; Louw, Diener, Landers, and Puenteledura, 2014). In line with the current best-evidence of pain neuroscience education, despite the pain, the patient displayed improved movements, showing a potential reconceptualization of her pain, which is a cornerstone of a pain science approach (Louv, Diener, Butler, and Puenteledura, 2011; Moseley, Nicholas, and Hodges, 2004).

The findings from this report highlight a possible new role of PT in the immediate postoperative period. The 3-week treatment program this patient received after LS is typically a time of limited movement (Louv, Butler, Diener, and Puenteledura, 2012; Louw, Louw, and Crous, 2009). By having a patient undergo a series of non-threatening, non-physical movements through cortical processes may indeed help retrain and solidify normal sensory and motor maps. Future studies would need to investigate if the immediate changes reported in this patient occur in all LS patients and if, during the 3 week waiting period intensify or spontaneously restore as movement and function improves. Furthermore, a clinical trial may need to establish if patients who receive the GMI training in the dormant period result in superior outcomes compared to patients receiving the usual 3-week rest period. It has been shown that various perioperative issues influence surgical outcomes including: expectations (Toyone et al, 2005); fear (Archer et al, 2014; Louw, Louw, and Crous, 2009; Oshodi, 2007); pain (Fletcher and Martinez, 2014; Toyone et al, 2005); fear (Archer et al, 2014; Louw, Louw, and Crous, 2009; Oshodi, 2007); pain catastrophization (Clarke et al, 2013) and more. The results from this case report, however, highlight yet another potential perioperative issue that warrants further investigation. Could restoration of altered cortical maps, in the acute phase post-LS, be predictive of LS outcomes? Furthermore, can PT by ‘‘moving a patient without moving’’ and reorganizing cortical maps of the lumbar spine, provide a non-threatening therapy to patients who underwent LS?

Declaration of interest

The authors report no conflicts of interest.

References


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