Impact of Pressure Biofeedback Analysis on Movement Control Exercise for Non-Specific Low Back Pain Treatment

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KEYWORDS
Movement Control dysfunction test, Movement control exercises, Lumbo-pelvic control, pressure biofeedback, Non-Specific Low Back Pain(NSLBP)

ABSTRACT
Introduction: Low back pain in the class of prevalent musculoskeletal conditions, with almost 90% of cases classified as non-specific low back pain (NSLBP). Interestingly, the classification of mechanical low back pain (LBP) includes movement control deficits, specifically uncontrolled lumbo-pelvic movements, reflecting a deficit in controlling active movements in day-to-day life. The pressure biofeedback unit is accustomed to assess the functional stability of the trunk.
Various traditional exercise protocols have been applied without making any sub-classifications. It is inappropriate to apply the same programs to all subjects with back pain.
This study aims to identify the type of movement control impairments, assess them through a pressure biofeedback unit, and treat patients with corresponding movement control exercises tailored to their specific impairments.
Aim: To ascertain the effect of movement control exercise (MCE) on NSLBP subjects using pressure biofeedback unit.
Material and Methods: In this study, totally 40 subjects with non-specific low back pain (NSLBP) were selected. They were divided into two groups: an experimental group (Group A) and a control group (Group B), each consisting of 20 subjects, using proper randomization. Pre-test assessment was conducted using the movement control dysfunction test and a pressure biofeedback unit. Group A received treatment with movement control exercises, while Group B underwent spinal extension exercises and a back care program. Post-test assessment was carried out after the intervention.
Results: The research study included 40 patients, with Group A comprising 20 patients receiving movement control exercises and Group B comprising 20 patients receiving spinal extension exercises. The results showed a reduction in pain, uncontrolled flexion, uncontrolled extension, and uncontrolled rotation patterns in both groups (p value, <0.05). However, the comparison between Group A and Group B revealed that movement control exercises resulted in greater improvement than spinal extension exercises.
Conclusion: Based on the findings, it can be concluded that movement control exercises are more effective than spinal extension exercises in treating NSLBP.

1. Introduction

Low back pain (LBP) is a common musculoskeletal ailment, with 90% of cases attributed to non-specific low back pain (NSLBP) (1, 2, 3, 4). The most effective type of exercise for chronic or acute LBP is still a subject of debate. Exercise therapy is widely used in conservative treatment worldwide (5, 6, 7). There are several models for assessing and retraining movement faults available for correcting movement dysfunction (8), such as Hodges' motor control research (9), Sahrmann's direction susceptible to motion (10), and Comerford and Mottram's kinetic control (11). These movement-based frameworks help in managing chronic, recurrent low back pain by identifying a connection between uncontrolled movement and pain provocation, which has been supported by some authors.

There are numerous sub-classifications of low back pain. For this study on Sahrmann and Comford movement analysis model, we will focus on a specific sub-category under non-specific low back pain (NSLBP). This sub-category is mechanical pain, which is primarily related to pain and posture.

Mechanical NSLBP can be further classified into movement impairment and movement control impairment. There are differences between these two impairments. Movement impairment involves restrictions in movement in either a single direction (plane) or multiple directions (plane). On the other hand, movement control impairment leads to restrictions in functional activities due to reduced active control of movement in day-to-day life.

The underlying cause of movement control impairment in subjects with mechanical pain is a lack of awareness of maladaptive movements and prolonged improper movements, leading to deficient lumbar movement control. Uncontrolled lumbar movements can manifest as uncontrolled flexion, extension, rotation, or a combination of these movements, as described by Comford.

The Sahrmann's kinesiopathologic model (KPM) suggests that sustained alignment and repetitive daily activities can lead to the accumulation of stress and irritation, resulting in micro trauma. Unconscious movement in a provoking manner can also produce micro trauma. The model explains that sustained alignment takes the path of least resistance and involves relative flexibility and stiffness of muscles, which can lead to altered motor performance and motor learning. Therefore, intervention programs should focus on cognitive aspects. If acute low back pain (LBP) is not promptly addressed with intense intervention, it can progress to chronic pain.

Movement control dysfunction, as identified by Luomajoki and Sahrmann, has good intra-rater and inter-rater reliability. In a study, six clinical tests and pressure biofeedback were used to identify uncontrolled lumbo-pelvic region impairment, and the subjects' motor control was challenged while actively controlling the impairment. Changes observed in pressure biofeedback were found to be relevant in estimating the motor control impairment (MCI) group. In summary, the evaluation of the type of ailments and recognition of causative factors are important for designing necessary exercises for day-to-day life. Proper education is also crucial to correct the patient's cognitive understanding.

Overall, this study aims to determine the effectiveness of Motor Control Exercise (MCE) in treating Non-Specific Low Back Pain (NSLBP).

2. Materials and Methods

Setting:

This study conducted over RMMCH (Rajah Muthiah medical college and hospital,) Chidambaram, Tamilnadu during the period from August 2023 To June 2024.The study protocol was approved by INSTITUTIONAL ETHICS COMMITTEE, RMMCH. (EC/NEW/INST/2020/1249)

Participants

Participants were selected through purposive sampling.

Inclusion criteria:

1. Age from 20 to 45 years.
2. Subjects those were diagnosed as NSLBP by Physician, PMR dept and those who were adopting European guidelines.
3. Radiological imaging also covered to rule out specific LBP.
4. Gender: both male and female.
5. BMI INDEX within 30
6. Two positive results shown for impaired movement control test only included in study.
7. NSLBP (3 months to 1 year duration of symptoms)

Exclusion criteria (13)

1. Specific low back pain (degenerative arthritis, carcinoma, nerve root pain)
2. Cardio-vascular disease
3. Underwent Surgical procedures
4. History of traumatized back
5. Pregnancy and other Obstetrics and gynaecological related disorders.

Procedure:

40 subjects with NSLBP were completed and recruited based on selection criteria.10 subjects dropped out due to some reasons. Assessment and treatment procedures were explained to all the patients and got signed with informed consent. They were randomly assigned into two groups. Group A received movement control exercise and Group B received spinal extension exercise.

Pre and Post test assessment was taken on 1stand 15th day using movement control dysfunction, pressure Biofeedback unit, and pain by NPRS. Both the groups were treated for 45 minutes/day/5 days per week, for three week

Treatment procedure:

The six movements testing for movement control dysfunction were tested the pattern of movement dysfunction once identified. The description of the test explained

Exercises were selected based on direction of impairment, flexion, extension, rotation or combination of patterns.

Treatment Plan:

For flexion symptoms:

Retraining lumbar flexion

- Control with partial support, retraining lumbar flexion
- Control in quadruped position
- When adopting a sitting position, make sure to sit with the lumbar spine and pelvis in a neutral position. Practice the sit-to-stand movement 15 to 20 times to make it a habit in daily life. Maintain the lumbo-pelvic position without provoking any symptoms. Consider activities like sustained sitting, forward bending, driving, and lifting to test the functional daily movements.

For extension symptoms:

- Back flattening on wall, standing position (abdominal and gluteal muscles co-contracted to posterior tilt) pelvis and flatten the lumbar spine in the wall.
- Prone-position actively pulls in abdominal wall by activation and holding contraction of lateral abdominal walls.
- Look for the extension related symptoms like sustained standing position, prone-lying reacting overhead activities (provoking symptoms) of extension pattern observed in daily functional activities).

For rotation symptoms:

- Bent knee fall out – person in supine lying, place one heel up, instruct to slowly lower the bent leg, the pelvis begin to rotate 45 degree of rotation range is achieved. usually uncontrolled rotation is associated with inefficient oblique abdominals, so recruited them in efficient way is

need.(so lift the ASIS anteriorly or forward facilitate oblique abdominals)

- Top leg turn out – side lying position; instruct the patient to open the leg in controlled manner without any pelvis movement.

Look for provoking symptoms in day to day functional activities like unilateral pain in spine, the movement causes pain away from the body. (FIG 1,2,3,4)

For control groups:

As same selection criteria was followed like the experimental groups. The conventional exercise-three kinds of spinal extension exercise were adopted for the subjects 5 days per week for three weeks. Exercise details sort out in appendices along with some back program instruction.

A. Outcome measures: (14)(15)(16)

Both the groups underwent six settings of test:

- Waiter's Bow
- Dorsal tilt of patient
- One leg stance
- Sitting knee extension
- Rocking forward and backwards
- Prone-lying active knee flexion ….Test details explained in appendices

B. Pressure biofeedback:

Pressure biofeedback is convenient tool to measure objectively uncontrolled movement of lumbo-pelvic region. (17)(18)(19)

Place the inflate pad to a base pressure at 40 mm Hg is kept in lumbar region (L3 level), instruction given verbally and Enough 3 trials are allowed. By double bent leg lift test and double bent lower test and bent knee fall out test, above all the test done. Then the pressure variations in the bio feedback unit were measured and the type of impairment would be recorded. Test details given in appendices

B. NPRS

It is a valid subjective measurement scale for pain and the intensity is evaluated.(20)

A. List of **functional difficulty** daily activities were measured: the daily activities which increase the symptoms were recorded.

Fig.1. Flexion training in hip without any movement of back

Fig.2. Extension training – abdomen and gluteal co-contraction

Fig.3. Rotation training – Hip and knee open up training without any pelvic movement

Fig.4. upright high sitting position with neutral pelvis and do extension of knee joint on each leg

3. Statistical Analysis

Shapiro-Willis test of normality was used for the selection of statistical tools for normal distribution, **sample t test (paired)** was used for within group analysis and **sample t test (independent)** was used for between group analyses. If the distribution was non-nominal, wilcoxon's signed rank test was used for within group analysis and Mann-Whitney 'u' test is used for between the group analysis, the entire statistical analysis was done using the statistical packages for the social –sciences (SPSS)

Table – 1 Basic character of the study patients

Variables	**Group A**		**Group B**		**Total**		**Test statistics**		
							value		p
Age in years(M, S.D)	38.50	6.28	32.25	7.18	35.37	7.37	Z	2.91	0.004*
Gender (N, %)									
Male	13	65	14	70	27	67.5			
Female	7	35	6	30	13	32.5	Z	0.33	0.739
BMI (M, S.D)	24.55	2.96	25.90	2.29	25.22	2.70	t	1.11	0.115

The basic character of the study patients is show in Table 1. The mean age of the group A patients was 38.50 ± 6.28 years and it was 32.25 ± 7.18 for group B patients, with the obtained significant difference, Z = 2.91, p = 0.004 which is< 0.05. The majority of the patients were male participants, proportion was 65 % in group A and 70 % in group B. the difference in gender was statistically insignificant betwwn groups. The mean BMI of group A was 24.55 ± 2.96 and it was closely resembled to group B, M = 25.90 ± 2.29. Therefore difference in the BMI was statistically insignificant between groups p = 0.115.

Table – 2 Pain - within group comparison

NPRS	Pre		Post		M.Diff		Test statistics	
	M	S.D	M	S.D	M	S.D	Z	P
Group A	6.05	0.76	2.35	1.04	3.70	1.22	3.95	0.001*
Group B	5.55	1.05	4.25	1.25	1.30	0.47	4.09	0.001*

It is revealed from table 2 that there was significant improvement in pain in group A from the pre mean of 6.05 ± 0.76 to 2.35 ± 1.04 following therapy. In group B the pain was reduced significantly from pre mean of 5.55 ± 1.05 to 4.25 ± 1.25 at the end of the study.

Table – 3 Pressure Bio feedbacks for detecting spinal motions- within group comparison.

Spinal movements	Pre		Post		M.Diff		Test statistics		
	M	S.D	M	S.D	M	S.D		value	P
UF									
Group A	57.00	7.33	48.30	4.82	7.80	4.09	Z	3.93	0.001*
Group B	56.90	9.41	53.70	9.14	3.20	2.55	t	5.62	0.001*
UE									
Group A	56.80	6.85	48.30	5.24	9.10	3.34		12.82	0.001*
Group B	57.40	5.24	52.90	8.42	4.50	2.82	t	7.14	0.001*

The within group comparison of pressure bio feedback is shown in table 3. There was significantly higher improvement in uncontrolled flexion in group A with the mean improvement of 7.80 ± 4.09, Z = 3.93, p = 0.001. There was significant improvement in uncontrolled flexion is group B as well but with the mean improvement of 3.20 ± 2.55, t = 5.62, p = 0.001. There was significantly higher improvement in uncontrolled extension and uncontrolled rotation in group A with the mean improvement of 9.10 ± 3.34 and 6.50 ± 2.58 respectively. Group B patients have also shown significant improvement in uncontrolled extension with the mean improvement of 4.50 ± 2.82.

Table –4 Comparisons of outcome variables between groups.

Outcome variables	M. Diff		Test statistics	
	M	S.D	Z	p
NPRS	2.50	1.52	5.00	0.001*
UF	5.50	4.09	3.83	0.001*
UE	6.80	3.84	4.06	0.001*

Between groups comparison of outcome variables is shown in table 4. There was significantly higher improvement in NPRS in group A than in group B with the mean difference in the improvement of 2.50 ± 1.52, Z = 5.00, p = 0.001. Likewise there was significantly higher improvement in uncontrolled flexion, uncontrolled extension in group A with the mean difference in the improvement of 5.50 ± 4.09, 6.80 ± 3.84 respectively. The overall findings suggested that group A patients had shown better improvement in all the outcomes.

TABLE 5: comparison of uncontrolled rotation – within group analysis.

UR		**PRE**		**POST**		**Difference**		**t/z value**	**P**
		Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**		
Right	**A**	47.29	2.64	43.12	1.49	4.17	1.15	3.31	0.002*
	B	48.06	5.64	47.47	5.26	0.58	0.38	2.06	0.056
Left	**A**	49.41	4.54	44.35	2.34	5.06	2.20	6.13	0.001*
	B	46.06	4.56	45.59	4.51	0.47	0.05	2.43	0.027*

It is inferred from table 5 that the mean UR (right) before therapy for group 'A' was 47.29 ± 2.64 and it was reduced significantly to 43.12 ± 1.49 post therapy, z = 3.31, p = 0.002 < 0.05 likewise there was significant reduction in the left UR in group 'A' from the pre therapy mean of49.41 ± 4.54 to 44.35 ± 2.34 post therapy, t = 6.13, p = 0.001 < 0.05.

In group B, the mean pre-value of UR (right) at the start of the study was 48.06 ± 5.64 and it was 47.47 ± 5.26 at the end of the study. The difference was statistically insignificant, t = 2.66, p = 0.056 > 0.05. the mean pre value of UR (left) for group 'B' was 46.06 ± 4.56 and it was reduced significantly to 45.59 ± 4.51 post therapy, t = 2.4, p = 0.027 < 0.05.

TABLE 6: Uncontrolled rotation – between groups comparison.

UR		**Mean deviation**	**t/z value**	**P value**
Right	**A**	2.56 ± 2.64	3.23	0.001*
	B			
Left	**A**	2.94 ± 3.27	4.06	0.001*
	B			

It is inferred from table 6 that, there was significantly higher improvement in UR (right) in group 'A', M.D = 2.56 ± 2.64, z = 3.23, p=0.001. Likewise, there was significantly higher improvements in UR (left) in group A, M.D = 2.94 ± 3.27, z = 4.06, p = 0.001<0.05.

Appendix:

4. Movement Control Dysfunction Test

Test: 1

- "WAITERS BOW" →Flexion of hips in upright standing posture without movement flexion of the low back.
- Correct: Forward bending of the hips without any movement of the low back (50º- 70º flexion hip)

Test:2

- "PELVIC TILT" →Dorsal tilt of pelvis actively in upright standing posture
- Correct: Actively in upright standing, Keeping thoracic spine in neutral position ,lumbar spine moves towards flexion.

Test: 3

- "SITTING KNEE EXTENSION" →upright sitting with neutral lumbar lordosis; do extension of the knee without movement (flexion) of low back.

Test: 4

- "QUADRUPED POSITION" → Transfer of the pelvis backward and forwards ("rocking") keeping low back in neutral starting position 90º hip flexion.
- Correct: 120º of flexion in hip without movement of the low back by transfer pelvis backward. Rocking movement towards to 60º flexionin hip without any movement in low back.

Test: 5

- Prone lying position with active knee flexion.
- Correct: active knee flexion at least 90º withoutany movement of the low back and pelvis.
- low back and pelvis.

Test: 6 (One Leg Stance)

Stand with the feet apart at one third of the intertrochanter distance then proceeds to stand on one leg (amount of lateral shift is measured).

- *Correct:* usually 8 cm of lateral shift of pelvis in both sides and small amount of discrepancy between sides.
- *Incorrect:* more than 10 cm of lateral shift ordiscrepancy of more than 2cm between sides

Group B: Spinal Extension Exercise Procedure:

Position of the Patient: Prone Lying Position

Exercise No: 1

- Ask the patient to lift his leg alternatively. The patient holds each leg for the time: 5 to 10 seconds with 10 seconds, considered relaxation for 10 repetitions.

Exercise No: 2

- Ask the patient to lift both hands along with head, neck and trunk and hold it for a period of time: 5 to 10 seconds with relaxation of 10 seconds. This exercise is done atleast with 10 repetitions.

Exercise No: 3

- The patient first lifts his right hand along with head, neck and trunk and then finally the left leg. This way is repeated with the left arm and right leg. Hold for 10 seconds with 10 seconds as relaxation and again repeat this exercise for 10 repetitions.

Back Care Programs (For Group B)

- Do not lift weights suddenly .practice correct ways of lifting weights with adequate bending your knees.
- If elderly persons be cautious while getting up from bed.
- Do not carry unequal weights on your shoulder and arms.
- When riding on two wheelers, drive cautiously and try to negotiate the curves.
- Practice safe methods of sneezing and coughing.
- While carrying out activities like sweeping, mopping on floor scrubbing avoid squatting or kneeling on floor.
- Maintain a healthy back.
- Exercise regularly keeps your back muscles in shape.

5. Measuring Tool:

5.1. Pressure Biofeedback Unit:

The pressure biofeedback is a useful clinical tool to objectively measures uncontrolled movement of lumbopelvic region. Pressure biofeedback unit testing core control during limb load tests.

Place the inflated pad to a base pressure of 40 mm Hg in lumbar region (L3).In order to increase the proper accuracy of the test, trials and corrections (verbal / cueing) were allowed to each subjects, the following tests were taken:

5.1.1. Double Bent Lower Leg Lift Test (For lumbar flexion UCM)

In crook lying position, slowly lift both the feet off the floor until both hips are flexed to 90̊ maintain this position for 5 seconds and keeping the lumbar spine controlled (no pressure change) slowly lower both feet to the floor.

Uncontrolled lumbar flexion – A pressure increase of more than 10mm Hg (increase to more than 50 mm Hg) denotes gross posterior tilt and uncontrolled lumbar flexion movement.

5.1.2. Double Bent Leg Lower Test (For lumbar extension UCM)

Double bent leg lowering unsupported, extend both the hips from 90̊ flexion to 45̊ feet towards the floor and hold then steady just a few centimetres off the floor while keeping the pressure constant at 40 mm Hg.

Uncontrolled lumbar extension – A loss of flattening pressure decreases to less than 30 mm hg denotes gross anterior pelvic tilt and loss of control in spinal extension.

Uncontrolled lumbar rotation–increase of pressure in PBU denotes excessive uncontrolled lumbo pelvic rotation.

5.2. NPRS:

NPRS is a valid subjective measure for acute and chronic pain. The patients are asked to mark a number according to their pain level. Pain intensity is evaluated using NPRS ranging from 0 to 10points.

0 is considered as no pain and 10 as a very severe pain.

1-3 indicates mild pain,

4-6 indicates moderate pain,

7-9 indicates severe pain,

10 worst pain.

6. Results

In group A, comparing pre and post mean difference, there was statistically significant improvement in NPRS, UF, UE, UR (right) and UR(left)with p value of 0.001 ,0.001,0.001,0.002.

In group B, there was statistically significant improvement in NPRS, UF, UE, UR (right), UR (left) with p value of 0.001, 0.001, 0.001, 0.056, and 0.027.

On comparison: between the groups Group A and Group B there was statistically significant improvement in NPRS, UF, UE, and UR (right and left) and of group A at 1% level of significance.(TAB 1,2,3.4,5,6)

7. Discussion

From the study, it was observed majority of the participants.65% in group A and 70 % in group B. The gender in difference was statically insignificant between groups.

The mean BMI of Group A was 24.55+2.5 and it was closely resembled to Group B. M =25.90+28.therefore difference in BMI was statistically insignificant between groups (p=0.115)

On comparison between the groups, there was significant improvement in NPRS in group A uncontrolled flexion, uncontrolled extension, and uncontrolled rotation respectively.

The overall findings had shown better improvement in all outcomes measured by pressure biofeedback in experimental group A. The possible explanation as follows:

Uncontrolled lumbar flexion movement was trained through by multifidus activation and to visualise the sacrum up along the shoulder.

Lumbar lordosis with slight increase at the same time pressure should be decreased. There will be no thoracic extension should be observed from patient. Ideally the efficient working of multifidus muscle recruitment, the pressure should decreased by 5-10Hg.(9,10)

Along with multifidus activation, corrective functional movement in their daily activities with appropriate cognitive training in their day to day activities also could be a reason in improvement in flexion related syndrome.

We also witnessed improvement in extension pattern, the possible explanation as follows: the poor control of extension due to inefficient oblique abdominals and anterior fasciculus of psoas major. Ideally with oblique recruitment pressure should increase by 8-10 mmHg .once we attained series of oblique facilitation, progression of exercise can be encouraged to subjects….

From other perspectives of journal view there is lack of evidence is effectiveness between the types of exercises. But janet **et al** evaluated movement control exercise verses general exercises in movement control impairment but they contributed towards mechanism behind movement control impairment relevant to low back pain.

Out of 50 subjects enrolled for the study, due to certain reasons, only 40 subjects able to complete the study. In future, study may be extended over various regions to generalize the results, but with larger samples is essential. though the spinal extension provide some improvement, but MCE is well documented and efficacy especially, under sub classification of LBP. The classification involved cognitive functional therapy elicits superior outcome in NSLBP compared than manual therapy and exercise. Behavioural oriented target approved in NSLBP seems more effective in reducing pain, disability, fear belief at long term level (21-25). So MCE can be added as one of beneficial treatment regimen in case of NSLBP.

8. Conclusion

In this study, movement control exercises were found to be more effective than the conventional exercises .This was proved with pain relief obtained by movement control exercises and also by improved movement pattern in NSLBP than the conventional group.

Limitations:

Small size sample only included in the study. Larger samples will be helpful to generalise the results and avoid bias

Recommendations:

1. This study need long term follow up to find the effects of treatment with movement control exercises.
2. Treatment duration can be extended for further weeks.
3. In future, study may be extended to various regions to generalize the study results.

Author Declaration:

- Financial or Other Competing Interests: None
- Whether Ethical Committee Approval obtained for this study? Yes
- Whether informed consent obtained from the participants involved in the study? Yes
- For the images had appropriate consent has been obtained from the subjects. Yes

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