The effect of diaphragm & rib cage somatic dysfunction as primary maintaining factor in low back pain

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Introduction

Low back pain is a very common problem that can find in woman or man and in any age. Almost everyone has low back pain at some point in their life. The low back, also called the lumbar region, is the area of the back that starts below the ribcage. Low back pain can be cause by result from a strain or injury to muscles and tendons in the back. Other causes include arthritis, structural problem, and disc injuries.

What is lower back pain?

Low back pain can result from many different injuries, conditions, or diseases, The most is often cause by an injury to muscle or tendons. The level of the pain can range from mild to severe. In some cases, pain can make it difficult or impossible to walk, work, sleep or do daily life activities.

Usually, low back pain gets better with rest and medication (pain relievers) or other alternative therapy way such as osteopathic, chiropractic manipulation, physical therapy rehabilitation exercise, acupuncture. This hands-on manual therapy technique can relieve pain and help the healing process. Some back injuries and conditions require surgical repair.

How common is lower back pain?

Low back pain is one of the most common reasons that people visit healthcare providers. About four out of five people have experience of lower back pain at some point in their lives. The risk factors for lower back pain include:

- Age: People over 30 years old have a chance to have more back pain. Degenerative of the joint and disc disease can progress with the age.
- Weight: People with an overweight have a higher risk to have lower back pain than normal weight
- Overall health: People with the healthy lifestyle like to exercise regularly will have a less risk than people who like smoke, drink alcohol excessively and live a sedentary lifestyle.
- Occupation: Job and activities that require heavy lifting or bending can increase the risk of a lower back pain
- Disease: such as osteoarthritis, certain types of cancer and other disease can have a higher risk of low back pain
- Mental health: Low back pain can be a result from depression and anxiety.

What are the symptoms of lower back pain?

The symptoms can come on suddenly or gradually. Sometimes, pain start after a specific event, such as bending to pick something up. Other times may not know the cause of the pain. Pain may be sharp or dull and achy, and it may radiate to your bottom or down the back of the legs, other symptoms of lower back pain include stiffness, posture problems and muscle spasms.

What is the cause of lower back pain?

A common cause of sprain and strain that lead to lower back pain include lifting a heavy object, twisting the spine while lifting, sudden movements that place too much stress on the low back such as a fall, poor posture overtime and sport injuries, especially in sports that involve twisting or large force of impact.

Causes of chronic lower back pain, pain that last more than three months and exceeds the body's natural healing process can involves a disc problem, a joint problem, or irritated nerve root. Common causes include lumbar herniated disc, degenerative disc disease, facet joint dysfunction, sacroiliac joint dysfunction, spinal stenosis, spondylolisthesis, osteoarthritis, deformity, trauma, and compression fracture.

While considerably less common can caused by infection, tumours, or autoimmune disease.

Anatomy of the diaphragm origin and insertion

The diaphragm is located at the inferior-most aspect of ribcage, filling the inferior thoracic aperture. It acts as the floor of the thoracic cavity and the roof of the abdominal cavity. The attachments of diaphragm can be divided into peripheral and central attachment. It has three peripheral attachments. First is lumbar vertebrae and cruciate ligaments. Second is costal cartilages of ribs 7-10 attach directly to ribs 11-12 and the last attach to xiphoid process of the sternum. The parts of the diaphragm that arise from the vertebrae are tendinous in structure and are known as the right and left crura.

The right crus arise from L1-L3 and their intervertebral disc, some fibers from the right crus surround the esophageal opening, acting as a physiological sphincter to prevent reflux of gastric contents into the esophagus.

The left crus arise from L1-L2 and their intervertebral discs. Posterolateral, the diaphragm arises from the lumbocostal arches over the Psoas and quadratus lumborum muscles. The remainder of the diaphragmatic skirt arises from the margin of the rib cage and from the sternum anteriorly.

Functions of the diaphragm

When the diaphragm pulls its central tendon down during contraction and then increases the vertical diameter of the thorax. This increases the negative pressure inside the thoracic cavity, which draws in air. Thus, the diaphragm is the most important muscle used in inspiration. During inhalation, the diaphragm contracts and pushed inferiorly into the abdominal cavity where it appears flat. Simultaneously the external intercostal muscles located in between the ribs raise the anterior chest wall like the handles of a bucket This results in the chest cavity becoming larger and wider, which allows air in from the outside. During exhalation, the rib cage and chest wall start to sag and revert to the original position. At the same time, there is relaxation and elevation of the diaphragm. This motion forces the air within the lungs to push out of the body.

The contraction of the diaphragm will assist in the contraction of the muscles of the anterior abdominal wall in raising the intra-abdominal pressure will normally process like micturition, defection, and parturition.

When people breathe in, the diaphragm descends, which decreases the intrathoracic pressure and improves the intra-abdominal pressure. This compresses the blood in the inferior vena cava (IVC) and forces it upward into the right atrium and helps to fill the heart. When abdominal lymph vessels are also compressed, its passage upward within the thoracic duct is aided by the negative intrathoracic pressure. Furthermore, valves in the thoracic duct prevent the backflow of the lymph in the thoracic duct.

How does the diaphragm relate to the lumbar region?

The origin of diaphragm at the lumbar area, the medial lumbocostal arch is a tendinous arch in fascia covering psoas major. Medially, it attaches to the side of the body of vertebra L1. Laterally, it connects to the front of the transverse process of vertebra L1.

The lateral lumbocostal arch is a tendinous arch in fascia covering the upper part of quadratus lumborum. Medially, attach to the front of the transverse process of vertebra L1. Laterally, it connects to the lower border of the 12^{th} rib.

The right crus arise from the anterolateral surface of the bodies of the upper three lumbar vertebrae and the intervening intervertebral disc.

The left crus arise from the corresponding parts of the upper two lumbar vertebrae.

Medial margin of two crura forms a tendinous arc across the front of the aorta called the median arcuate ligament.

From looking at the anatomy of origin and insertion of diaphragm that involve with the Lumbar vertebrae, the cruses that arise into the lumbar area. Including the thoracoabdominal pump that create the intra negative pressure to help inhalation and exhalation. If diaphragm and rib cage have a somatic dysfunction. It means the reduce of the function and movement of diaphragm and rib cage. It will cause the tension pulling onto the Lumbar vertebrae and muscle of Lumbar straining maintaining the lower back pain. Especially the chronic low back pain. There is some research that mentioned about the related between diaphragm dysfunction and low back pain as below.

<u>The review of the research on diaphragm & rib cage somatic dysfunction has a link to low</u> <u>back pain</u>

Reviewing all the research and published from ScienceDirect and PubMed using the keyword "Diaphragm and Low back pain" finding 8 articles that show the malfunction of a diaphragm have the direct effect to low back pain. All of 8 articles are agree in the same conclusion that there is a link between diaphragm problem and low back pain. It means if a diaphragm problem issue either dysfunction, respiratory problem, weakness, or restriction will cause or maintain the low back pain problem. This is all the details of the 8 research.

1. Osteopathic Manipulative Treatment Including Specific Diaphragm Techniques Improves Pain and Disability in Chronic Nonspecific Low Back Pain: A Randomized Trial ⁽¹⁾ by Mireia Martí-Salvador PT and his team, published on Archives of Physical Medicine and Rehabilitation, volume 99, issue 9, September 2018, pages 1720-1729.

The study to investigate the effect of an osteopathic manipulative treatment(OMT), which include a diaphragm intervention compared to the same OMT with a shame diaphragm intervention in chronic nonspecific low back pain (NS-CLBP).

The result is An OMT protocol that includes diaphragm techniques produces significant and clinically relevant improvements in pain and disability in patients with NS-CLBP compared to the same OMT protocol using sham diaphragm techniques.

The research conclusions: Low back pain (LBP) is often managed as a disorder limited to isolated lumbar structures; however, it usually presents in conjunction with respiratory dysfunction, suggesting that LBP is not an isolated musculoskeletal problem.

Interestingly, LBP's association with breathing disorders seems to be even stronger than its relation with obesity and physical activity. Despite this, the underlying mechanisms of this association remain poorly understood. In addition to its respiratory function, the diaphragm also plays an important role in stabilizing the spine during postural, balance, and load-bearing activities, and so it is reasonable to assume that diaphragm dysfunction could also provoke low back disorders.

2. Postural Function of the Diaphragm in Persons with and without Chronic Low Back Pain⁽²⁾

By Pavel Kolář, PaedDr, PhD and his team, published on Journal of Orthopaedic & Sports Physical Therapy, Published Online: April 1, 2012, volume 42, issue4, pages 352-362.

The study to examine the function of the diaphragm during postural limb activities in patients with chronic low back pain and healthy controls. This study designed specifically to test the dynamics of the diaphragm in chronic spinal disorders is lacking by using a dynamic MRI system and specific spirometer, measurement during tidal breathing (TB) and isometric flexion of the upper and lower extremities against external resistance with TB were performed. Standard pulmonary function tests, including respiratory muscle drive (PImax and PEmax), were also assessed. The research findings reduced diaphragm movement in patients with chronic low back pain compared to healthy controls when isometric flexion against resistance of the upper or lower extremity was applied, mainly in the anterior and middle portions. The conclusion is patients with chronic low back pain

appear to have both abnormal position and a steeper slope of the diaphragm, which may contribute to the etiology of the disorder.

- 3. Greater diaphragm fatigability in individuals with recurrent low back pain ⁽³⁾ by Lotte Janssens and his team on Respiratory Physiology & Neurobiology Volume 188, Issue 2, 15 August 2013, Pages 119-123. The research study 1. diaphragm fatigability was examined in 10 low back pain patients and 10 controls, 2. Low back pain patients show a greater susceptibility to diaphragm fatigue and 3. diaphragm fatigue may be a potential factor in the etiology of low back pain. The conclusion is the diaphragm plays an important role in spinal control. Increased respiratory demand compromises spinal control, especially in individuals with low back pain (LBP). The objective was to determine whether individuals with LBP exhibit greater diaphragm fatigability compared to healthy controls.
- 4. Ultrasonography comparison of diaphragm thickness and excursion between athletes with and without lumbopelvic pain ⁽⁴⁾ by César Calvo-Loboa and his team. Publish in Physical Therapy in Sport volume 37, May 2019, pages 128-137. The aim of this study was to compare diaphragm thickness and excursion between athletes with and without lumbopelvic pain (LPP) by trans-costal and trans-hepatic rehabilitative ultrasound imaging (RUSI), respectively. Using participants forty matched-paired athletes with LPP (n = 20; LPP case group) and without LPP (n = 20; Healthy control group) were recruited.

The conclusions is athletes who suffered from LPP presented a reduced diaphragm thickness compared to healthy matched-paired athletes. Therefore, these novel findings may suggest that diaphragm reeducation could be a mainly focus of intervention related to athletic performance, prevention, and rehabilitation.

- 5. The presence of respiratory disorders in individuals with low back pain: A systematic review ⁽⁵⁾ by Nele Beeckmans and his team. Published on Manual Therapy volume 26, December 2016, pages 77-86. The study performs a systematic review on the relation between respiratory disorders (RD) and low back pain (LBP). Study's background is inspiratory muscles, such as the diaphragm, play a key role in both respiration and spinal control. Therefore, diaphragm dysfunctions are often related to low back pain (LBP). However, few is known on the association between the presence of LBP and the presence of respiratory disorders A result is A total of 16 articles were included. A significant correlation between the presence of LBP and the presence of RD such as dyspnea, asthma, different forms of allergy, and respiratory infections was found.
- 6. The effect of diaphragm training on lumbar stabilizer muscles: a new concept for improving segmental stability in the case of low back pain ⁽⁶⁾ by Regina Finta and his team. Published on Pain Res, 2018 Nov 28; 11:3031-3045. The aim of this study was to assess the effects of diaphragm training on low back pain and thickness of stabilizer muscles of the lumbar spine. Fifty-two individuals were recruited with a history of chronic low back pain in the randomized controlled trial. The participants were divided randomly into two groups. One of the groups took part in a complex training program and completed with diaphragm training (DT group, n=26). The control (C) group took part

only in the complex training (n=21). The thickness of transversus abdominis, diaphragm, and lumbar multifidus muscle was measured with ultrasonography in two positions: lying and sitting. All muscles were assessed in relaxed and in contracted state in the lying position and in a relatively relaxed (calm sitting) and relatively contracted state (during weightlifting) in the sitting position. The study result is after the training, severity of the pain was significantly reduced in both the groups. Conclusion the results suggest that diaphragm training has an effect also on the thickness of other active stabilizers of the lumbar spine, such as transversus abdominis and lumbar multifidus muscles.

- 7. Breathing exercises in the treatment of chronic low back pain to reduce pain perception and stress ⁽⁷⁾ by Alyx Taylor and Edoardo Elisei. Published in European Journal of Integrative Medicine volume 48, December 2021. The results showed that risk factors for chronic low back pain include female gender, older age and being overweight. Exercises for improved diaphragmatic breathing were associated with significant reductions in chronic low back pain.
- 8. The effect of stabilization exercises on diaphragm muscle thickness and movement in women with low back pain ⁽⁸⁾ by Esra Dülger and his team. Published in Musculoskelet Rehabil. 2018;31(2):323-329. The study's background, diaphragm is an important component of spinal stability. In presence of low back pain, there may be some alterations in this muscle like other muscles that are responsible for Lumbar stabilization. This study aims to assess the effects of stabilization exercises on diaphragm muscle thickness and motion along with lumbopelvic stability. Results, After the treatment, in the treatment group, increase in diaphragm thickness and improvement in lumbopelvic stability were statically significant (p< 0.05). The conclusion is as a result stabilization exercises increase diaphragm muscle thickness and improve lumbopelvic stability in women with low back pain.</p>

The Manual Osteopathic technique for Diaphragm and rib cage

Osteopathic technique to release the diaphragm improves its mobility, relieving the tension within the surrounding structures, allows better breathing and gain the function back to normal.

- 1. Functional diaphragm balancing technique: Gentle vertical pressure applied for 5 minutes at the diaphragm level.
- 2. Muscle fiber stretching technique: A cranial traction performed from the lower edge of the costal arches during the inspiratory breathing phase for more than 10 respiratory cycles.
- 3. Phrenic-centre inhibition technique: The soft tissue pumped during the expiratory phase by gently and simultaneously using both hands to create pressure in cranial and caudal directions for more than 10 respiratory cycles.
- 4. Global abdominal hemodynamic maneuver: Upward vibration of the visceral block performed during the inspiratory phase for 10 respiratory cycles.
- 5. Myofascial release of the diaphragm (Doming) technique
- 6. Diaphragmatic Restriction Release, Motion specific Release. (MSR) technique Inhalation procedure- encourage the diaphragm to drop down during inhalation, as it does naturally. Exhalation procedure- encourage the diaphragm to move upwards during exhalations it does naturally. Recoil breathing procedure at the end of the technique.
- 7. Pelvis Diaphragm myofascial release technique
- 8. Upper thoracic pump technique
- 9. Visceral Osteopathy technique for movement stomach and liver because these organs are suspended by ligaments to the diaphragm. So, when this latter is not moving effectively, it affects the structures that are attached to it.
- 10. Osteopathic manual therapy technique for improve mobility of the rib cage
- 11. Diaphragm Breathing Exercise

Conclusion

Diaphragmatic dysfunction is an important and recognized as a primary factor of the causes of low back pain. People who suffer from diaphragmatic dysfunction often have early fatigue of diaphragm, altered, and decreased respiratory excursion, as well as inadequate proprioceptive function ^{(9-11).} The diaphragm is an important dynamic stabilizer of the trunk. It is activated when a person carries weights, causing all the stabilizing muscles of the trunk (abdominal and multifidus) to contract and decrease the load on the lumbar spine. From the moment, it is demanded too much with a high respiratory rate or the act of carrying weights for prolonged periods, the diaphragm goes into fatigue, impairing lumbar mechanics and thus being a possible cause of low back pain ^{(9).}

From all articles review Indeed, there is a connection between the diaphragm and lumbar spine, beyond their anatomic relations, has been widely reported in the scientific literature and may partly explain the good results obtained in all the study for the diaphragm treatment group. In addition to its respiratory function, the diaphragm also plays an important role in trunk stabilization and postural control. So, the effect of diaphragm & rib cage somatic dysfunction is the primary cause to maintaining factor in low back pain.

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