Open Journal of Therapy and Rehabilitation, 2016, 4, 117-124
Published Online August 2016 in SciRes. http://www.scirp.org/journal/ojtr
http://dx.doi.org/10.4236/ojtr.2016.43010

Regional Interdependence: A Model That Needs to Be Integrated in the Functional Evaluation and Physiotherapy Treatment—Part 1

Luca Collebrusco[1], Rita Lombardini[2], Giovanna Censi[3]

[1]Rehabilitation Unit, National Health Service of Umbria, Perugia, Italy
[2]Department of Medicine, University of Perugia, Perugia, Italy
[3]INRCA, Marche Polytechnic University, Ancona, Italy
Email: tdr.colle@tiscali.it

Received 27 May 2016; accepted 17 July 2016; published 20 July 2016

Abstract

Background: Rehabilitation is increasing the need to use codes in order to make both a functional diagnosis and a therapeutic intervention as correct and targeted as possible. Thus, it is very important to integrate the model of Regional Interdependence (RI) in the classical rehabilitation evaluation methods, since it will be of help for understanding, solving dysfunctional problems, and improving the patient management, which is often difficult given the fact that there is no concordance on functional tests and timing of treatments. The RI should be added to the functional evaluation each time that a patient presents symptoms in a specific location, which interest also distal regions. This is due to the functional and anatomical connections of the myofascial system, vascular, autonomic nervous system (ANS), the peripheral nervous system (PNS) and the neuroimmunoendocrine system. The RI can be summarized into three groups that are correlated when it comes to applying it practically: upper, bottom and front quadrant. Adding the concept of RI to the clinical and therapeutically practice, it would have positive effects on improving the quality of life and allocate better health's resources. The aim of this paper is to make the functional assessment in clinical practice faster and more standardized.

Keywords

Physical Therapy, Regional Interdependence, Rehabilitation, Nutrition

How to cite this paper: Collebrusco, L., Lombardini, R. and Censi, G. (2016) Regional Interdependence: A Model That Needs to Be Integrated in the Functional Evaluation and Physiotherapy Treatment—Part 1. *Open Journal of Therapy and Rehabilitation*, **4**, 117-124. http://dx.doi.org/10.4236/ojtr.2016.43010

1. The Regional Interdependence in Clinical Practice

The Regional Interdependence examination (RI) can be defined as an evaluative and therapeutically model for the management of patients with musculoskeletal disorders according to International Classification of Disease (ICD), ICD-10-CM, M 99.09 in somatic dysfunction (SD), which implies that a dysfunctional and segmental event of a part of the body can give a remote repercussion in another regional complex. The RI contemplates a coordinated and integrated action of multiple systems: musculoskeletal, biopsychosocial, neurophysiological, and somato-visceral. This model is based on how the joints interact with each other from a neurological and a biomechanical point of view [1]. For this reason, these systems should be seen as integrated models that eliminate the need to choose exclusively between the biomedical systems, neurophysiological or biopsychosocial, in order to fully respond and solve the patient's request for help (signs, symptoms and functions) and contribute also to a remote response of the body [2]. Consequentially, the assessment and management strategies should not only look into the symptomatic area but also identify remote anatomical structures that can be the source of such symptoms [3]. However, this approach does not suggest that we should abandon the classical functional assessment, but add to it additional concepts, since unfortunately in patients with musculoskeletal disorders, it is not always possible to identify a single and primary dysfunctional cause (particularly in the spinal column) [4]. The RI can also add greater clarity to the clinical/therapeutic framework directing toward a better intervention guide. The model helps in the rehabilitation practice especially when the symptoms of a patient are not clear or if the answer to the intervention is less effective than expected. Thus, during the clinical and functional assessment it should always be taken into account eventual problematics of the regional systems which may be directly or indirectly associated with the patient's local skeletal muscle disorder. Recent evidence supports that the valuation approach and the treatment should take place according to the functional-anatomical quadrants: the upper quadrant, the lower quadrant, and the most recent and less studied, the front quadrant. The scientific support of the efficacy of the quadrants is essentially given by the presence of peripheral and central sensitization mechanisms [5] and by the anatomical-myofascial continuity [6], which will partly clarify the SD visceral departure [7]. We can find in the literature that RI is related to the functionality of the quadrants. For the upper quadrant there are references such as: cervical pain that can be associated with the thoracic region [8] and the elbow [9]. The elbow pain associated with the shoulder [10]. For the lower quadrant: the Low Back Pain (LBP) might be associated with osteoarthritis of the hip and knee [11]-[13], or related to foot and ankle problems [14]-[18]. Knee pain can be related to hip functional implications [19] [20]. The patellar pain syndrome (PFPS) seems to be associated with functional alterations hip, ankle, foot [18]. For the front quadrant: it's possible to detect an association between anterior visceral pain and lower back pain, although there are very few studies investigating the mechanisms [7] [21]-[24]. These three quadrants through the RI model might make more complete the functional evaluation of the symptoms in daily practice, so we reported three case reports, each related to a quadrant (**Figure 1**).

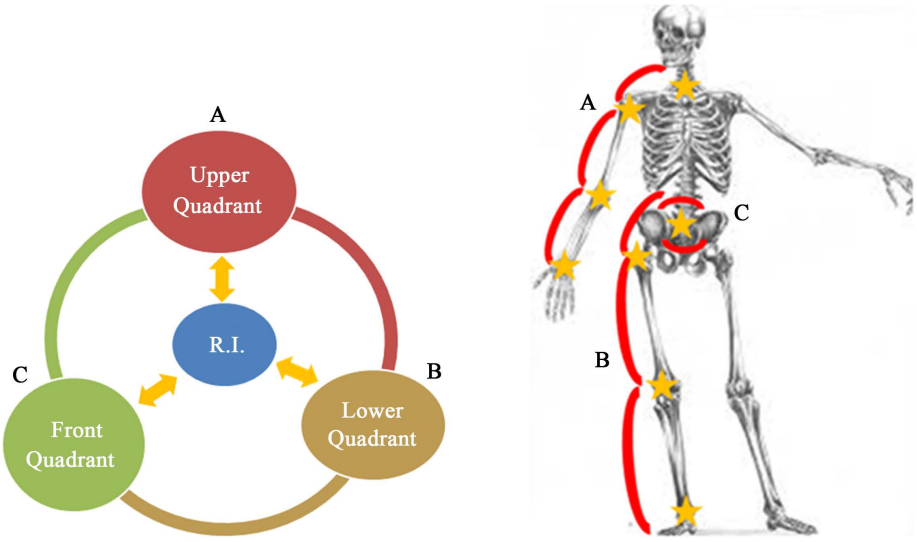

Figure 1. Legend: Regional Interdependence (RI), Lower Quadrant (A); Front Quadrant (B); Upper Quadrant (C).

2. Lower Quadrant

2.1. Data Collection

A 52-year-old male patient went to consultation for LBP with rear side radiation to the gluteus, which propagates in the groin from the right side since almost three months. This continuous pain, except during the nighttime, increases in the early morning and then after few steps fades and reappears more pronounced in the evening. After having consulted the Family Practitioner (FP) and the Orthopedical doctor, was referred to have lumbar Nuclear Magnetic Resonance (NMR), which showed disc protrusion of L5S1 highlighting a wide-ranging that non-imprints the dural sac. Also after the recommendation to rest and use if necessary not Steroidal Anti-Inflammatory Drugs (NSAIDs), nothing changed. At the remote anamnesis, he reported having had 20 years ago a surgery on his right knee with meniscus-external excision and reconstruction of the anterior cruciate ligament (ACL), with the presence of almost −10˚ extension deficit. The trauma took place during a game of football. Moreover, he reported having pneumonia two years ago.

2.2. Musculoskeletal Assessment

The lumbar spine showed a recti linearization of the curve with a limited stiffness. The right hip has a lower internal rotation of 20 degrees compared to the contralateral. Patrick's test, Scour tests, Hip Flexion Test, Thomas Test to the right psoas were positive, as well as the performance of the hip abduction test (motor control) of the right side were positive. At the end of evaluation was carried out the Visual Analogic Scale (VAS) and Oswestry Disability Index Scale (ODI) as well as at the end of the last session.

2.3. Functional Diagnostic Conclusions

The lower back pain of right side with groin irradiation it is due to the hip, which causes loss of mobility during rotation and extension movements.

2.4. Therapeutic Proposal

Osteopathic Manipulative Treatment (OMT) and home exercise program. OMT protocol consists in Long-axis distraction with hip thrust, anterior-posterior directed force to the proximal femur non-thrust, poster-anterior directed force to the proximal femur non-thrust, right Hip caudal glide mobilization with the belt support, Muscle energy technique (Me) Psoas right. The home exercise program consists of: Aerobic exercise (up to 10 minutes cycle or walk); Strengthening (3 sets of 10 repetitions of hip abduction (Abd), hip extension, hip lateral rotation); Knee extension; Stretching (60 seconds passive stretch of the hip flexors, knee extensors, hip extensors, knee flexors, hip abductors and lateral rotators, ankle plantar flexors).

2.5. Timing

There have been five OMT sessions. The first two sessions were in the first week of treatment, in the second week was made the third session where at the end the patient was trained to home exercise program to do every other day until the end of the treatment protocol (5 Weeks). The last session, the fifth, was done 15 days after the fourth session. Each of OMT treatment session lasted around 25 - 30 minutes. The home-exercise program took about 30 - 40 minutes.

2.6. Results

The patient had significantly improved the symptoms already after the first week of treatment and decreased during the treatment sessions. The symptoms went from an initial VAS score of 8 in the first assessment, to a VAS of 2 at the end of the five weeks treatment. In the performance of the Oswestry Disability Index scale (ODI) scale the percentage scored from 8%, (equivalent to moderate disability) to a percentage of 10% (equivalent to minimum disability) at the end of the five weeks treatment protocol. Symptoms and the score of the scales improved and the patient reported that he had a better hip mobility and had less difficulty to get on the bike by lifting the right leg.

3. Front Quadrant

3.1. Data Collection

A 41-year-old nulliparous female patient, which had a medical consultation for constant pain with a sense of constant lumbar heaviness during the daytime, with increased symptoms after eating or when constipation were present. Symptoms present since returning to Italy after a period of 5 months abroad for work purposes. She also reported that once in Italy after meals she swelled. The FP investigated the symptoms with negative results, and excluded any problem through a gynecological specialist examination. The anamnesis did not reflected comorbidities and systemic diseases as well as the absence of surgeries, not use drugs (including birth control pills).

3.2. Musculoskeletal Evaluation

Stiffness of the lumbar spine is enhanced. No mobility limitations in the lower back and the spring test were negative, with no radiation of pain to the gluteus or below the knees. To abdominal palpation was present muscles' tension in all the quadrants, with sensation of pain radiating posteriorly above the right iliac fossa and even more pain in the mesogastrium area. The Thomas test scored positive on the right side. At the end of the evaluation was carried the ODI as well as at the end of the last session.

3.3. Functional Diagnostic Conclusions

The low back pain, based on the functional assessment, is thought to be due to an anterior visceral-somatic irradiation caused by the bowel. For this reason, were done specific sessions of OMT and the patient was directed to consult a specialist in nutrition, in order to follow a nutritional protocol to treat gastrointestinal dysfunction (**Table 1**).

3.4. Therapeutic Proposal

Consisted in following the OMT: Me and CS (counterstrain treatment) Psoas Muscle, Lower Thoracic cage Release (for Diaphragm release), Me Transitional D12L1 area, Mid Thoracic Extension/Closing Manipulation, Maneuver VIS (visceral manipulative treatment) of the ileoceale tract, and "Mesenteric Lift Manouver" and high velocity low amplitude (HVLA) Sacral Iliac Transitional to the root of the mesentery.

3.5. Timing

Were done five OMT treatment sessions: the firsts two during the first week, one section during the second week,

Table 1. General dietary advice for patients with IBS.

Avoid	Caution	Low Increase
Large melas	Eggs	Carbohydrate-rich foods: buckwheat, oats, etc.
Alcoholic beverages	Wheat products	Soluble fiber: oat bran, soy, barley, rice, currants, etc.
Caffeinated drinks	High-salicylate foods: nuts, corn, wine, tomato, seasoned, meat, etc.	
Carbonated drinks	High amine foods: chocolate, banana, avocado, spinach, etc.	
Fatty food	High-lactose content products: milk, ice cream, and yogurt	
Hot spices	High-fructose content products: honey, date, orange, apple, pear, and corn sirup	
	Sorbitol-content products: artificial sweeteners and stone fruits	
	Gas-producing foods: beans, peas, broccoli, cabbage, and bran	

Prebiotics: psyllium and inulin; *Probiotic*: combinations of Lactobacilli, Bifidobacteria, and Streptococci. N.B.: assess tolerance to gluten, fructose, and low-lactose dairy products by means of a breath test.

than a week off, a section in the fourth week, three week off, and the last session on the eighth week. So the session was carried within two months. During the last session was carried the ODI scale. The duration of each session ranges from 20 to 40 minutes, depending on the patient's tolerance and response of the tissues. Nutritional regimen was followed starting from the second OMT session and had to be followed for at least 6 months.

3.6. Results

The patient already improved after the first week of treatment (after 2 sessions of OMT), presenting less lower back pain and less feeling of heaviness, even if it remained some bloating after eating and hive's irregularities, but the constipation decreased. At the end of the last session of the treatment protocol, the patient no longer presented the initial symptoms, and the abdominal bloating was almost disappeared after meals and the bowel function returned almost entirely legitimate. In the ODI scale the percentage changed from the initial 28% (equivalent to moderate disability), to 8% (equivalent to mild disability) at the end of the two months of treatment.

4. Upper Quadrant

4.1. Data Collection

A 38-year-old male patient went to consult for right anterior shoulder pain, which was present since almost two months and arising after having lifted a tarpaulin cover. Pain was continuously present, except at nighttime and in the intermediate position of the elevation of the shoulder. During the anamnesis, he reported that 15 years ago had a surgery for an appendectomy, and two years ago he had a fracture of the right fibula which was treated with pinstripe valve for 20 days.

4.2. Musculoskeletal Assessment

The patient resulted positive to the Hawkins Kennedy Test, Arc Sign in painful Abd between 60 - 120 degrees, weakness detected during the infraspinatus muscle test. During the functional examination of the cervical-dorsal junction and upper thoracic spine and medium, was present hypo mobility during extension, flexion and rotation movements through application of an anteroposterior pressure on the spinous processes and the transverses. It was also detected hypomobility of costovertebral joint of the first right rib. Shoulder active ROM evaluation included flexion (F), Abd, external rotation (ER) and internal rotation (IR). The VAS scale was assessed at the beginning and the end of treatment.

4.3. Functional Diagnostic Conclusions

The anterior shoulder pain perceived on the right was due to the cervical/dorsal junction, due to the first coast and the middle-upper thoracic spine.

4.4. Therapeutic Proposal

The patient received OMT treatment of soft tissue (ST) of the upper trapezius sitting, SCOM and muscle paravertebral upper dorsal, one maneuver of HVLA to the cervical/dorsal junction, one maneuver of HVLA to the right coast while supine, one HVLA maneuver to the middle dorsal spine from the supine position.

4.5. Timing

Three sessions were carried to the patient. The first OMT treatment was carried out after the initial assessment. Other 2 treatments were carried out after 1 week and after 3 weeks. Each session lasted for 25 - 30 minutes and the treatment protocol had a total duration of 1 month (4 weeks).

4.6. Results

At the initial assessment, the patient had a score in the VAS scale of 8 and the active range of motion (ROM) was F: 100˚, Abd: 95˚, ER: 110˚. Right after the first week of treatment, the patient has significantly improved shoulder mobility to F: 115˚ Abd: 115˚ ER: 120˚ and does not report feeling of pain. Before the second session, the patient reported that the week after the first treatment session, the pain significantly decreased from a VAS of 8 to a VAS

of 5. Mobility remained the same of the first session. After the second session, the shoulder mobility improved to F: 130˚, Abd: 130˚, ER: 135˚; the VAS remained unchanged. At the third treatment session, the patient reported that the pain was almost disappeared and reported VAS of 2, describing to feel more "light" and to have reached greater mobility at the cervicodorsal level as well as preserved the shoulder mobility reached after the second session. With the third treatment further improved, the shoulder mobility reached F: 145˚, Abd: 145˚, ER: 160˚, with the resolution of the pain (VAS = 0).

Despite the lack of healthy control data, the three case reports support the concept of a functional assessment and treatment oriented towards a framework concept [25].

The fallout that could happen during the clinical practice applying the RI model offered greater support and integration in the rehabilitation activities and a better patient management in functional terms (improving signs and symptoms), but also improving quality of life, containment of health care costs [26]. In this way, it would be possible to take consciousness of the resources available, not only from management and evaluation of the output point of view (measurable products of the individual activities provided by the treatment), but with an evaluation of the outcomes (*i.e.* measuring only users' health status, quality of life). Nowadays the professional skills are essential both to improve the quality of service offered and to optimize the resources, taking into account the patient care experience that continues to be underestimated. The direction of research in the reliability and the application of the RI model is promising and is trying to improve the methodological aspects of the studies as well as the clinical impact as a classification tool, providing, in this way, accurate strategies in the implementation of the rehabilitation practice.

References

[1] Wainner, R.S. (2007) Regional Interdependence: A Musculoskeletal Examination Model Whose Time Has Come. *Journal of Orthopaedic & Sports Physical Therapy*, **37**, 658-660. http://dx.doi.org/10.2519/jospt.2007.0110

[2] Sueki, D.G., Cleland, J.A. and Wainner, R.S. (2013) A Regional Interdependence Model of Musculoskeletal Dysfunction: Research, Mechanisms, and Clinical Implications. *Journal of Manual and Manipulative Therapy*, **21**, 90-102.

[3] McDevitt, A., Young, J., Mintken, P. and Cleland, J. (2015) Regional Interdependence and Manual Therapy Directed at the Thoracic Spine. *Journal of Manual and Manipulative Therapy*, **23**, 139-146.

[4] Abenhaim, L., Rossignol, M., Gobeille, D., Bonvalot, Y., Fines, P. and Scott, S. (1995) The Prognostic Consequences in the Making of the Initial Medical Diagnosis of Work-Related Back Injuries. *Spine* (*Phila Pa* 1976), **20**, 791-795. http://dx.doi.org/10.1097/00007632-199504000-00010

[5] Dodick, D. and Silberstein, S. (2006) Central Sensitization Theory of Migraine: Clinical Implications. *Headache*, **46**, S182-S191. http://dx.doi.org/10.1111/j.1526-4610.2006.00602.x

[6] Janda, V. (1996) Sensory Motor Stimulation. In: Liebenson, C., Ed., *Rehabilitation of the Spine*, Williams & Wilkins, Baltimore, 319-328.

[7] Collebrusco, L. and Lombardini, R. (2014) What about OMT and Nutrition for Managing the Irritable Bowel Syndrome? An Overview and Treatment Plan. *Explore* (*NY*), **10**, 309-318. http://dx.doi.org/10.1016/j.explore.2014.06.005

[8] Gonzalez-Iglesias, J., Fernandez-de-las-Penas, C., Cleland, J.A. and Gutierrez-Vega Mdel, R. (2009) Thoracic Spine Manipulation for the Management of Patients with Neck Pain: A Randomized Clinical Trial. *Journal of Orthopaedic & Sports Physical Therapy*, **39**, 20-27. http://dx.doi.org/10.2519/jospt.2009.2914

[9] Suter, E. and McMorland, G. (2002) Decrease in Elbow Flexor Inhibition after Cervical Spine Manipulation in Patients with Chronic Neck Pain. *Clinical Biomechanics* (*Bristol, Avon*), **17**, 541-544. http://dx.doi.org/10.1016/S0268-0033(02)00025-6

[10] Lucado, A.M., Kolber, M.J., Cheng, M.S. and Ecternach, J.L. (2010) Subacromial Impingement Syndrome and Lateral Epicondylalgia in Tennis Players. *Physical Therapy Reviews*, **15**, 55-56. http://dx.doi.org/10.1179/174328810X12647087219036

[11] Stupar, M., Cote, P., French, M.R. and Hawker, G.A. (2010) The Association between Low Back Pain and Osteoarthritis of the Hip and Knee: A Population-Based Cohort Study. *Journal of Manipulative and Physiological Therapeutics*, **33**, 349-354. http://dx.doi.org/10.1016/j.jmpt.2010.05.008

[12] Di Lorenzo, L., Forte, A., Formisano, R., Gimigliano, R. and Gatto, S. (2007) Low Back Pain after Unstable Extracapsular Hip Fractures: Randomized Control Trial on a Specific Training. *Eura Medicophys*, **43**, 349-357.

[13] Nelson-Wong, E., Flynn, T. and Callaghan, J.P. (2009) Development of Active Hip Abduction as a Screening Test for Identifying Occupational Low Back Pain. *Journal of Orthopaedic & Sports Physical Therapy*, **39**, 649-657. http://dx.doi.org/10.2519/jospt.2009.3093

[14] Cibulka, M.T. (1999) Low Back Pain and Its Relation to the Hip and Foot. *Journal of Orthopaedic & Sports Physical Therapy*, **29**, 595-601. http://dx.doi.org/10.2519/jospt.1999.29.10.595

[15] Rothbart, B.A. and Estabrook, L. (1988) Excessive Pronation: A Major Biomechanical Determinant in the Development of Chondromalacia and Pelvic Lists. *Journal of Manipulative and Physiological Therapeutics*, **11**, 373-379.

[16] Kosashvili, Y., Fridman, T., Backstein, D., Safir, O. and Bar Ziv, Y. (2008) The Correlation between Pes Planus and Anterior Knee or Intermittent Low Back Pain. *Foot & Ankle International*, **29**, 910-913. http://dx.doi.org/10.3113/FAI.2008.0910

[17] Brantingham, J.W., Lee Gilbert, J., Shaik, J. and Globe, G. (2006) Sagittal Plane Blockage of the Foot, Ankle and Hallux and Foot Alignment-Prevalence and Association with Low Back Pain. *Journal of Chiropractic Medicine*, **5**, 123-127. http://dx.doi.org/10.1016/S0899-3467(07)60144-X

[18] Rowe, J., Shafer, L., Kelley, K., West, N., Dunning, T., Smith, R., *et al*. (2007) Hip Strength and Knee Pain in Females. *North American Journal of Sports Physical Therapy*, **2**, 164-169.

[19] Finnoff, J.T., Hall, M.M., Kyle, K., Krause, D.A., Lai, J. and Smith, J. (2011) Hip Strength and Knee Pain in High School Runners: A Prospective Study. *American Academy of Physical Medicine and Rehabilitation*: *AAPM&R*, **3**, 792-801. http://dx.doi.org/10.1016/j.pmrj.2011.04.007

[20] Sutlive, T.G., Lopez, H.P., Schnitker, D.E., Yawn, S.E., Halle, R.J., Mansfield, L.T., Boyles, R.E. and Childs, J.D. (2008) Development of a Clinical Prediction Rule for Diagnosing Hip Osteoarthritis in Individuals with Unilateral Hip Pain. *Journal of Orthopaedic & Sports Physical Therapy*, **38**, 542-550. http://dx.doi.org/10.2519/jospt.2008.2753

[21] Panagopoulos, J., Hancock, M.J., Kongsted, A., Hush, J. and Kent, P. (2014) Does Anterior Trunk Pain Predict a Different Course of Recovery in Chronic Low Back Pain? *Pain*, **155**, 977-982. http://dx.doi.org/10.1016/j.pain.2014.01.023

[22] Collebrusco, L. and Lombardini, R. Osteopathic Manipulative Treatment and Nutrition: An Alternative Approach to the Irritable Bowel Syndrome. 8*th Interdisciplinary World Congress on Low Back & Pelvic Pain*, Dubai, 27-31 October 2013, 499.

[23] Lombardini, R. and Collebrusco, L. Osteopathy and Nutrition for Managing the Irritable Bowel Syndrome—Brief and Useful Guide. Universitas Studiorum S.r.l., Mantova, Italy.

[24] Collebrusco, L. and Lombardini, R. (2013) Osteopathic Manipulative Treatment and Nutrition: An Alternative Approach to the Irritable Bowel Syndrome. *Health*, **5**, 87-93. http://dx.doi.org/10.4236/health.2013.56A2013

[25] Chaitow, L. (2008) Biochemistry and Bodywork. *Journal of Bodywork and Movement*, **12**, 95.

[26] Collebrusco, L. (2015) An Integrated Rehabilitation Model: An Ideal Framework For Limiting Health Care Costs. *Open Journal of Therapy and Rehabilitation*, **3**, 9-13. http://dx.doi.org/10.4236/ojtr.2015.31002

Glossary

Abd: Abduction
ACL: Anterior Cruciate Ligament
ANS: Autonomic Nervous System
CS: Counterstrain Treatment
ER: External Rotation
F: Flexion
FP: Family practitioner
HVLA: High Velocity Low Amplitude
ICD-10 CM: International Classification of Disease V. 10
IR: Internal Rotation
LBP: Low Back Pain
M 99.09: Code Segmental and somatic dysfunction of abdomen and other regions (ICD-10CM)
Me: Muscle Energy
NMR: Nuclear Magnetic Resonance
NSAIDs: Non Steroidal Anti-Inflammatory Drugs
ODI: Oswestry Disability Index
OMT: Osteopathic Manipulative Treatment
PFPS: Patellofemoral Pain Syndrome
PNS: Peripheral Nervous System
RI: Regional Interdipendence
ROM: Range Of Motion
SD: Somatic Dysfunction
ST: Soft Tissue
VAS: Visual Analogic Scale
VIS: Visceral Manipulative Treatment