Frontiers in Health InformaticsISSN-Online: 2676-7104 www.healthinformaticsjournal.com
2024; Vol 13: Issue 3 Open Access

Effectiveness of Posture Analysis Using Kinovea in Enhancing Movement Control in NSLBP Patients

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Cite this paper as: K.Balathandayutham, S.Subbiah and Sarulatha Haridass (2024). Effectiveness of Posture Analysis Using Kinovea in Enhancing Movement Control in NSLBP Patients. *Frontiers in Health Informatics,* 13(3), 10246-10259

ABSTRACT:

OBJECTIVE:
To compare the effectiveness of movement control exercise versus spinal extension exercises in Non-specific low back pain assess through pain, postural evaluation.

INTRODUCTION:
Low back pain (LBP) affects almost everyone in their lifetime and impact over social economic status. LBP is broadly classified into specific and nonspecific types. Nonspecific has 10% non-specific low back pain has multi-factorial causes include, muscle strain, poor posture psychological stress etc.

So, it is essential to perceive various sub groups of low back pain existence, the mechanism Behind the low back pain to be understood, and improve diagnostic strategies and tailor-made intervention.

Amongwhich, Movement control exercises are a type of therapeutic approach used in the management of NSLBP. It enhances, co-ordination, stability, specific movement control (cognitively) that overall improve the movement pattern, reduce future recurrences, acute pain into chronic pain. It's always crucial to include postural evaluation, and evaluate the effects of movement control exercise (MCE) over the NSLBP subjects.

STUDY PROCEDURE
40 subjects with NSLBP were selected based on the selection criteria. Assessment and treatment procedure were explained to the patients and they were randomly assigned into two separate groups. Group A received MCE and Group B received spinal extension exercise.

Pretest assessment were taken on 1st day before treatment using movement control dysfunction test, pain, postural evaluation- analysis by kinovea software of specific functional activities. both the group were treated for 15 days. At the end of the 15thday the post evaluation of (MCDT), pain, postural evaluation was recorded and statistically analyzed.

RESULTS
In group A, comparing pre and post mean difference, there was statistically significant improvement in NPRS [z=12.50, p=0.001], UF [z=9.78, p=0.001], UE [z= 11.26 p= 0.002,

In group B, there was less statistically significant improvement than group A in NPRS [z= 12.36, p= 0.001], UF [z= 5.88, p= 0.001], UE [z= 3.68, p= 0.002],

On comparing group A and group B there was statistically significant improvement in NPRS [z= 4.92, p=

0.001], UF [z= 3.99, p= 0.001], UE[z=4.78, p= 0.001]

CONCLUSION

- *The study concluded that movement control exercise is an effective treatment for non-specific low back pain*
- *Movement control exercise is comparatively better in improving pain, postural evaluation shows (improved uncontrolled flexion and extension) than spinal extension in NSLBP.*

Keywords*: Movement Control dysfunction test, Movement control exercises, Lumbo-pelvic control, , Non-Specific Low Back Pain(NSLBP)*

INTRODUCTION

Low back ache has been reported prevalence about 23% in India.[1] Non-Specific Low back pain does not have identified cause with no specific pathology from the literatures, it accounts for 90% of cases where specific Low back pain holds 10% of cases.[2]

This kind of pain may experience at one point of their lifetime. Specific cases include identifiable causes. But in NSLBP has multifactorial causes due to a faulty posture, articular involvement, muscular dysfunction instability and overuse.

Even many professional experiences the episode of LBP especially position or posture related, notably nurses, dental profession, physiotherapist etc experienced it. Literatures suggest, dentists experienced 70% of low back pain in their lifetime. Dental professionals spend most of their workdays in static awkward positions.[3] This might cause back ache and altered positions performed during dental work lead to occupational pain in dentists. The reason behind is either awkward posture, repeated posture use, standing for long time, produce fatigue and more musculoskeletal disorders.[4,5] thus Understand the posture-related pain is crucial, especially in the context of NSLBP helpful to Understand the scenarios behind the mechanism, hence clinical decision making urges proper selection of treatment aspects.

According to Hayden et al, exercise therapy does not seem to be significant improvement in pain, function status, in acute NSLBP. But author wood et al [6]There is need for proper selection in comparison groups for the best contribution of the effective management of chronic low back pain .The classification of the patients, prevents acute into chronic, it's possible to explore the effect of exercise therapy in sub-groups classification.

So it is essential to identify the sub-groups classification. there are various authors discussed about classification, notably Hodges[7] (motor control research), Mooney (force closure model), sahramann[8](direction susceptible to motion,comford&mottram[9] (Kineticcontrol), O Sullivan & Dankesh[10,11] (control impairment).

Sahrmann proposed the basic kinesio pathologic model (KPM) is that the sustained alignment and repetitive movements of their daily activities leads to accumulation of tissue stress and irritation results in cumulative micro trauma.

Patients with mechanical NSLBP are further divided into those with movement impairment (MI) and movement control impairment,[12]MCI patients presented with mechanical pain and lack of awareness of maladaptive movementleads to impairments of lumbar movement control.[13]This uncontrolled movement in NSLBP is further classified based on the direction of control deficit that is uncontrolled flexion, uncontrolled extension, uncontrolled rotation or combination of different uncontrolled movement patterns as described by comford[9]

We knew there are heterogeneous set of treatments such as specific muscle strength, stretch, flexibility, mobility exercise, aerobic exercise, functional rest, Mckenzieyoga.etc. So there is essentiality to observe the difference, to attain unique contribution of exercise therapy.

In this study, NSLBP is further classified and measured and tailor made exercise intervention done and analysed, implementation of programme through cognitive level and repeated in functional activities.

It was clear that the study aims to find out the effect of movement control exercise in non-Specific low back pain.

METHODOLOGY

STUDY DESIGN:
Experimental study- interventional study (design as per advice from our institutional ethical committee)

SAMPLE SIZE:
40 subject with nonspecific low back pain, 20 in Experimental group (Group A) and 20 in control group (Group B) were classified.

STUDY SETTING:
Patients are diagnosed under the guidance of Physician, Physical Medicine and rehabilitation, physician explained with European guidelines of low back pain classification. Radiographs images done to rule out specific low back pain pathology.The study got approval from INSTITUTIONAL ETHICAL COMMITTEE, RMMCH(EC/NEW/INST/2020/1249). The study done during the time period, June 2023 to June 2024. Rajah Muthiah medical college and hospital (RMMCH), Annamalai University, chidambaram.

SAMPLING
Purposive sampling

TREATMENT

DURATION:
15 days' daily session (weekly 5 days for 3 week)

SAMPLE SELECTION:

INCLUSION CRITERIA:
- Age 20 – 45 years.
- Gender – Both male and female.
- Two or more positive results shown for impaired movement control test.
- Low back pain (>3 months' duration of symptoms up to 1 year)
- BMI < 30

EXCLUSION CRITERIA:
- Specific low back pain(nerve root involvement, cancer, fracture)
- Exercise restricted cardiovascular disease.
- Traumatic back injury patients
- Postural hypotension.

STUDY PROCEDURE:
40 subjects with NSLBP were selected based on the selection criteria. Assessment and treatment procedure were explained to the patients and obtained inform consent. and it was randomly assigned into two important groups. Group A received movement control exercise and Group B received spinal extension exercise.

Pretest assessment were taken on 1st day before treatment using movement control dysfunction test, pain, postural evaluation of specific functional activities. Both the group was treated for 15 days. At the end of the 15thday, the post evaluation of (MCDT), pain, and postural evaluation were recorded. Postural evaluation is

done through by kinovea software analysis.

OUTCOME MEASURE:

- Movement Control Dysfunction Test (MCDT)
- Kinovea software posture analysis
- Numerical Pain Rating Scale (NPRS)

MOVEMENT CONTROL DYSFUNCTION TEST (14,15,16,17,18)

Both the groups underwent six batteries of tests, the following tests are explained as:

1. "WAITERS BOW".
2. DORSAL TILT OF PELVIS.
3. SINGLE LEG STANCE.
4. HIGH SITTING KNEE EXTENSION.
5. ROCKING FORWARDS AND BACKWARDS.
6. PRONE LYING POSITION: ACTIVE KNEE FLEXION.

TESTING PROCEDURE:

The description of each individual test was clearly narrated as:

PATIENT POSITION: The patient sitting or lying on the treatment table.

THERAPIST POSITION: The therapist stands in front of the patient or beside the patient

TEST: 1 (WAITERS BOW)

Instruct the patient, actively lean forwards till flexion of hips (upto 50° - 70°) in u standing position, keep control the lumbar spine and pelvis in neutral position by palpating the spinous process of L_2, L_5 and S_2 with finger tips.

✓ *Correct*: during testing, fingers do not move.

× *Incorrect*: if the palpating fingers moves further apart; uncontrolled lumbar flexion is identified.

TEST: 2 (DORSAL TILT OF PELVIS)

Instruct the subjects to do Dorsal tilt of pelvis actively in standing. Position

✓ *Correct*: Keep the thoracic spine in neutral, lumbar spine moves towards flexion.

× *Incorrect: ifany* uncontrolled thoracic movement occurs.

TEST: 3 (SINGLE LEG STANCE POSITION)

Stand with the feet apart at one third of the intertrochanteric distance then proceeds to stand on one leg (here 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: if* more than 10 cm of lateral shift or discrepancy of more than 2cm between sides.

TEST: 4 (HIGH SITTING: KNEE EXTENSION MOVEMENT)

Subjects adopts high sitting position with neutral lumbar lordosis, instruct extension of the knee within 10-15° of full range.

✓ *Correct:* Ability to hold in lumbo-pelvic neutral position.

× *Incorrect:* complaints of unilateral pain occur in lumbar spine. Uncontrolled lumbo-pelvic rotation before knee reaches 10-15° from full extension.

TEST: 5 (ROCKING FORWARDS AND BACKWARDS IN QUADRIPUD POSITION)

Subject in quadruped position, transfer of the pelvis backward and forwards ("rocking") keep lower back in neutral position (90º of hip flexion) by palpating the spinous process of L_2, L_5 & S_2 with finger tips.

✓ *Correct*: subjects maintain neutral spine upto forwards (120º of hip flexion) and backwards (60º hip flexion).

× *Incorrect:* palpating fingers moves close and far apart in uncontrolled extension and flexion respectively.

TEST: 6 (PRONE LYING POSITION: ACTIVE KNEE FLEXION)

In prone position, ask the subjects actively flex one knee approximately 120°.

✓ *Correct*: at least 90º of hip flexion without movement of the low back and pelvis.

× *Incorrect:* person complains of unilateral pain; uncontrolled lumbar rotation begins.

Once the test procedure completed the challenging functional activities of each patient was recorded. And modified and cognitively trained and incorporated in functional activities.

MEASURING TOOLS:

A. KINOVEASOFTWARE POSTURE ANALYSIS:

- Kinovea is a video annotation tool designed to capture annotate and measure motion in videos. (19)
- The restricted functional activity was noted.for example; flexion related sitting activity, likewise extension related restricted activity was recorded. Movement of different body parts was observed and using cross line marker tool utilized in software.-guidelines adopted from software.
- The images were loaded in computer screen and at every body movement was paused, assessed, postural position studied and scored on score sheet.
- Each event was paused and measurement of angle of joints was taken for the study. Flexion activity measurement illustrated in appendix

B. NUMERICAL PAIN RATING SCALE (NPRS) (20)

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.

1to3 shows mild pain,

4to 6 shows moderate pain and

7 to 9 shows severe pain.

TREATMENT PROCEDURE

GROUP A: MOVEMENT CONTROL EXERCISE

I. Flexion control training:

If the person complaints of flexion related symptoms like unsupported sitting, bending, some difficulty in flexion related activity of the participants, recorded.

1. Retrain lumbar flexion control with chair support:

Ask the patient to support the chair, instruct to forward lean with straight back and hip flexion achieved and

the lumbar flexion, posterior pelvic tilt can be controlled, as a progression. Sit to stand training encouraged without any support

2. Flexion training: sit to stand with both arms crossed
Ask the patient to sit tall with both feet on the floor and his pelvis positioned in neutral position, with both arms crossed. The pattern of forward flexion is repeatedly done with neutral pelvis. Repeat this exercise for 15- 20 times, that is cognitively train it, at the same time independent hip flexion is encouraged as far as lumbar flexion and posterior pelvic tilt should be controlled .for further progression, once cognitively trained, it is incorporated into his functional flexion related activities and his regular positions modified.

II. Extension control training: prone lying position

1. The lumbar spine kept in neutral alignment (that is in normal shallow lordosis). The patient is instructed to bend both knees and the same time instruction given to maintain neutral position and not to move into anterior tilt or increase in depth of lordosis.

Note: if any increase in lumbar lordosis is observed the flexion must stopped and return back to start position. Note if control is poor start training with unilateral knee flexion.

2. Exercise: patient is instructed to stand near the wall. There must be no loss of lumbar neutral position, or pelvic sway. The abdominal muscle and gluteal muscle are both co-achieved to control the neutral spine.

III. Rotation control training: ask the patient to lie down in sidelying position, usually the patient complaints of unilateral symptoms in lumbar spine. Instruct to turn the upper leg up and out to the side in controllable manner without any pelvic rotation.

GENERAL INSTRUCTIONS
In Each movement - 10 seconds holding with 15 repetitions, rest between the movements were given. The optimal Exercises were selected based on the direction of impairments i.e., flexion, extension, rotation or combination of impairments.

Impairments and Relevant Activities
1. For flexion related impairment syndrome, especially repeated or sustained sitting, bending forward, driving, lifting etc were retrained in a neutral spine control.
2. For extension related impairment syndrome, especially walking down slopes, looking up, reaching overhead, sustained standing etc were retrained in extension control.
3. For rotation related impairment syndrome, unilateral symptoms provoked by movements or sustained postures away from midline e.g., side bend or rotation were retrained like through dissociative movement correction.

GROUP B: SPINAL EXTENSION EXERCISE (conventional exercise)

POSITION OF THE PATIENT: Prone lying.

EXERCISE NO: 1
Patient's starts exercise in comfortable position. Instruct the patient lift his right leg off from the ground and hold for 5-10 second. Slowly lower his right leg down and relax for 10 seconds. Afterwards lift his left leg and hold it for 5-10 seconds and lower down. Relaxation time for 10 seconds. Repeat this exercise for 15 counts.

EXERCISE NO: 2
The patient takes his relaxed comfortable position and maintains in prone position. Instruct to lift his head and raise his trunk and arm for a period of 5-10 seconds. Relax for 10 seconds. Its repeated for 15 Repetitions.

EXERCISE NO: 3
The patient takes his prone position. Instruct the patient lift his Right Hand and Left leg along with lifting the trunk. Hold it for 5-10 seconds. Repeat this left arm and Right leg, Relaxation time for 10 seconds. It is

repeated for 15 times.

1. Flexion training : sit to stand training with neutral pelvis.

2. Retrain lumbar flexion control with partial support.

3. Extension control training: bend knee with neutral pelvis.

4. Rotation control training: open up upper leg with neutral pelvis.

II.KINOVEA MEASUREMENT OF FLEXION ACTIVITY (functional activity)

STATISTICAL ANALYSIS

Test of normality was conducted using Shapiro-Wilk test before selecting statistical tests. The basic character between groups was analyzed by Mann-Whitney U test. Within group pre-post analysis was studied by paired sample t test. Between groups analysis was studied by Mann-Whitney U test. Entire statistical analysis was carried out by statistical packages of social sciences (SPSS-21)

Table – 1 Basic character of study patients

Variables	Group A		Group B		Total		Test statistics	
							Z	p
Age in yrs (M,S.D)	38.50	6.28	31.70	7.06	35.10	7.44	3.08	0.002*
Gender (N, %)								
Male	13	65	14	70	27	67.5	0.33	0.799
Female	7	35	6	30	13	32.5		

M-Mean, S.D-Standard deviation, N-Number, %-percentage, z-Mann-Whitney U test

It is inferred from Table 1 that mean age of the study patients was 35.10±7.44 years with significant difference in age between groups, z=3.08, p= 0.002<0.05. gender distribution shows that majority of patients were male, 67.5%, z=0.33, p=0.799>0.05.

Table – 2 Pain score (NPRS) – within group pre-post comparison

NPRS	Pre		Post		M.D		Test statistics	
	M	S.D	M	S.D	M	S.D	t	P
Experimental	6.05	0.76	2.60	0.88	3.45	1.25	12.50	0.001*
Control	5.55	1.05	4.25	1.25	1.30	0.47	12.36	0.001*

M-Mean, S.D-Standard deviation, M.D-Mean difference, t-Paired sample t test, p-Probability, *-Significant

It is inferred from Table 2 that mean NPRS of the experimental group was 6.05±0.76 and it was significantly improved to M=2.60±0.88 post treatment, M. D=3.45±1.25, t=12.50, p=0.001<0.05. The mean baseline NPRS for control was M=5.55±1.05 and it was significantly improved to 4.25±1.25 with the obtained M. D=1.30±0.47, t=12.36, p=0.001<0.05 post therapy.

Table – 3 Comparison of uncontrolled flexion with in group pre-post analysis

UF	Pre		Post		M.D		Test statistics	
	M	S.D	M	S.D	M	S.D	t	P
Experimental	66.70	4.41	60.60	3.56	6.10	2.79	9.78	0.001*
Control	63.30	3.69	61.00	3.75	2.30	1.75	5.88	0.001*

M-Mean, S.D-Standard deviation, t-Paired sample t test, p-Probability, *-Significant

It is inferred from Table 3 that mean pre UF for experimental group was M=66.70±4.41 and it was significantly improved to M=60.60±3.56 following therapy, M. D=2.79, t=9.78, p=0.001<0.05. The mean baseline UF for control was M=63.30±3.69, the improvement was significant following therapy, M=61.00±3.75, t=5.88, p=0.001<0.05.

Table – 4 Comparison of uncontrolled extension with in group pre-post analysis

UE	Pre		Post		M.D		Test statistics	
	M	S.D	M	S.D	M	S.D	t	P
Experimental	27.90	1.65	23.90	1.37	4.00	1.59	11.26	0.001*
Control	27.10	2.99	26.10	2.94	1.00	1.21	3.68	0.002*

M-Mean, S.D-Standard deviation, t-Paired sample t test, p-Probability, *-Significant.

It is observed from table 4 that mean UE improvement was significant following therapy in experimental group with the obtained M. D=4.00±1.59, t=11.26, p=0.001<0.05. There was significant improvement found in control following therapy, M. D=1.00+1.21,t=3.68, p=0.002<0.01.

Table – 5 Between group comparison of study outcomes

Variables	M.D	Z	p
NPRS	2.37+1.43	4.92	0.001*
UF	5.40+2.79	3.99	0.001*
UE	2.50+2.06	4.78	0.001*

M.D-Mean difference, z=Mann-Whitney U, p=probability, *-Significant

It is inferred from Table 5 that experimental group had better pain improvement than control, M. D=2.37±1.43, and it was statistically significant improvement, z=4.92, p=0.001<0.05. Likewise, experimental group had better improvement in UF and UE with the obtained M.D of 5.40±2.79 and 2.50±2.06 respectively, p<0.05.

RESULTS

In group A, comparing pre and post mean difference, there was statistically significant improvement in NPRS [z=12.50, p=0.001], UF [z=9.78, p=0.001], UE [z= 11.26 p= 0.002, In group B, there was less statistically significant improvement than group A in NPRS [z= 12.36, p= 0.001], UF [z= 5.88, p= 0.001], UE [z= 3.68, p= 0.002], On comparing group A and group B there was statistically significant improvement in NPRS [z= 4.92, p= 0.001], UF [z= 3.99, p= 0.001], UE[z=4.78, p= 0.001]

DISCUSSION

The study compared the effectiveness of movement control exercise vs spinal extension exercise in NSLBP. After statistical analysis, the following aspects are described. Regarding the demographic variable analysis. In group-A, the average mean value for age was 35.20±7.44, whereas the average mean value for group B was 31.70, on comparison the average means, there was age difference between the groups, most of the patients

are male 67 %.

On analysis of pain score, between the groups, the mean reduction in NPRS was significantly higher in group 'A'; whose z value = -4.78 and p value = 0.001.

The reason behind improvement in pain seems: from the author Farrar JT et al [20] due to repetitive misuse of the tissue like capsules, ligaments, tendons, muscles create pain, also increased nocciceptive input to CNS also produce pain. The impairment correction in longstanding repetitive movement's benefits overcome this pain.

From the other authors, view poor movement habits, poor postural alignment and improper neuro dynamic sensitization leads to imbalance between global stability and mobility muscles. It produces mechanical stress to various structures results in pain and pathology. While in dysfunction, letsanalyses the new local muscle classification; according to sahramann and comerford concepts.

Local stabilizer: undergoesmotor control deficit and recurrent deficiency and reduced muscle stiffness and poor

Global stabilizer: gone muscle active shortening (loss of inner range control)

Global mobilizer: involves loss of myofascial extensibility.

Janda (1994,1996)[21,22] classified muscle as postural (shortened two joint muscle). Phasic (weakened one joint muscle) .he is the First clinician to quantify dysfunction in related to pathology that is about (recruitment imbalance)

O Sullivan (2005)[23], lee et al 1999[24] explained imbalance in trunk muscle strength is the risk factor for low back pain.

Sahremann (1992, 2000a, 2000b)[25,26,27] identified many clinical imbalances between synergetic and antagonistic muscles. So from the above implications, proper recruit efficiency, training throughout all the range of motion and increase the muscle extensibility. Tailor made exercise helpful to the concerned impairment (flexion, extension, rotation).

It was also observed that significant improvement in uncontrolled flexion in group 'A' than group 'B', whose z value =3.99and p value =0.001 there was significant improvement in flexion pattern in group A.

The possible explanation was as follows:

The uncontrolled lumbar flexion was trained through, multifidus activation patient advised to visualize the pulling of sacrum up along the bed towards the shoulder .lumbar lordosis slightly increased and the pressure will decreased .do not use thoracic extension this is noted with lifting of the chest.

Along with multifidus activation, incorporating corrective functional movement could be the reason for improvement of outcoming in flexion related syndrome.

It was observed from the study there was significant improvement in uncontrol extension in group A than group B whose z value =4.78 and p value =0.001.

The extension movements gain significant improvement. This in accordance with movement control exercises which aims to improve function through repetitive normal use and the retrain of delayed muscle activity first in order to improve the control of spine.

Since the reason for the impairment movement control behavior relates to conditioning & habituation, mal-adaptive process like avoidance (or) overuse in acute pain .additionally, impairment in non-awareness of the posture pain provocation with altered cortical representation of the lumbar spine.

Thus the correction of movement impairments through flexion ,extension, rotation pattern training effective in reducing pain, fear belief, disability, at long term level.this resultsmatches with cognitive functional therapy[28,29,30] produces superior outcomes in NSLBP than manual therapy and exercise.

In our study spinal extension group too impacts, that improvement is match with the author pradeepet al,[31] the reason might be strengthen the muscle, especially tranverse abdominis aid in rehabilitate LBP individuals.

Though we traditionally applied our exercise program without any specification, to all group of low back pain patients, it is better to classify subgroups to get desired good results.

On based of our results, we inferred that the movement control exercise as one of effective treatment can be incorporated in treatment regime of NSLBP subjects.

RECOMMENDATION

1. It was recommended that the study would be conducted with larger population.
2. The study would be conducted with different areas/region of the place, to find the precise prevalence.
3. The study will be conducted with comparison of exercise
4. In future, study may be extended over various regions to generalize the results.

LIMITATIONS

1. Small size sample only included in this study.
2. Long term treatment effects was not followed – up in the later months.

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