

Comparative Study to find out the Efficacy of Manual Correction by McKenzie Technique and Therapeutic Exercise in Correcting Acute Lumbar Lateral Shift

Running Title: Efficacy of manual correction by MC. Kenzie technique and therapeutic exercise in correcting acute lumbar lateral shift

Authors:

Dr. Santanu Sarkar PT¹, Dr. Saptarshi Chakraborty PT², Dr. Aatreya Bhattacharya PT³, Dr. Dipayan Mallik PT^{4*}

¹Associate Professor and HOD, Department of Physiotherapy, Vidyasagar Institute of Health, Paschim Midnapore, West Bengal, India.

²Assistant Professor, Department of Physiotherapy, Vidyasagar Institute of Health, Paschim Midnapore, West Bengal, India.

³Faculty, Department of Physiotherapy, Vidyasagar Institute of Health, Paschim Midnapore, West Bengal, India.

⁴Assistant Professor, Department of Physiotherapy, KPC College and Hospital, Kolkata, West Bengal, India.

Corresponding Author:

Dr. Dipayan Mallik, Assistant Professor

Department of Physiotherapy, KPC College and Hospital, Kolkata, West Bengal, India.

DOI: <https://doi.org/10.5281/zenodo.23209101>

Received: 11 September 2026, Revised: 29 September, Accepted: 05 October 2026, Online First: 10 October 2026

ABSTRACT

Background: Acute onset lumbar lateral shift, also known as a list or acute scoliosis, is a common clinical presentation associated with low back pain. Although the presence of a lateral shift has been associated with a poor prognosis for conservative management, therapeutic exercise and manual correction using the McKenzie technique have been reported to produce correction of the deformity and improvement in pain and spinal mobility. The aim of this study was to compare the effectiveness of manual correction using the McKenzie technique combined with therapeutic exercise versus therapeutic exercise alone in correcting acute lumbar lateral shift. **Materials and Methods:** This experimental study was conducted on subjects diagnosed with scoliosis and presenting with acute lumbar lateral shift at the outpatient department of Vidyasagar Institute of Health, Rangamati, Paschim Midnapore, West Bengal. A total of 30 subjects aged 40–55 years were recruited and assigned into two groups of 15 subjects each. Group A received manual correction using the McKenzie technique along with therapeutic exercise, while Group B received therapeutic exercise alone. Cobb's angle and lumbar lateral flexion range of motion were assessed before treatment and after the treatment period. Data were analyzed using SPSS version 23.0 and Microsoft Excel. Paired t-test was used for within-group comparisons and unpaired t-test for between-group comparisons. The level of significance was set at $p < 0.05$. **Results:** Both groups showed statistically significant improvement following treatment. Cobb's angle decreased from $20.87 \pm 1.96^\circ$ to $14.07 \pm 1.10^\circ$ in Group A and from $21.60 \pm 2.03^\circ$ to $12.67 \pm 1.29^\circ$ in Group B. Right lateral flexion improved from $33.73 \pm 2.76^\circ$ to $35.87 \pm 2.53^\circ$ in Group A and from $34.27 \pm 1.98^\circ$ to $37.87 \pm 2.00^\circ$ in Group B. Left lateral flexion improved from $36.20 \pm 2.36^\circ$ to $40.33 \pm 3.03^\circ$ in Group A and from $36.00 \pm 2.00^\circ$ to $40.33 \pm 2.03^\circ$ in Group B. Between-group analysis showed a significant difference in post-treatment Cobb's angle ($p = 0.0034$) and right lateral flexion ($p = 0.0231$), while no significant difference was observed in left lateral flexion ($p = 1.000$). **Conclusion:** Both manual correction using the McKenzie technique combined with therapeutic exercise and therapeutic exercise alone were effective in reducing Cobb's angle and improving lumbar lateral flexion in subjects with acute lumbar lateral shift. However, therapeutic exercise alone demonstrated greater improvement in Cobb's angle and right lateral flexion and may be considered a useful therapeutic approach for correction of acute lumbar lateral shift.

Keywords: Lateral Shift, McKenzie Technique, Therapeutic Exercise, Swiss Ball, Thera-Band, Self-Correction, Scoliosis

INTRODUCTION

The presentation of a lateral shift or trunk list associated with the development of acute low back pain is a common clinical event.¹ In the opinion of Porter and Miller, it was associated with disc protrusion and was considered to have a poor prognosis for conservative management.² This acute-onset deformity has been variously described as sciatic scoliosis, lateral shift,³ trunk list,² acute lumbar/sciatic scoliosis,⁴ wind-swept spine,⁵ or lateral deviation.⁶ The prevalence of acute lateral shift associated with back pain varies according to the clinical setting and circumstances. About one-quarter of subjects referred with low back pain to a physiotherapy clinic in New Zealand were reported to have a lateral shift.⁷ Of 88 consecutive acute and chronic subjects referred to physical therapy in the United States, 11 (12.5%) were classified as having a relevant lateral shift. In another study of 1,776 subjects presenting at a back pain clinic in England, 100 (5.6%) had a gravity-induced trunk list.² In a Finnish chronic back pain population, 22 of 39 subjects (56%) randomly recruited into a reliability study had a relevant lateral shift,⁸ while in a study of consecutive chronic low back pain subjects in the United States, 36% had a relevant lateral shift.⁹

The lateral shift may occur toward either the right or left side^{8,10-12} and may be directed toward the dominant side of pain (ipsilateral) or away from the side of pain (contralateral). The majority of affected subjects have a contralateral shift.^{3,11,13} Occasionally, the shift may change from side to side, a presentation that has been termed alternating scoliosis.¹⁴ The lateral shift may be explained by avoidance of compression or irritation of a spinal nerve, either actively or reflexively through muscle spasm,^{4,15-17} or by aberrant disc mechanics in which a protrusion or herniation acts as a space-occupying phenomenon, pushing the trunk away from the painful lesion.^{2,3,10,18} A contralateral shift may also occur as a result of collapse of the upper vertebral body into a large annular fissure, producing an ipsilateral shift presentation.^{3,18,19}

Although the presence of a lateral shift has been reported to be associated with a poor prognosis with conservative care, McKenzie claimed that approximately 90% of patients respond rapidly to manual correction,³ particularly when the shift is contralateral. It has also been reported that a lateral shift associated with a positive crossed straight-leg-raise test may indicate a poor prognosis with conservative care or following discectomy.²⁰⁻²² The McKenzie method of mechanical diagnosis and therapy (MDT) is one of the commonly used approaches in the management of spinal pain conditions.^{23,24} In subjects presenting with a lateral shift, manual correction has been reported to produce superior outcomes compared with nonspecific massage and general care advice.

A lateral shift represents a lateral deviation of the spine in which the patient may become locked in a shifted position. Such patients may be unable to straighten or laterally glide the trunk to an erect position, or may be unable to maintain the corrected position when achieved.²⁵ The condition may present with a shift to either the right or left side and may occasionally occur as alternating scoliosis. In a lateral shift, the body may actively or reflexively adopt a position to reduce compression or irritation of a spinal nerve root.

McKenzie described a lateral shift as a combination of rotation and lateral flexion of one vertebra in relation to the vertebra below. This results in displacement of the trunk to the right or left in relation to the lower part of the body. A lateral shift may occur in association with acute low back pain, disc protrusion, or disc herniation. Limited evidence is available regarding the effectiveness of the McKenzie method for the management of acute lumbar lateral shift.²⁶

The McKenzie method may be used to correct a lateral shift and may also help prevent chronicity of the condition. Patients can be taught self-correction techniques to maintain the corrected position. This approach may help reduce pain, improve spinal range of motion, and improve muscle flexibility.²⁷

Therefore, the present study was conducted to compare the effectiveness of manual correction using the McKenzie technique combined with therapeutic exercise versus therapeutic exercise alone in correcting acute lumbar lateral shift in subjects presenting with scoliosis.

MATERIALS AND METHODS

Study Design and Setting

The present experimental study was conducted among subjects diagnosed with scoliosis and presenting with lumbar lateral shift at the outpatient department of Vidyasagar Institute of Health, Rangamati, Paschim Midnapore, West Bengal. The study was conducted over a period of six months, from January to June 2015. The identity, diagnostic information, and therapeutic records of all participants were kept confidential throughout the study.

Inclusion Criteria

Male and female subjects aged 40–55 years were included if they met the following criteria:

- X-ray evidence of scoliosis;
- Positive scoliosis test; and
- Clinical diagnosis of scoliosis.

Exclusion Criteria

Subjects were excluded if they had any of the following:

- Previous surgical correction of the vertebrae;
- Spinal injury or trauma within the previous 12 months;
- Spondylolisthesis;

- History of disc herniation;
- Fixed flexion deformity of the hip;
- Osteoporosis;
- Spinal infection;
- Fracture;
- Spondylosis;
- Severe mental illness;
- Pregnancy; or
- Spinal or other relevant tumors.

Sample Size

A total of 30 subjects were recruited for the study. The sample size was determined based on the outcome measures and findings reported in previous publications.

Study Technique

The 30 subjects were assigned equally into two groups, with 15 subjects in each group.

Group A: Received manual correction using the McKenzie technique along with therapeutic exercises.

Group B: Received therapeutic exercises alone.

Outcome Measures and Data Collection

Cobb's angle and lumbar range of motion (ROM) were assessed on the first day before initiation of treatment and after two weeks of treatment in both groups. The mean values were calculated at baseline and after two

weeks to determine changes in lateral shift, ROM, and Cobb's angle.

The standard deviation (SD) was calculated to assess the variation of observations around the mean. The probability value was calculated to determine the statistical significance of changes from baseline to the post-treatment assessment.

Statistical Analysis

Differences within each group were assessed using the paired t-test, while differences between the two groups were assessed using the unpaired t-test. Statistical analysis was performed using SPSS version 23.0. A p-value <0.05 was considered statistically significant.

Ethical Considerations

All participants were provided with an informed consent form approved by the institution. The purpose, importance, procedures, and follow-up requirements of the study were explained to the participants in their vernacular language. Written informed consent was obtained from all participants before their inclusion in the study. Participants were informed that they were free to withdraw from the study at any time without prejudice. The study was conducted after approval from the Institutional Human Research Ethics Committee.

RESULTS

Table 1: Demographics characteristics of the study subjects. (n=30)

Agegroup	Group A	Group B
40-45	9	11
46-50	5	4
51-55	1	0
Gender		
Male	5	6
Female	10	9

Age of the subjects in this study was between 40 to 55 years. Gender ratio of sample male to female was 05: 10 in group A that is 05 males and 10 females participated in the study. Group B consisted of 06 males and 09females' i.e 06:09 ratio. (Table 1)

Table 2: Cobb's angle analysis between group A &B.

Group	Pre treatment	Post treatment	Mean reduction	Paired 't'	df	P value
A	20.8667±1.959	14.0667±1.099	6.80000±2.0770	12.679	14	.000
B	21.6000±2.028	12.6667±1.290	8.93333±1.7511	19.757	14	.000

The t-test for paired samples was used for group A and group B for Cobb's angle. As seen from the table mean and standard deviation of group A for grip strength were pre (20.8667±1.95911) and post (14.0667±1.09978) with p value 0.000.

Mean and standard deviation of pre and post of group B for Cobb's angle were (21.6000±2.02837) and (12.6667±1.29099) with p value 0.000. (Table 2)

Table 3 : Right lateral flexion rom analysis between group A &B.

Group	Pre treatment	Post treatment	Mean reduction	Paired 't'	df	P value
A	33.7333±2.7637	35.8667±2.5317	2.133±0.2557	8.342	14	.000
B	34.2667±1.9809	37.8667±1.9952	3.60±1.2984	10.739	14	.000

The t-test for paired samples was used for group A and group B for ROM. As seen from the table mean and standard deviation of group A for Right lateral flexion was pre (33.7333±2.7637) and post (35.8667±2.5317) with p value 0.000.

Mean and standard deviation of pre and post of group B for Right lateral flexion was pre (34.2667±1.9809) and post (37.8667±1.9952) with p value 0.000 (Table 3)

Table 4: Left lateral flexion rom analysis between group A & B.

Group	Pre treatment	Post treatment	Mean reduction	Paired 't'	df	P value
A	36.20±2.36	40.33±3.03	4.133±0.3887	10.633	14	.000
B	36.0±2.0	40.33±2.0254	4.333±1.0465	16.037	14	.000

As seen from the table mean and standard deviation of group A for Left lateral flexion was pre (36.20±2.36) and post (40.33±3.03) with p value 0.000.

As seen from the table mean and standard deviation of group B for Left lateral flexion was pre (36.0±2.0) and post (40.33±2.0254) with p value 0.000. Statistical analysis showed significant difference within the groups. (Table 4)

Table 5: Comparison between group analysis for Cobb's angle

	Mean		SD		Un-Paired 't'	P
	Group A	Group B	Group A	Group B		
Pre	20.8667	21.6000	1.95911	2.02837	1.0071	0.3225
Post	14.0667	12.6667	1.09978	1.29099	3.1972	0.0034

The t-test for unpaired samples was used between pre and Post test of the Cobb's angle for group A and group B. As seen from the table 5 and figure mean pre Cobb's angle of group A was 20.8667±1.95911 and for group B was 21.6000±2.02837. Statistical analysis showed no significant difference between the groups P=0.3225 (> 0.05).

Mean post Cobb's angle of group A was 14.0667±1.09978 and for group B was 12.6667±1.29099. Statistical analysis showed a significant difference between the groups P=0.0034 (> 0.05).

Analysis shows that there was a significant reduction in Cobb's angle from pre to post in both groups at the end of six week. However at the end of six week group B showed significantly greater improvement than group A. (Table 5)

Table 6: Comparison between group analysis for right lateral flexion

	Mean		SD		Un-Paired 't'	P
	Group A	Group B	Group A	Group B		
Pre	33.7333	34.2667	2.7637	1.9809	0.6076	0.5484
Post	35.8667	37.8667	2.5317	1.9952	2.4030	0.0231

The t-test for unpaired samples was used between pre and Post test of the right lateral flexion for group A and group B. As seen from the table 5 and figure mean pre right lateral flexion of group A was 33.7333±2.7637 and for group B was 34.2667±1.9809. Statistical analysis showed no significant difference between the groups P=0.5484 (> 0.05).

Mean post right lateral flexion of group A was 35.8667±2.5317 and for group B was 37.8667±1.9952. Statistical analysis showed a significant difference between the groups P=0.0034 (> 0.05). (Table 6)

Table 7: Comparison between Group Analysis for Left lateral flexion

	Mean		SD		T	P
	Group A	Group B	Group A	Group B		
Pre	36.20	36.0	2.36	2.0	0.2504	0.8041
Post	40.33	40.33	3.03	2.0254	0.0000	1.0000

The t-test for unpaired samples was used between pre and Post test of the left lateral flexion for group A and group B. As seen from the table 5 and figure mean pre left lateral flexion of group A was 36.20±2.36 and for group B was 36.0±2.0. Statistical analysis showed no significant difference between the groups P=0.8041 (> 0.05).

Mean post left lateral flexion of group A was 40.33 ± 3.03 and for group B was 40.33 ± 2.0254 . Statistical analysis showed a not significant difference between the groups $P=0.0034$ (> 0.05). (Table 7)

DISCUSSION

The results of the present study showed that both manual correction using the McKenzie technique combined with therapeutic exercise and therapeutic exercise alone were beneficial in the management of acute lumbar lateral shift. Both groups demonstrated statistically significant improvement in Cobb's angle and active range of motion after two weeks of treatment compared with baseline. However, the reduction in Cobb's angle was greater in Group B, which received therapeutic exercise alone, than in Group A, which received manual correction using the McKenzie technique combined with therapeutic exercise.

A satisfactory explanation for the development of acute lumbar lateral shift remains elusive. In 1973, Finneson proposed that the topographical position of disc herniation in relation to the exiting spinal nerve may account for the displacement.²⁸ According to this theory, protrusions located medial to the nerve root may cause the trunk to shift toward the side of pain (ipsilateral), whereas protrusions located lateral to the nerve root may cause the trunk to shift away from the side of pain (contralateral).

In the present study, Cobb's angle decreased significantly from baseline to post-treatment assessment in both the McKenzie-based treatment group and the therapeutic exercise group. In Group A, Cobb's angle decreased from $20.87 \pm 1.96^\circ$ to $14.07 \pm 1.10^\circ$, whereas in Group B it decreased from $21.60 \pm 2.03^\circ$ to $12.67 \pm 1.29^\circ$. The within-group changes were statistically significant ($p < 0.001$). Between-group analysis showed no significant difference at baseline ($p = 0.3225$), indicating comparable baseline Cobb's angle values. However, a statistically significant difference was observed between the groups after treatment ($p = 0.0034$), with Group B demonstrating greater reduction in Cobb's angle.

Studies investigating therapeutic exercise for lateral shift and scoliosis have reported that spinal and pelvic muscle strengthening exercises may help correct the deformity and prevent its progression.¹¹ Therapeutic exercise may be particularly useful in scoliosis management because it can be used to improve posture, spinal mobility, muscle strength, and functional stability. Postural correction exercises, spinal stretching exercises, and muscle strengthening exercises may contribute to improved spinal alignment and functional movement when performed regularly. These observations are consistent with previous reports describing the relationship between exercise, ligament and muscle-fascia function, and joint mobility.¹⁴

The findings of the present study also support the concept that lumbar stabilization exercises may

improve spinal range of motion by enhancing the function of deep abdominal and stabilizing muscles, thereby contributing to trunk stabilization.¹⁵ Improvement in spinal mobility following therapeutic exercise may be related to improved muscular control and reduced mechanical restriction during movement. Thus, therapeutic exercise may have benefits extending beyond correction of spinal alignment to improvement in overall functional capacity.

In the present study, right lateral flexion improved significantly in both groups. Group A improved from $33.73 \pm 2.76^\circ$ to $35.87 \pm 2.53^\circ$, whereas Group B improved from $34.27 \pm 1.98^\circ$ to $37.87 \pm 2.00^\circ$. The between-group comparison showed no significant difference at baseline ($p = 0.5484$), while a significant difference was observed after treatment ($p = 0.0231$), indicating greater improvement in right lateral flexion in Group B.

Left lateral flexion also improved significantly within both groups. In Group A, left lateral flexion increased from $36.20 \pm 2.36^\circ$ to $40.33 \pm 3.03^\circ$, while in Group B it increased from $36.00 \pm 2.00^\circ$ to $40.33 \pm 2.03^\circ$. However, the between-group comparison after treatment showed no statistically significant difference ($p = 1.000$). Therefore, although both treatment approaches improved left lateral flexion, neither approach demonstrated superiority over the other for this outcome.

The present findings are also consistent with the reported clinical use of the McKenzie method in the management of mechanical spinal disorders. Although the presence of a lateral shift has been associated with a poor prognosis with conservative care,² McKenzie reported that a substantial proportion of patients may respond rapidly to manual correction,³ particularly when the shift is contralateral. Lateral shift associated with a positive crossed straight-leg-raise test has also been reported to be associated with a poorer prognosis with conservative management or following discectomy.²⁰⁻²² The McKenzie method of mechanical diagnosis and therapy (MDT) remains one of the commonly used approaches for the management of mechanical spinal pain conditions.^{23,24}

Manual correction may be particularly useful when the trunk can be progressively moved toward the midline through repeated correction and self-correction. However, if correction of the lateral shift does not proceed as expected despite repeated therapy and self-correction, the condition may be temporarily resistant to correction. End-range loading and repeated movements may be used as part of the mechanical correction approach to reduce the derangement and restore normal movement patterns.

The improvement in lumbar lateral bending observed in both groups may also be explained by the effects of repeated therapeutic movements and exercises on

spinal mobility. Repetitive movements may facilitate movement of the spinal segments and reduce resistance to motion, potentially allowing subjects to move more freely. The greater improvement observed in the therapeutic exercise group for right lateral flexion and Cobb's angle suggests that therapeutic exercise may have an important role in improving spinal alignment and functional mobility in subjects with acute lumbar lateral shift.

Overall, the findings of the present study indicate that both treatment approaches were effective over the two-week treatment period. However, therapeutic exercise alone produced greater improvement in Cobb's angle and right lateral flexion, whereas improvement in left lateral flexion was comparable between the groups. These findings suggest that therapeutic exercise may be a useful treatment option for improving spinal alignment and lumbar mobility in subjects with acute lumbar lateral shift.

Strengths of the Study

- Direct comparison of two physiotherapy approaches for acute lumbar lateral shift.
- Both Cobb's angle and lumbar lateral flexion ROM were assessed.
- Two treatment groups with equal sample sizes allowed between-group comparison.
- Baseline and post-treatment measurements were performed using objective outcome measures.
- The study provides preliminary evidence regarding the role of therapeutic exercise in improving lumbar alignment and mobility.

Future Directions

- Future studies should include a larger sample size to improve statistical power and generalizability.
- Longer-term follow-up should be performed to determine whether the improvements in Cobb's angle and ROM are maintained.
- Future research should include a broader age range and participants from multiple centers.
- Randomized controlled trials with standardized treatment protocols are recommended.
- Future studies may also assess pain intensity, disability, functional status, and quality of life in addition to Cobb's angle and ROM.

Limitations of the Study

Sample size was small and subjects with small range group between 40 to 55 years of age were considered for the study, thus results cannot be generalized to other age. Subjects could not be followed up for longer period.

CONCLUSIONS

The present study provided evidence to support the use of McKenzie method and exercise therapy in reducing Cobb's angle and improving range of motion in

subject with lateral shift (scoliosis). In addition, results supported that exercise therapy group was more effective than McKenzie group in reducing Cobb's angle and improving range of motion.

DECLARATIONS

Ethics Approval and Consent to Participate

The study was conducted after approval from the Institutional Human Research Ethics Committee. Written informed consent was obtained from all participants before their participation in the study. The participants were informed about the purpose and procedures of the study and their right to withdraw from participation at any time without prejudice.

Consent for Publication

Not applicable. No individual participant-identifying information or identifiable images are included in this manuscript.

Availability of Data and Materials

The data generated and/or analyzed during the present study are available from the corresponding author on reasonable request.

Competing Interests

The authors declare that they have no competing interests.

Funding

The authors received no financial support or funding for this study.

Authors' Contributions

All authors contributed to the conception and design of the study, data collection, analysis and interpretation of the results, and preparation and critical revision of the manuscript. All authors approved the final version of the manuscript and agreed to be accountable for all aspects of the work.

Acknowledgements

The authors would like to acknowledge all the participants who took part in this study and contributed to its completion.

AI Use Disclosure

The authors declare that no generative artificial intelligence tools were used to generate or substantially modify the scientific content of this manuscript.

REFERENCES

1. Gillan MG, Ross JC, McLean IP, Porter RW, The natural history of trunk lward, its associated disability and the influence of McKenzie management, Eur Spine J.1998, 7:480-483

2. Porter RW, Miller CG, Back Pain and trunk ltwast. Spine. 1986; 11:596-600
3. McKenzie RA. Manual correction of sciatic scoliosis, New Zealand Med J. 1972;484:194-199
4. Weitz EM. The lateral bending sign. Spine 1981;6:388-397.[PubMed]
5. Grieve GP. Common Vertebral Joint problems. Edinburgh, UK: Churchill Livingstone 1981.
6. Cyriax J. Textbook of Orthopedic Medicine: Diagnosis of soft tissue Lesions. 8th ed. Vol.1. London, UK: Balliere Tindall;1982.
7. Fritz JM, George S. The use of a classification approach to identify subgroup of subjects with acute low back pain Interrater reliability and short- term treatment outcomes. Spine 2000;25:106-114
8. Kilpikoski S, Airaksinen O, Kankaanpää M, Leminen P, Videman T, Alen M. Interexaminer reliability of low back pain assessment using the McKenzie method. Spine.2002;27:E207-E214.
9. Laslett M. The Diagnostic Accuracy of the Clinical Examination Compared to Available Reference standards IN Chronic Low back Pain Subjects [thesis]. Faculty of health Sciences, Linköping University, Linköping Sweden, 2005.
10. McKenzie RA, May S. Mechanical Diagnosis and therapy: The Lumbar Spine. 2nd ed. Waikanae, NZ: Spinal Publications;2003.
11. Tenhula JA, Rose SJ, Delitto A, Association between direction of lateral lumbar shift movement tests, and side of symptoms in subjects with low back pain. PhysTher. 1990;70:480-486.
12. Donahue MS, Riddle D, Sullivan MS, Interrater reliability of a modified version of McKenzie's Lateral shift assessments obtained on subjects with low back pain. PhysTher 1996;76:706-726.
13. Matsui H, Ohmori K, Washihara H, Tsuji H, Significance of sciatic scoliotic ltwast in operated subjects with lumbar disc herniation. Spine. 1998;23:338-342.
14. Capener N, Proceedings of the Royal Society of Medicine. Vol.26. London, UK, Longmans, Green ; 1933. Alternating Scoliosis.
15. Falconer MA, McGeorge M, Begg AC, Surgery of lumbar intervertebral disc protrusion: A study of principles and results based upon 100 consecutive cases submitted to operation. Br J Surg. 1948;35:225-249
16. Grieve GP. Treating backache :A topical comment. Physiotherapy. 1983;69:316
17. White AA, III, Panjabi MM. Clinical Biomechanics of the Spine. 2nd ed. Philadelphia: JB Lippincott Company; 1990.
18. Lastett M. The McKenzie method of managing acute lumbar ltwast, kyphosis and hyperlordosis. American Back Society Symposium 1991.
19. Suk KS, Lee HM, Moon SH, Kim NH, Lumbosacral, Scoliotic ltwast by lumbar disc herniation spine. 2001;26:667-671.
20. Roberts A. A Randomised, Controlled, Prospective Trial of NSAID (ketoprofen) and McKenzie Treatment. [Thesis]. University of Nottingham UK, 1999.
21. Clear HA, Adams R, Maher CG. Reliability of detection of lumbar lateral shift. J Manipulative PhysiolTher. 2005;26:476-480.
22. Khuffash B, Porter RW, Cross leg pain and trunk ltwast Spine. 1984;14:602-603.
23. Battie MC, Cherkin DC, Dunn R, Ciollo MA, Wheeler KJ, Managing low back pain: Attitudes and treatment preferences of physical therapists. PhysTher. 1994;74:219-226.
24. Foster NE, Thompson KA, Baxter GD, Allen JM, Management of nonspecific low back pain by physiotherapists in Britain and Ireland: A descriptive questionnaire of current clinical practice, Spine 1999;24:1332-1342.
25. Mark Laslett, Lateral shift correction. J Man Manip Ther. 2009
26. Mark Laslett. Manual Correction of an Acute Lumbar Lateral Shift: Maintenance of Correction and Rehabilitation: A case report with video. J Man Manip Ther. 2009; 17(2): 78-85.
27. Angela Dunsford, Saravana Kumar and Sarah Clarke. Integrating evidence into practice: use of McKenzie-based treatment for mechanical low back pain. J Multidiscip Healthc. 2011; 4: 393-402.
28. Saeid Alemo, A. Sayadipour. Chronic Mechanical Lower Back Pain. J Neurology Ortho P Med urg (2008); 28(1):5-11.