

Effectiveness of Symptom Guided Therapeutic Approach in Treating Discogenic Pain with Radiculopathy Using a Combination of Directional Preference Exercises, Mobilisation and Neural Mobility Exercises – A Case Report

Devasahayam Augustine Joshua, B.P.T., PG Dip in Manip Phy (Otago)

Department of Rehabilitation Services, Changi General Hospital, Singapore

ABSTRACT

Researchers have reported various therapeutic approaches to treat patients with low back pain. The mechanical diagnosis and therapy as proposed by McKenzie, has been shown to be effective in diagnostic, therapeutic and prognostic inference. Most often, the treatment options considered in these studies was directional preference exercises and manual procedures utilising movement and positions. But the effectiveness of symptom guided therapeutic approach in treating discogenic low back pain with radiculopathy using directional preference exercises, mobilization and neural mobility exercises is unknown.

A case of a forty three-year-old male presenting with discogenic low back pain along with radiculopathy was assessed with McKenzie approach. Appropriate treatment strategy was selected and prescribed based on the initial assessment. The patient was re-evaluated each session, and treatment modification was made according to his symptom presentation during each visit. He proved to be symptom free after seven visits. This could have been due to disc regression and enhanced neural mobility obtained due to treatment. This case report demonstrates the effectiveness of symptom guided therapeutic management to treat patients with discogenic low back pain along with radiculopathy using appropriate treatment strategies. Finally, the report summarizes the treatment offered and discusses the possible explanation of the specific treatment strategies implemented.

Keywords: Disc herniation; Treatment approach; Discogenic back pain; Radiating pain; Exercises.

INTRODUCTION

It is common for patients with low back pain to have various clinical presentations and pain patterns. In particular, patients with disc pathology may either have axially dominant low back pain resulting from internal disc abnormality like annular fissuring or radicular pain resulting from prolapsed lumbar disc. While diagnosing disc pathology has been a challenge for clinicians^{1,2} recent literature^{3,4} has addressed the usefulness of dynamic mechanical assessment as proposed by McKenzie for diagnosis and management of disc pathology, but the most effective, conservative

treatment approach has yet to be elucidated. The McKenzie approach involves a step by step clinically reasoned process which includes history taking, range of motion testing, repeated end range movement testing together with sustained postural loading to determine the effect on the symptoms that are provoked during assessment. This systematic analysis of signs and symptoms helps the therapist to classify most patients according to directional patterns from which the probable diagnosis can be made and the therapeutic positions or movements can be deduced. Further systematic progression of the therapy is made through modifying those applied mechanical forces by monitoring the pain behaviour and the changes in motion and function.

Presented at the Annual Scientific Meeting, CGH, Singapore 2009

It has been widely accepted that the conservative treatment including Mckenzie approach improves neurological symptoms^{5,8,9,10,11}. But selecting appropriate patients for conservative management is a challenging task. It involves a multi factorial clinical decision process and comprises a variety of treatment options for the patient. Even though surgical approach is widely used, the usefulness of surgery versus conservative measures in managing the patient with lumbar disc pathology presenting with sciatica still remains controversial⁶. The literature suggests conservative treatment over the surgical option for patients with disc pathology^{7,8}. But adopting the appropriate conservative treatment approach is by no means an easy feat. Various studies^{9,10,11} have analyzed the effectiveness of different combinations of conservative therapy. Although some combinations do provide positive outcomes, it can never be generalized for all patients. On the other hand, if the patients are managed with a feedback from their symptoms, it encourages compliance and active participation of the patient in the treatment process. It also has a high potential for preventing chronic low back pain¹² from developing. Delitto et al¹³ has found in her study that the treatment strategy based on signs and symptoms and response to movement may result in a more effective outcome compared with an unmatched non-specific treatment.

Some studies have found that classifying the patients into subgroups according to their clinical presentation is of utmost importance^{14,15}. While other studies have highlighted the importance of utilising various combinations of directional preference exercises as well as other conservative treatment strategies while treating patients with low back pain^{9,13}. Delitto et al¹³, suggest that use of extension preference exercise along with mobilization helps patients with back pain. But Erhard et al⁹, state that combined program of manipulation along with flexion and extension exercises was more effective than a pure extension exercise program. But most studies fail to shed light on the importance of systematically progressing the treatment. Since results from studies are diverse, different clinically viable symptom guided treatment strategies should be studied in various combinations. A combined program of directional preference exercises, mobilization and neural mobility exercises utilising symptom guided therapeutic approach has not been studied yet.

Hence, in order to maximize the success in conservative approach, Mckenzie assessment would be utilized in this case study to make the provisional diagnosis and further treatment strategies would be planned according to patient's symptom presentation during each review, thus explaining the symptom guided therapeutic approach.

The purpose of this case report is to demonstrate the effectiveness of symptom guided therapeutic approach using the above mentioned dynamic assessment to diagnose and treat patients with discogenic pain along with radiculopathy by means of a unique combination of directional preference exercises, mobilization and neural mobility exercises.

History

A 43-year-old male office administrator presented with complaints of dull aching pain while sitting, in the right hip region and right leg, which becomes sharp while getting up and walking. He also complained of pain in the right leg while leaning forwards in sitting position. He did not complain of any event of injury but the onset of low back pain was gradual and insidious, persisting for three weeks which increased in intensity and affected his daily activities. He had an injury on his right gastrocnemius muscle during a soccer game three weeks ago after which he was having a limping gait due to pain for which he was receiving physiotherapy treatment. During this period, he was complaining of mild, gradual increase in low back pain. This was aggravated by prolonged sitting and while getting up from the chair. He complained of constant pain with a severity of 5/10 on the verbal rating scale. He was taking painkillers during nights to relieve the constant pain.

Physical Examination

On observation, no swelling or erythema was noted in the lumbar region as well as in the right calf. He had a good sitting posture with normal lumbar lordotic curve. On palpation, no pain was noted on lumbar region bilaterally and no pain over right calf region. Tenderness was noted over right hip region. On examination, the active range of motion (AROM) test of lumbar spine revealed pain during lumbar active extension and also during combined lumbar right side flexion, extension and right-sided rotation movement. Evidence

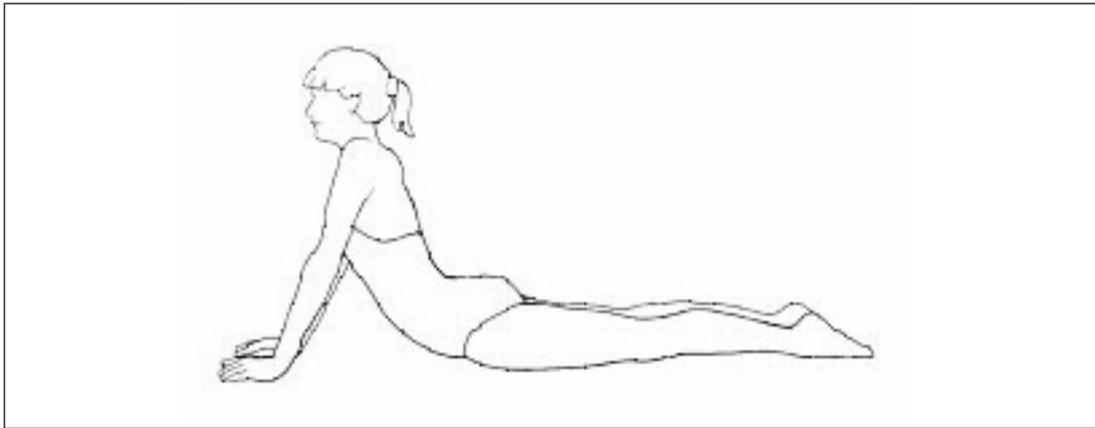


Fig. 1: Prone on hands position.

based clearing tests confirmed no pathology in right hip joint and sacroiliac joints. Slump test on the right side brought on pain over right L5 dermatome region, which may denote likely right L5 nerve root involvement.

Treatment

As per findings from the subjective and objective assessment, the patient was suspected to have lumbar disc derangement syndrome with a likely nerve root adherence – right-sided L5 radiculopathy. As per Robin A. McKenzie's method of subgrouping low back pain patients by having them perform lumbar movements repeatedly, directional preference for this patient was identified as lumbar extension with right lateral glide as his pain centralised from leg to low back with sustained relief after completion of the above stated repeated movements. Initial treatment was planned accordingly as the patient revealed a directional preference. Patient was placed in prone lying with his legs off the edge of the bed to his right side, along with lumbar spine in right lateral side glide position. Now the patient was asked to do lumbar extension to reach prone on elbow position for ten times. Then it was repeated ten times to reach prone on hand position. This resulted in pain relief and improved pain free range of motion. The patient was instructed to perform this exercise ten times daily.

As per recent Mechanical Diagnosis Therapy (MDT) bulletin, which highlights the good utility of frequent reassessment and dynamic planning of treatment strategies by knowing what to expect out of patient's recovery¹⁹, a comprehensive assessment and subsequent

symptom guided planning of treatment strategy was applied to this patient presenting with discogenic pain along with radiculopathy.

On Visit 2, the patient reported that he got relieved of the dull, constant pain and the frequency of present intermittent pain reduced after doing prescribed exercises. But he still had 6/10 pain on the verbal rating scale while getting up from the chair and while pulling on socks and also had antalgic gait due to low back pain. Reassessment on day 2 revealed only mild pain on extension and no pain on right side rotation, which he had previously. Treatment was planned to continue with extension based directional preference exercises as indicated by the assessment. Hence the patient was advised to lie on prone and asked to do lumbar extension exercises reaching prone on hands position for 20 times. Then with his legs off to the right side of the bed along with the lumbar spine in right side glide position, overpressure was applied in opposite directions with one hand over right lateral aspect of pelvis and other hand over the left lateral aspect of the patient's trunk creating a shear force there by assisting the right side glide positioning of lumbar spine. While this force is being applied, the patient was asked to reach prone on hands position (Fig. 1) for three times. This maneuver was done twice. The patient reported improvement and less intense pain after the treatment. He was asked to continue with the exercise protocol as prescribed during the initial visit.

On Visit 3, the patient reported less pain intensity, 4/10 on verbal rating scale, along with reduced frequency of pain. Patient did not have any pain during walking and had less pain while sitting and

Table 1. Outlines the details of each visit, showing the time lapse between each treatment session, objective findings, treatment given and rationale for treatment.

Visit	Time Lapse Between Visits	Objective Findings	Treatment Offered	Rationale for Treatment
One	Three days	Observation: No swelling or erythema was noted in the lumbar region as well as right calf region & Normal Lumbar curvature on sitting. Palpation: Tenderness at Right posterior hip region. Lumbar AROM: Painful during lumbar active extension and also during combined lumbar right-sided rotation movement. Slump: Right side positive with L5 dermatome distribution. Clearing tests: Rip Hip and SIJ joints confirmed with no pathology	Patient was placed in prone lying with his legs off the edge of the bed to his right side, along with lumbar spine in right lateral side glide position. Now the patient was asked to do lumbar extension to reach prone on elbow position for ten times. Then it was repeated ten times to reach prone on hand position.	As patient fits into disc pathology, Possible disc regression may be one of the reasons for recovery.
Two	Two days	Observation: Antalgic gait, Pain on getting up from chair and putting on socks (VNP 6). Lumbar AROM: Mild pain (VNP 2) on extension and no pain on right side rotation.	As per day one along with manual lateral glide shear force.	Addition of manual lateral glide shear force may help to progress disc regression further by reducing postero-lateral intervertebral foramen space.
Three	Three days	Observation: No pain on gait and decreased pain while sitting and while getting up from chair. Lumbar AROM: VNP 3 on extension, VNP 6 on flexion. PIVMS: L4/L5 level left facet hypomobility.	1. Two sets with ten repetitions as per day two treatment. Post treatment- Patient reported less than VNP 2/10 during lumbar flexion, and pain free extension. 2. Grade IV mobilization- lumbar rotation to the left L4/5 for three times in a single session. Post treatment-improvement in lumbar AROM left rotation and no change in flexion.	As above. Added manual L4/5 mobilisation would have relieved the joint capsular tightness or hypomobility.
Four	Two days	Observation: No pain on getting up from the chair and walking, all his functional activities. No change in referred pain. Lumbar AROM: VNP 2 on extension, VNP 3 on flexion. Repeated movement test: Flexion biased.	1. Three sets of this exercise doing twice per set as per day two treatment. 2. FIL exercises for 15 times Post treatment-no pain on lumbar Flexion and extension.	As above. FIL exercises could've helped to reduce pain by improving lumbar flexion range.
Five	Three days	Observation: Constant pain (VNP 4) over right lower lumbar, hip and buttock region. Sharp pain on getting up from chair. Normal and pain-free gait and functional activities. Slump: Right side positive with L5 dermatome distribution. Lumbar AROM: Painful extension.	1. FIL exercises for 15 times. 2. Neural mobility exercises. Post treatment- Lumbar AROM increased and no pain on extension.	FIL exercises could have helped to reduce pain by improving lumbar flexion range. Added Neural mobility exercises could have improved the effects of possible adherent nerve root.

Table 1. Outlines the details of each visit, showing the time lapse between each treatment session, objective findings, treatment given and rationale for treatment (contd).

Visit	Time Lapse Between Visits	Objective Findings	Treatment Offered	Rationale for Treatment
Six	1 week	Observation: Mild pain on getting up from chair. Lumbar AROM: Pain-free AROM except mild pain on active lumbar extension from full lumbar flexion. Slump: Right side positive with L5 dermatome distribution.	Modified Neural mobility exercises: 15 times/session. Post treatment-Decreased right L5 nerve root referred pain.	Added Modified Neural mobility exercises could have further decreased the effects of possible neural adhesions.
Seven	1 week	Observation: Reported Pain-free ADL. Mild transient referred pain (VNP 3) on reaching to floor from sitting in chair position. Lumbar AROM: Pain-free. Slump: Positive on right side. However, less in perceived neural tension and reported very mild pain at the end of range neural stretch.	Modified Neural mobility exercises: 15 times/session. Post treatment-Decreased referred pain.	Added Modified Neural mobility exercises could have further decreased the effects of possible neural adhesions.
Tele-visit Eight	1 week	Patient contacted through telephone and reported that he is pain-free in all ADL and wanted Discharge at request.		

while getting up from chair. On reassessment, the patient still had 3/10 pain on the verbal rating scale during active lumbar extension. But during this visit, he had 6/10 pain on the verbal rating scale during active flexion, which was reproducible with overpressure. He also had restriction during the lumbar rotation to the left side when compared to the right side. Passive physiological intervertebral motion segment (PPIVMS) tests were performed and the patient was suspected to have restricted opening of the facet joint on L4/L5 level at the left side. As the symptoms differed from the regular presentation, an appropriate treatment strategy was decided according to the present clinical findings. The same protocol with the patient in prone lying and legs off the bed to the right side with overpressure on sides was applied twice with rest in between. On reassessment after this maneuver, patient reported less pain 2/10 on verbal rating scale during active lumbar flexion. He also reported no pain during active lumbar extension. In order to cater to the above mentioned PPIVMS findings, aiming to improve the active range of motion in left lumbar rotation, Grade IV mobilization-lumbar rotation to the left was applied at L4/L5 level with the patient in right side lying for three times in a

single session. This maneuver improved the range of active lumbar rotation. Patient was then advised to continue with the same prescribed exercises.

After two days, during Visit 4, the patient reported that he did not have pain while getting up from the chair and walking. His functional activities were normal and pain free but he reported that he felt no considerable differences in pain while comparing the previous week. On reassessment, the patient revealed 3/10 pain on the verbal rating scale during active lumbar flexion and 2/10 pain on the verbal rating scale during active lumbar extension. Although the patient presented less pain intensity on active lumbar extension and no pain on functional activities, he still had complaints of the right radicular pain. In order to relieve the residual 2/10 pain on active lumbar extension, same active lumbar extension exercise was done with the patient in prone along with counter pressure on the sides to aid right side glide of lumbar spine. This pain got relieved completely this time after three sessions of this exercise doing twice per session. As the provisional classification suggested a change in directional preference, patient was instructed to perform flexion in lying (FIL) exercises for 15

times. This change in preference was confirmed with the reassessment after the FIL exercises, which relieved the residual pain completely. FIL exercise with 15 repetitions daily was added to patient's home program.

During Visit 5, the patient complained of increased pain 4/10 on verbal rating scale which was constant for the past two days, particularly over the right lower lumbar, hip and buttock region. Pain was sharp while getting up from the chair and stayed dull all through the day. But his gait was normal and pain free. All other functional activities remained normal. The slump test was positive during the reassessment. He had full active range of movement in all planes but had pain during active lumbar extension. As the referred pain was still present, a different treatment approach was used. He was asked to perform the 'FIL' exercises for 15 times. For this exercise, from crook lying position, the patient brought both knees to his chest and then applied slight over pressure with the arms around the knees. After this session, neural mobility exercises were added to the patient. In high sitting position, the patient was asked to assume slouched position and then was asked to extend his right knee and dorsiflex his right foot. He was then asked to flex his neck forwards until he reaches the painful zone. He was strictly advised not to bend his neck further into painful range of motion. After few repetitions, the range of motion increased and on reassessment, the patient had no pain during lumbar active range of motion and during slump test. He was asked to add this neural mobility exercise in his home exercise program for 15 times daily.

During Visit 6, the patient felt better but still had mild pain while getting up from chair on the right lower lumbar, hip and buttock region. On reassessment, the patient had full pain free range of motion in lumbar spine except for the pain during active lumbar extension from full flexed position in standing. Slump test was positive during this visit also. Similar neural mobility exercise was done for 15 times in a single session.

Another neural mobility exercise was added during this visit. In high sitting, the patient was asked to extend his knees and then he was asked to reach his toes with added neck flexion. This exercise was also repeated for 15 times in a single session. These exercises decreased the referred pain. He was then

advised to add the second neural mobility exercise in his home program.

During Visit 7, the patient felt a lot better after doing the neural mobility exercises and was pain free in all functional activities. On reassessment, the patient felt 3/10 mild referred pain on the verbal rating scale, which is only provoked transient when he tried to reach the floor using his hands while sitting in a chair with his knees extended, which got relieved after reaching the complete forward bending posture. He had pain free, full active range of movement in lumbar spine. However, slump test was positive. But the pain intensity was less during neural stretch.

During this visit, the patient was able to assume long sitting position, which showed that he regained some of his neural mobility. Apart from the same neural mobility exercises, another neural mobility exercise was added during this visit. With the patient in long sitting on the couch, he was asked to reach his toes with neck flexion. He experienced very mild pain at the end range of neural stretch. He was advised to add this exercise to his home program and was asked to perform 15 times a day. Although his slump test was considered positive, the neural tension, which the patient experienced, was very less and he demonstrated gradual increase in neural mobility. As the patient was doing all the prescribed exercises so far, including directional preference exercises and neural mobility exercises, the recovery from discogenic pain with radiculopathy was gradual and consistent. He was advised to continue these exercises at home. A week later, the patient called up and informed the physiotherapist that he was fine and obtained discharge at request. After his discharge, a verbal consent was obtained to write this manuscript.

DISCUSSION

All inter-vertebral segments consist of two adjoining vertebrae and connected by soft tissues including inter-vertebral discs, ligaments, muscles and facet joint capsules. These structures are well innervated and hence pain may arise if damage is present. Any of these structures could be the source of referred pain in this patient. The initial evaluation demonstrated that the slump test on right side produced referred pain over L5 dermatome. This biased our thinking towards right sided L5 nerve root mechanosensitisation or radiculopathy along

with a possible disc protrusion impinging on the L5 nerve root.

Brotz et al¹² reports in his study that the McKenzie concept proposes a mechanical diagnostic evaluation that forms the basis for the treatment approach guided by reduction of neurological symptoms and signs. His study illustrates that 'repeated spinal end range moments' maneuver can be used as a diagnostic tool to identify a significant proportion of patients with the lumbar disc prolapse within initial five days after the onset of pain. As explained by different authors^{16,17,18}, one can make an accurate diagnosis as well as plan appropriate treatment strategy based on directional patterns demonstrated by the patients. Research literature shows that this method of assessment has better accuracy more than MRI in distinguishing painful from non-painful discs as demonstrated by Domelson et al¹⁷ and also helps the clinician to aim for early recovery and long lasting results preventing recurrence as proven by Nwuga et al¹⁸.

Applying this form of assessment in clinical practice helped to identify this patient to be a better responder for conservative treatment. However, the symptom guided therapeutic approach requires the clinician to select and modify treatment according to the clinical presentation of the patient. Hence, this approach need not be confined to directional preference exercises alone.

As discussed before in the treatment section, according to the mechanical diagnostic evaluation, the main features of this patient's clinical presentation were consistent with the discogenic pathology. Conservative approach with a combination of directional preference exercises, mobilization and neural mobility exercises were used in treating this patient with disc pathology. But this combination did not come up readily after the initial assessment. As it was evident during the first visit, the patient fit in to a directional pattern and hence he was treated with directional preference exercises during the first two visits. As the patient's symptoms varied through the multiple visits, his directional preference changed as well. This is the novel issue with this case study, which is being highlighted. Treatment was progressed during first two visits according to patient's requirement but on the third visit, the patient presented with restricted active lumbar rotation to the left. As he presented

with a restricted opening pattern of L4/5 left facet joint, Grade IV mobilization was done at L4/5 facet joint in lumbar spine left rotation with patient in right side lying, which increased the lumbar spine range of motion. During the fourth visit, the patient demonstrated a good lumbar spine range of movement, but presented with a change in directional preference. FIL exercise was introduced during this visit which completely resolved the pain. As the patient complained of increased pain during fifth visit, the treatment strategy had to be reconsidered. Neural mobility exercises were added progressively in addition to other exercises during visits fifth through seventh, which gradually relieved the referred pain completely.

CONCLUSION

This combination of exercises was decided based on this patient's clinical presentation, as the symptom guided therapeutic approach requires the clinician to select and modify the treatment according to the ongoing clinical presentation. As highlighted in a recent review done on 2007²⁰, there is a need to identify optimal sequencing of therapies and methods to tailor therapy to individual patients as we can find multiple non-pharmacological therapies available at hand to treat back pain patients. Hence, effort has been put up in this case report to document the symptom guided approach as one of the optimal method to tailor specific treatment strategies for low back pain patients progressively through the patient's recovery. To be more specific, this case study is a good example demonstrating the efficacy of the symptom guided therapeutic approach in treating disc pathology with radiculopathy with a combination of directional preference exercises, mobilization and neural mobility exercises. Future studies in this aspect are necessary to gain more insight about this conservative treatment approach.

REFERENCES

1. Cherkin C, Deyo R, Wheeler K, Ciol M. Physician variation in diagnostic testing for low back pain: who you see is what you get. *Arthritis Rheum.* 1994 Jan;37(1): [15-22]. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/8129759>.
2. van Rijn JC, Klemetsö N, Reitsma JB, Majoie CB, Hulsmans FJ, Peul WC, et al. Observer variation in MRI evaluation of patients suspected of lumbar disk herniation. *AJR Am J Roentgenol.* 2005 Jan;184(3):[1027]. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/15615992>.
3. Donelson R, Aprill C, Medcalf R and Grant W. A prospective study of centralization of lumbar and referred pain. A predictor of symptomatic discs and anular competence. *Spine.* 1997 May 15;22(10):[1115-22]. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/9160470>.

4. Wetzel FT, Donelson R. The role of repeated end-range/pain response assessment in the management of symptomatic lumbar discs. *Spine Journal*. 2003 Mar-Apr;3(2): [146-54]. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/14589229>.
5. Sei A, Nakamura T, Fukuyama S, Ikeda T, Senda H, Takagi K. Spontaneous regression of lumbar hernia of the nucleus pulposus. Follow up study of 4 cases by repeated MRI. *Rev Chir Orthop Reparatrice Appar Mot*. 1994;80(2):[144-9]. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/7899632>.
6. Zeidman SM, Long DM. Does a herniated lumbar disk with nerve root entrapment require surgical intervention: Are alternative treatments as effective? *Current review of pain*. 1998;2: [115-9]. Available from: <http://www.springerlink.com/content/1774t775g2475221/>
7. Deyo R, Weinstein. Primary care: Low back pain. *N Engl J Med*. 2001;344(5):363-70.
8. Rothoerl RD, Woertgen C, Brawanski A. When should conservative treatment for lumbar disc herniation be ceased and surgery considered? *Neurosurg Rev*. 2002 Jun;25(3):[162-5]. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/12135229>.
9. Erhard RE, Delitto A, Cibulka MT. Relative effectiveness of an extension program and a combined program of manipulation and flexion and extension exercises in patients with acute low back syndrome. *Phys Ther*. 1994 Dec;74(12):[1093-100]. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/7991650>.
10. Long A, Donelson R, Fung T. Does it Matter Which Exercise? A Randomized Control Trial of Exercise for Low Back Pain. *Spine*. 2004 Dec; 29(23):[2593-602]. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/15564907>.
11. Zentner J, Schneider B, Schramm J. Efficacy of conservative treatment of lumbar disc herniation. *J Neurosurg Sci*. 1997 Sep;41(3):[263-68]. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/9444579>.
12. Brötz D, Küker W, Maschke E, Wick W, Dichgans J, Weller M. A prospective trial of mechanical physiotherapy for lumbar disk prolapse. *J Neurol*. 2003 Jun;250:[746-9]. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/12796839>.
13. Delitto A, Cibulka MT, Erhard RE, Bowling RW, Tenhula JA. Evidence for use of an extension-mobilization category in acute low back syndrome: a prescriptive validation pilot study. *Phys Ther*. 1993 April;73(4):[216-22]. Available from: <http://ptjournalonline.net/cgi/content/abstract/73/4/216>.
14. Fritz JM. Use of a classification approach to the treatment of 3 patients with low back syndrome; *Phys Ther*. 1998 Jul;78(7):[766-77]. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/9672548>.
15. Fritz JM, George S. The use of a classification approach to identify subgroups of patients with acute low back pain. Interrater reliability and short-term treatment outcomes. *Spine*. 2000 Jan;25(1):[106-14]. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/10647168>.
16. McKenzie RA. The lumbar spine: mechanical diagnosis and therapy. Spinal Publications, Waikanae, New Zealand:1981, 178p.
17. Domelson R. A prospective study of centralisation of lumbar and referred pain. *Spine*. 1997; 22(10):1115-22.
18. Nwuga G, Nwuga V. Relative therapeutic efficacy of the Williams and McKenzie protocols in back pain management. *Physiotherapy Practice*. 1985; 1:99-105.
19. Kornowski J. MDT Flexion/Rotation – A Group Effort. *MDT Bulletin of The McKenzie Institute® Americas Region*. 2008; 2(1):[2-3]. http://www.mckenziemdt.org/forms/MDTBulletinVol2No1_%20with%20f
20. Roger Chou R, Huffman LH. Non-pharmacologic Therapies for Acute and Chronic Low Back Pain: A Review of the Evidence for an American Pain Society/American College of Physicians Clinical Practice Guideline. *Ann Intern Med*. 2007 Oct 2; 147(7):492-504.