The Effects of Massage Therapy on Reducing Pain, Improving Sleep Quality, and Increasing Breathing Function on a Sciatica Patient: A Case Study

Melinda Lugo

Acknowledgements:

Many thanks to Randall Clark for his guidance and support throughout the case report process; to the faculty and staff of the Center for Neurosomatic Studies; and to the research patient for agreeing to participate in the case study.

Abstract:

Background: Sciatica is one of the most common variations of low back pain. As many as 30% of sciatica patients experience pain symptoms one year after onset, making a substantial impact on quality of life and workplace productivity. The efficacy of medications prescribed to treat sciatica is unclear, and the long-term effects of using these interventions makes them undesirable for chronic pain patients.

Participant: A 36-year-old Hispanic female office worker with recurrent pneumonia presents with low back pain and sciatica in the left hip following a weightlifting injury.

Diagnosis: Sciatica; notable health issues include a history of low back pain, recurrent pneumonia, and bronchitis

Purpose: To discover if the utilization of massage, combined with inner unit stabilization exercises, can decrease pain, improve sleep quality, and increase breathing pattern functionality

Intervention: The practitioner is a 44-year-old female in the 8th month of an 18-month program at the Center for Neurosomatic Studies (CNS). Biweekly targeted, deep-tissue massage treatments were performed, and the patient completed inner unit stabilization exercises as at-home practice. Results were tracked using the Bournemouth Back Questionnaire, ODI, PGIC, and postural assessments.

Results: Pain levels were significantly reduced in both the lower back and hip, and overall quality of life scores improved as indicated on the Bournemouth Back Questionnaire, ODI, and PGIC. The patient also discontinued use of her rescue inhaler by the end of the study.

Conclusion: Specific, directed massage techniques and inner unit stabilization exercises decreased back and hip pain, improved sleep quality, and increased breathing function in one sciatica patient. Further research is needed to determine if the same outcomes can be expected for a larger population of patients with the same symptoms.

Keywords: Sciatica, low back pain, breathing pattern, sleep quality, massage, inner unit stabilization, case report

Introduction and Literature Review:

The National Institute of Neurological Disorders and Stroke reports that 80% of adults experience low back pain (LBP) at some point in their lives. (1) Back pain is the leading cause of job-related disability and is a leading contributor to missed work days. (1) An estimated 20% of people affected by LBP develop chronic back pain: that is, pain lasting 12 weeks or more. (1) According to a 2010 statistic, LBP is considered the most burdensome in terms of mortality or poor health in the US, behind ischemic heart disease and chronic obstructive pulmonary disease (COPD). (1) The fact that LBP impacts such a vast portion of the population, and that it impacts health, quality of life, and productivity makes research in the treatment of back pain relevant to the health community.

Approximately 60% of LBP patients present with pain in the leg, and sciatica is one of the most common variations of LBP. (2) Sciatica pain is often attributed to nerve root impingement, and the severity of the pain, along with how far the pain radiates down the leg, can have impact

patient recovery time. (2) According to a European study, 30% of sciatica patients still experience pain symptoms one year after onset. (3) Effective interventions are needed to reduce recovery time and improve patient quality of life.

While prescription NSAIDs are often used to treat chronic pain symptoms, there are risks associated with their usage. These include myocardial infarction, stroke, and perforation of the GI tract. (1, 4) In the last two years, the FDA has strengthened its warnings against prolonged use of NSAIDs, adding that the increased risks for heart attack or stroke can happen within just weeks of using these medications. (4) Based on the increased risks, the need for an alternative form of treatment is evident.

LBP sufferers contend with a myriad of symptoms that impact their overall health, including sleep disturbances. A study published by the *European Spine Journal* indicated that 58% of LBP sufferers surveyed experienced sleep disturbances resulting from their back pain. (5) Sleep disturbances are known to have many long-lasting physical and psychological effects, including depression, obesity, hypertension, and cardiovascular disease. (5) Addressing the connection between chronic back pain and sleep disturbances can have a significant impact on overall patient health.

There is also growing interest in the role breathing pattern disorders play trunk stability, functional movement, and pain pathologies. In a study published by *The International Journal of Sports Physical Therapy*, individuals with LBP show signs of improper breathing mechanics, and poor coordination of the diaphragm (a primary breathing muscle) may result in lumbar spine instability and negatively affect functional movement. (6) Thoracic breathing—relying on accessory respiratory muscles instead of the primary respiratory muscles (diaphragm, pelvic floor, multifidus, and transverse abdominus)—is linked to overexertion of the accessory muscles

and a decrease in CO2 in the bloodstream. This can trigger negative changes in health and performance on multiple levels. (6) If effective breathing patterns can be taught, that could encourage increased trunk stability and improved functional movement; perhaps, it could help prevent injury or reinjury.

The purpose of this case study is to determine if specific, directed massage, paired with inner unit stabilization exercise, can reduce pain, improve sleep quality, and increase breathing function in a patient with chronic LBP classified as sciatica.

Methods:

Profile of Client:

The patient is a 36-year-old, 5'3", 200-pound married female. She works from home as an online consultant for an insurance company. Her work is sedentary, requiring that she work at a computer for 40-45 hours per week.

The patient's goals are to have more energy, be free of pain, and sleep better. Her primary complaint is lower back and hip pain following a weightlifting injury, which occurred in August 2016. After completing deadlifts, she noticed her lower back was tight and sore. Initially, the pain was on the left side of her lower back, just superior to the sacrum (left quadratus lumborum). She later noticed sharp, pinching pain starting at her left hip and radiating down into her gluteal region and down the leg just superior to the lateral left knee. Eventually she was unable to stand upright or bend to touch her toes (previously not an issue for her), and she reported severe pain. Her pain was still present at the time of the first treatment, with burning/pinching sharp pains starting at the left hip and travelling down the leg.

The patient reports her pain is affecting sleep quality. She awakens multiple times a night because of pain and has difficulty finding a comfortable sleeping position. Once she finds it, it is difficult to return to sleep. She is currently getting 4-6 hours of interrupted sleep each night. The lack of quality sleep is affecting her energy levels, and she has difficulty completing some tasks due to fatigue and pain. She is unable to stand for longer than 30 minutes. Washing, dressing, and lifting cause her pain, Pain levels prevent her from pursuing physical activities that she was previously able to do. These include bicycling, walking, exercising, and paddle boarding, along with regular household chores like cooking and cleaning.

The patient has had multiple bouts of pneumonia, including 2 occurrences requiring hospitalization (at age 2 and 7, respectively). Recurrent pneumonia is defined as more than 2 episodes in one year, or 3 or more episodes anytime during a person's life. (7) Since the 2 childhood episodes, the patient had at least one other bout of pneumonia along with several other occurrences of walking pneumonia, as diagnosed by her primary care physician. The patient has had multiple bouts of bronchitis, and she reported that she had ongoing breathing difficulties.

Currently, the patient is taking Meloxicam 7.5 mg (an anti-inflammatory) and Metaxalone 800 mg (a muscle relaxant). She takes the Meloxicam once every 3 days, and the Metaxalone as needed. At the time the study began, the patient was in the process of weaning herself off the Metaxalone and had gone 2 weeks without requiring prescription-strength pain relief. She also was using a rescue inhaler as needed to assist with breathing difficulties stemming from bronchitis.

Contraindications:

No contraindications were present at the time of the study.

Diagnostic Assessment:

At the time of the injury, the patient saw her healthcare provider, who completed an interview and examination and diagnosed her with sciatica. The patient received steroid injection to reduce inflammation and started a course of prescription NSAIDs and muscle relaxants. Steroid injection and medication are among the more common treatments for sciatica. She has also received some massage treatments to help address the issue, but has had limited success with her treatment to date.

Assessment Measures/Clinical Findings:

A postural assessment was completed by the student therapist on the first day of treatment and on all subsequent visits. The assessment is an 84-point measurement of the patient in standing, supine, and seated positions to identify potential sources of postural imbalances along the midsagittal, coronal, and transverse planes. A plumb bob was used to complete visual assessments along the midsagittal and coronal plane. Since this is a visual assessment, the plumb bob establishes a true vertical line from which the therapist can assess the patient for lateral shearing, lateral tilt, or rotation of the cranium along the midsagittal plane. (8) The therapist places the index finger of one hand on the patient's manubrium, then aligns the plumb bob with the manubrium to complete the visual assessment. The plumb bob is also used to establish a vertical line for completing visual assessment of the patient in the coronal plane. (8) By using this tool, the therapist can assess whether the patient is in anterior, neutral, or posterior position in relation between five landmarks on the coronal plane. (8) Refer to the protocol as described in *The Posturology Handbook*.

Standing measurements indicated the pelvis was tilted to the right and was rotated anteriorly on the right, while the hips had a left obliquity. The greater trochanter measured superior on the right side. The patient's right acromioclavicular joint and clavicle measured both superior and anterior on the right side. In supine, the acromioclavicular and clavicle measurements remained the same; however, the orientation of the pelvic and trochanteric measurements switched: the pelvis measured both inferior and anterior on the left side, with the greater trochanter measuring superior on the left. No pelvic obliquity was present in the supine position. In the seated position, no pelvic or cranial distortions were observed.

Along the coronal place, the patient presented with a head forward posture, and goniometer measurements indicated she had above average pelvic flexion (14 and 15 degrees on the left and right hips, respectively, outside the normal range of 5-10 degrees of flexion for females). (8)

The diaphragm performs both breathing and postural functions, providing both trunk stability and helping maintain breath. (6, 9) To determine if a Breathing Pattern Disorder (BPD) exists, a Hi Lo breathing assessment is done: the clinician observes the patient breathing in and out in a seated position, looking for movement in the chest and abdomen. (6) Visual assessment indicated the patient had a thoracic breathing pattern, with very little abdominal movement during inspiration and expiration but a great deal of movement in the upper thoracic and cervical region.

Outcome Measures:

The patient's progress was recorded using the Bournemouth Back Questionnaire, which was administered to the patient prior to the start of each session. The Oswestry Low Back Pain Scale was administered prior to the 1st, 6th, and 10th sessions. At the end of the study, the patient also completed the Patient's Global Impression of Change scale. The Oswestry Low Back Pain

Disability Questionnaire (ODI), the Back Bournemouth Questionnaire (BBQ), and the Patient's Global Impression of Change scale (PGIC) are widely used and validated outcome measures used with chronic pain patients in a variety of clinical settings. (9, 10) They were selected for this study because they are concise, easy to complete, and reliable self-reporting outcome measures.

Therapeutic Intervention:

The practitioner is a student at the Center for Neurosomatic Studies. She is in the 8th month of the 18-month, 1278-hour certification program. Her training to date includes general massage technique, myofascial release, joint mobilization, and trigger point therapy, along with specific cranial, temporomandibular joint, visceral, and lower body protocols.

Treatments were administered at the Center for Neurosomatic Studies in Clearwater, Florida. The patient received 10 1-hour treatments, administered biweekly over a 5-week period. The treatments were completed under the supervision of the clinic director, himself an experienced massage therapist and instructor. The classroom was arranged as a clinic, with curtains in place to provide privacy. The practitioner used an Oakworks massage table, Massage Star tools, and Biotone Massage Gel. A plumb bob, goniometer, chopsticks, and stepstool were tools used to complete the assessments.

The patient's pain and postural distortions indicated attention should be focused on the gluteal muscles, the deep hip rotators, and the erector spinae group. (11) Based on the patient's history of breathing difficulties, along with a visual assessment of the patient's breathing, it was determined that the diaphragm, lungs, and deep costal muscles would also be treated. (11, 12)

Home learning/practice in the form of inner unit activation exercises were added to encourage trunk stabilization and more effective, diaphragmatic breathing. (12, 14)

Techniques used to treat the patient included myofascial release, friction, glides, and static pressure to alleviate the affected muscles. To treat the lungs, the practitioner used compressions along the thoracic cage while the patient lay in prone, supine, and side-lying positions. (12) Deep costal muscles were treated using friction and cross-friction strokes with the patient also in prone, supine, and side-lying. (11) The therapist used both her thumbs and a massage star tool for this application, adjusting for client comfort as needed. Diaphragm, iliacus, and psoas treatments are performed with the patient in a supine position with bent knees to allow therapist access to the abdomen and thoracic cage. (11) Refer to *Neurosomatic Approaches to the Lower Body* and *Neurosomatic Approaches to the Cranium, Temporomandibular Joint, and Viscera* for protocols. The table below represents the muscle groups and organs addressed in each treatment, along with any home learning activities given to the patient.

Treatment Summary by Date (treatment side indicated by "L", "R", or "BL" for left, right, or bilateral treatment)

Date	Muscles/Organs Treated	Techniques Used	Purpose for Treating	Home Learning/Practice
4/1/2017	Gluteus Maximus(L); Gluteus Medius(L); Gluteus Minimus(L); Quadratus Lumborum (BL); Deep Hip Rotators (L)	Compression; friction; cross-friction; glides; trigger point release	Relieve trigger points and tightness in affected muscles, relax attachments in lumbar/sacral region, relieve pain around piriformis and other deep hip rotators	N/A
4/5/2017	Erector Spinae Group (BL); Quadratus Lumborum (BL); Iliacus (BL); Psoas Major/Psoas	Compression; friction; cross-friction; glides, trigger point release; myofascial release	Relieve trigger points and tightness in affected muscles, relax attachments in lumbar/sacral region, reduce	N/A

	Minor (BL); Gluteal Group (L); Pectoralis Minor (R); Deep Hip Rotators (L)		pelvic flexion, relieve pain around piriformis and other deep hip rotators, myofascial work and compression to treat pectoralis minor	
4/8/2017	Quadratus Lumborum (BL); Erector Spinae (BL); Dural Tube; Rotatores (R); Gluteal Group (L);	Compression; friction; cross-friction; glides; trigger point release, dural tube mobilization	Relieve trigger points and tightness in affected muscles, relax attachments in lumbar/sacral region, relieve pain around piriformis and other deep hip rotators; mobilization of Dural tube for neck tightness	TVA activation exercises: breathing exercises, seated and standing, 2x daily
4/12/2017	Superficial Abdominals (BL); Lungs (BL); Erector Spinae (BL); Quadratus Lumborum (BL); Gluteal Group (L)	Compression; friction; glides; trigger point release	Relieve trigger points and tightness in affected muscles, relax attachments in lumbar/sacral region, aid in movement in thoracic cage and abdomen to improve breathing pattern functionality	TVA activation exercises: breathing exercises, seated and standing, 2x daily
4/19/2017	Erector Spinae Group (BL); Iliacus (R); Psoas Major/Psoas Minor (BL); Quadratus Lumborum (BL)	Compression; friction; cross-friction; glides; trigger point release	Relieve trigger points and tightness in affected muscles, relax attachments in lumbar/sacral region, reduce pelvic flexion	TVA activation exercises: breathing exercises, seated and standing, 2x daily
4/22/2017	Superficial Abdominals (BL); Diaphragm (BL); Upper Trapezius (BL)	Compression; compression with opposition; friction; cross-friction; glides; trigger point release	Relieve trigger points and tightness in affected muscles, relax attachments in lumbar/sacral region, improve breathing pattern functionality	TVA activation exercises: breathing exercises, seated and standing, 2x daily
4/26/2017	Erector Spinae (BL); Deep Costal Muscles (L); Lungs (BL); Deep Hip Rotators (L); Upper Trapezius (BL); Dural Tube	Compression; compression with opposition; friction; cross-friction; glides; trigger point release; Dural tube mobilization	Relieve trigger points and tightness in affected muscles, relax attachments in lumbar/sacral region, improve breathing pattern functionality by relaxing deep costal muscles	Same as above, plus: marching in supine exercise, 2x daily

4/29/2017	Deep hip rotators (BL); Glute Medius and Minimus (L); External Obliques (BL); Internal Obliques (BL)	Compression; compression with opposition; friction; cross-friction; glides; trigger point release	Relieve trigger points and tightness in affected muscles, relax attachments in lumbar/sacral region, relieve pain around piriformis and other deep hip rotators	Same as above, plus: marching in supine exercise, 2x daily
5/3/2017	Lung (BL); Diaphragm (BL); Deep Costal Muscles (L); Superficial Abdominals (L);	Compression; compression with opposition; friction; cross-friction; glides; trigger point release	Improve breathing pattern functionality by targeting primary breathing muscles and organs, along with relaxing muscles around thoracic cage	Same above, plus: marching in seated and standing positions, quadruped, and quadruped with opposite arm/leg, 2x daily
5/6/2017	Deep Hip Rotators (L); Erector Spinae Group (BL); Superficial Abdominals (L); Posterior neck (BL)	Compression; compression with opposition; friction; cross-friction; glides; trigger point release	Relieve trigger points and tightness in affected muscles, relax attachments in lumbar/sacral region, relieve pain around piriformis and other deep hip rotators	Same above, plus: marching in seated and standing positions, quadruped, and quadruped with opposite arm/leg, 2x daily

Informed Consent:

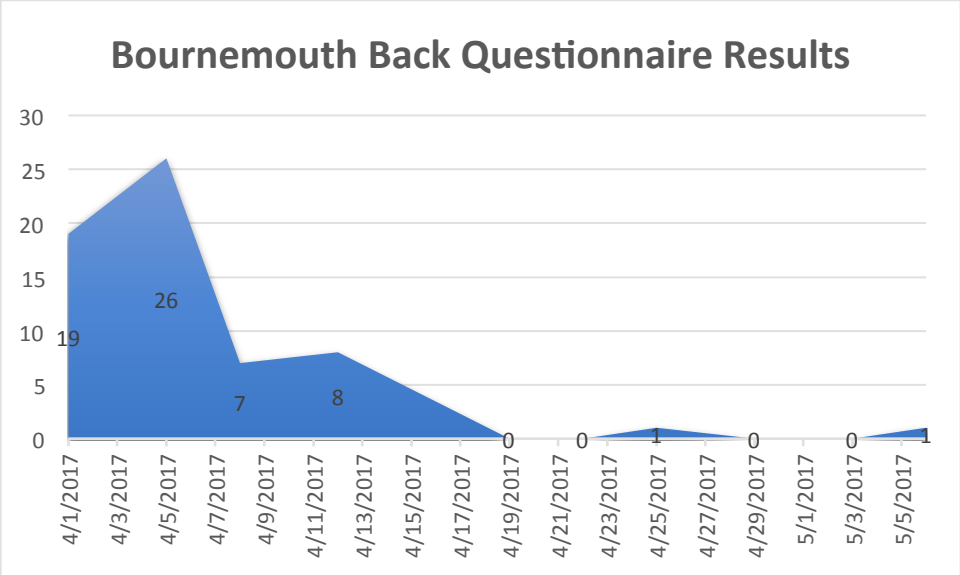
The research participant completed and signed a Client Consent for Publication of Case Report form. She consented to using her images and other clinical information related to her case to be submitted as part of this case report under the condition of anonymity. She was educated about clinical findings as well as treatment options, and agreed to the course of treatment recommended by the student practitioner.

Results:

The patient complied with the treatment plan and attended all sessions as agreed to at the beginning of the study. She tolerated treatment well, and provided regular reports of her progress, including pain levels, sleep quality, and other daily living functions. She was given a

series of inner unit stabilization exercises as part of a daily home treatment plan. These exercises were meant to activate her primary breathing muscles (diaphragm, pelvic floor, multifidi, and transverse abdominus). The patient was largely compliant with the home treatment plan, missing just 2 days of planned exercise.

The patient reported a noticeable reduction in pain symptoms after the third session. Composite scores on the Bournemouth Back Questionnaire dropped from 26 to 7 by the fourth treatment, and scores remained in the 0 to 1-point range from the 5th treatment through the end of the study. Results on the Oswestry Low Back Pain Scale also indicate a decline in pain, with the Disability Index Score dropping from 36% (moderate disability) to 8% (minimal disability) by the conclusion of the study. (15)



Summary of Oswestry Low Back Pain Scale

Date	4/1/2017	4/22/2017	5/6/2017
Pain Intensity	2	0	0
Personal Care	2	0	0

Lifting	**1**	**0**	**0**
Walking	**1**	**0**	**0**
Sitting	**2**	**1**	**1**
Standing	**3**	**0**	**1**
Sleeping	**2**	**0**	**1**
Social Life	**1**	**0**	**0**
Traveling	**2**	**0**	**1**
Changing Degree of Pain	**2**	**0**	**0**
Disability Index Score	**36%**	**2%**	**8%**

The patient reported significant changes to sleep quality and duration. At the beginning of the study, the patient consistently got 4-6 hours of "fitful" sleep every night, with pain preventing her from finding a comfortable sleeping position in which she could sleep. By the 3rd treatment, the patient reported she was getting 7-9 hours of sleep nightly. When the patient did awaken in the middle of the night, she was able to quickly find a comfortable position and return to sleep. These results continued throughout the duration of the study period.

Beginning with the fourth session, treatments to address the lungs, diaphragm, transverse abdominus, and deep costal muscles were added. The left lung and left side of the diaphragm appeared to have the most restriction when completing the visual assessments and in palpation. Following that 4th treatment, the patient reported her breathing issues were subsiding and she discontinued use of her rescue inhaler. During both lung and diaphragm treatments, the patient had a noticeable response to treatment, indicated she felt an immediate improvement in the quality of her breathing. She also reported noticing greater trunk strength and stability following

the implementation of the home learning activities. This enabled her to stand for longer periods of time while performing a variety of tasks including bending and lifting.

The patient completed the PGIC at the end of the study and indicated that since the beginning of treatment, the change in activity limitations, symptoms, emotions, and overall quality of life related to her pain condition were "a great deal better, and a considerable improvement that has made all the difference."

Patient's Perspective:

"I had an excellent experience throughout the process. I went in with an open mind and learned a lot about my body and things I can do to help get me back to an active lifestyle. Now that the study is over, not only am I pain free, but my sleep, breathing and general mobility are all much improved. With your help, I've accomplished my goal of becoming more active. Not only have I started going on bike rides again, but I've been able to long dog walks with the pups and started getting workouts in at home as well."

Discussion:

The intervention used in this study was effective at addressing the patient's three main desires of having more energy, sleeping better and being free of pain. In addition to these gains the patient is also sleeping better and has an increase in general mobility. Although the patient had previously tried massage therapy and medication to address her pain, nearly a year after the onset of symptoms, the patient was still in pain and using medication to address her pain. By utilizing targeted massage technique to reduce her pain and addressing her deep abdominal muscles, hip rotators, deep costal muscles, and lungs, the patient's postural distortions were reduced. This reduction in pain allowed for the implementation of the home exercise plan that allowed the

patient to focus on stabilizing her inner unit, leading to increased strength and endurance in those muscles and improvement in her breathing pattern. The combination of these techniques may have allowed the patient to show a much greater improvement than she had experienced with massage therapy and pain medication.

A study in *The Scientific World Journal* affirms that treatment of chronic low back pain must not only treat pain symptoms, but must also train the patient to develop strength in target muscle groups and use proper body mechanics to avoid repeated injury. (17) Adopting a treatment strategy that including massage therapy treatment, trunk stability training, and breathing pattern practice was the most prudent course of action to take to help the patient avoid reinjuring herself.

An association has been made between breathing pattern and functional movement. In one study, individuals with inefficient breathing patterns scored lower on the Functional Movement Screen (FMS) assessment than those who presented with normal breathing patterns. (6) Individuals who are thoracic breathers showed hypertonicity of the accessory breathing muscles. (6) Inefficient use of the diaphragm alters trunk stability and can negatively impact body mechanics. (6, 13) It can be concluded that ineffective breathing patterns inhibit functional movement and can, as a result, be a predictor of dysfunction and future injury. Forced breathing exercises are shown to improve lumbar stabilization and breathing function while providing stimulation to the abdominal muscles and erector spinae group. (6, 9, 13) The patient in this study reported an improvement in breathing function and an increase in endurance during physical activity.

Actigraphy studies show that people with chronic pain have less efficient sleep than healthy individuals, and existing research points to significant disruptions in brain activity during sleep for chronic pain patients. (6, 18) Sleep deficits have significant effects on health, as it suppresses major functions that can impact memory consolidation, immune function, and cognitive

performance. (6) The use of opioid pain medication can make the problem much worse, making the use of these medications even less desirable. (17, 18) Add to that evidence showing that patients taking opioid medication have higher rates of sleep apnea and decreased arterial oxygen saturation. (6) These health implications highlight the importance of finding more suitable treatment options for chronic pain patients. The research patient reported sharp improvement in both sleep quality and duration, and discontinued use of her prescription pain medication.

Specifically directed massage technique, paired with inner unit activation exercise, proved to be an effective treatment for this patient. Although this case study explores the effects of treatment on only one participant, the future implications of this treatment could extend beyond reducing pain, but could increase overall quality of life for chronic pain patients and decrease the need for pain medication. Further study is needed to assess the effectiveness of this protocol for a larger population size.

References

1. Low Back Pain Fact Sheet | National Institute of Neurological Disorders and Stroke. *Nindsnihgov*. 2017. Available at: https://www.ninds.nih.gov/Disorders/Patient-Caregiver-Education/Fact-Sheets/Low-Back-Pain-Fact-Sheet. Accessed April 19, 2017.

2. Foster N, Konstantinou K, Lewis M et al. The clinical and cost-effectiveness of stratified care for patients with sciatica: the SCOPiC randomised controlled trial protocol (ISRCTN75449581). *BMC Musculoskeletal Disorders*. 2017;18(1). doi:10.1186/s12891-017-1513-5.

3. Stynes S, Konstantinou K, Dunn K. Classification of patients with low back-related leg pain: a systematic review. *BMC Musculoskeletal Disorders*. 2016;17(1). doi:10.1186/s12891-016-1074-z.

4. Mobic (meloxicam) dose, indications, adverse effects, interactions... from PDR.net. *Pdrnet*. 2017. Available at: http://www.pdr.net/drug-summary/Mobic-meloxicam-1245.8232. Accessed April 19, 2017.

5. Alsaadi S, McAuley J, Hush J, Maher C. Prevalence of sleep disturbance in patients with low back pain. *European Spine Journal*. 2010;20(5):737-743. doi:10.1007/s00586-010-1661-x.

6. Bradley H, Esformes J. Breathing Pattern Disorders and Functional Movement. *The International Journal of Sports Physical Therapy*. 2014;9(1):28-39. Available at: : https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3924606/. Accessed April 19, 2017.

7. Zan Y, Liu H, Zhong L, Qiu L, Tao Q, Chen L. Childhood recurrent pneumonia caused by endobronchial sutures. *Medicine*. 2017;96(4):e5992. doi:10.1097/md.0000000000005992.

8. Clark R, Jones T, Wade K. *The Posturology Handbook*. 1st ed. Clearwater: Neurosomatic Educators LLC; 2016.

9. Kang J, Jeong D, Choi H. Effect of exhalation exercise on trunk muscle activity and oswestry disability index of patients with chronic low back pain. *Journal of Physical Therapy Science*. 2016;28(6):1738-1742. doi:10.1589/jpts.28.1738.

10. Irgens P, Lothe L, Kvammen O, Field J, Newell D. The psychometric profile of chiropractic patients in Norway and England: using and comparing the generic versions of the STarT Back 5-item screening tool and the Bournemouth Questionnaire. *Chiropractic & Manual Therapies*. 2013;21(1):41. doi:10.1186/2045-709x-21-41.

11. Clark R, Jones T, Wade K. *Neurosomatic Approaches To The Lower Body*. 1st ed. Clearwater: Neurosomatic Educators LLC; 2015.

12. Clark R, Jones T, Wade K. *Neurosomatic Approaches To The Cranium, Temporomandibular Joint, And Viscera*. 1st ed. Clearwater: Neurosomatic Educators LLC; 2015.

13. Ki C, Heo M, Kim H, Kim E. The effects of forced breathing exercise on the lumbar stabilization in chronic low back pain patients. *Journal of Physical Therapy Science*. 2016;28(12):3380-3383. doi:10.1589/jpts.28.3380.

14. Clark M, Sutton B, Lucett S. *NASM Essentials Of Personal Fitness Training*. 4th ed. Burlington: Jones and Bartlett Learning; 2014.

15. Mobbs R, Phan K, Maharaj M, Rao P. Physical Activity Measured with Accelerometer and Self-Rated Disability in Lumbar Spine Surgery: A Prospective Study. *Global Spine Journal*. 2016;6(5):459-464. doi:10.1055/s-0035-1565259.

16. Allen, BA, LMBT L. Case Study: The Use of Massage Therapy to Relieve Chronic Low-Back Pain. *International Journal of Therapeutic Massage & Bodywork: Research, Education, & Practice*. 2016;9(3). doi:10.3822/ijtmb.v9i3.267.

17. Robertson J, Purple R, Cole P, Zaiwalla Z, Wulff K, Pattinson K. Sleep disturbance in patients taking opioid medication for chronic back pain. *Anaesthesia*. 2016;71(11):1296-1307. doi:10.1111/anae.13601.

18. Majchrzycki M, Kocur P, Kotwicki T. Deep Tissue Massage and Nonsteroidal Anti-Inflammatory Drugs for Low Back Pain: A Prospective Randomized Trial. *The Scientific World Journal*. 2014;2014:1-7. doi:10.1155/2014/287597.