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Effects of Sacral Mobilization in Patients with Spondylolisthesis of L5 Over S1

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Abstract

Aim of the Study was to find out the efficacy of sacral mobilization in patients with spondylolisthesis L5 over S1 in lumber range of motion, function and radiological changes.

Methodology: Study design-experimental pre and post-test design.

Thirty subjects with low back pain due to spondylolisthesis of L5 over S1 with or without radiation to lower limb were randomly distributed to Group 1-15 subjects treated by Sacral mobilization + conventional exercises and Group 2-15 subjects treated by conventional exercises group for 4 weeks, 5 days/week. Pre-test measurements for all dependant variables % of slippage by X-rays, lumbar flexion range by Schober's Test and functions by Oswestry Disability Index were taken prior to beginning of therapy and post measurements after 4 weeks of therapy and the data was analyzed by using a mixed design 2 × 2 ANOVA.

Results: The overall results of the study suggest that both groups have significant improvement of ROM and function over the period of 4 weeks, but more in experimental group which received sacral mobilization along with flexion exercise, core strengthening, stretching of tight muscle and hot pack shows more significant effects in improvement of Lumbosacral Angle (LSA), percentage of slip compared with conventional group.

Low Back Pain (LBA), Straight Leg Raise (SLR), Oswestry Disability Low Back Pain Questionnaire Index (ODI), Lumbosacral Angle (LSA), Standard error of Mean (SME).

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Introduction

Low Back Pain (LBP) is an ever increasing problem, not only for those who are suffering with it, but also because of the drain on the resources of society due to work days lost, and disability payment [1]. With over 80% of LBP being of unknown origin many ideas of causation and treatment has been proposed, as reviewed by Waddell et al. [2]. One hypothesis is that there may be a dysfunction in the control of the abdominal and paraspinals muscles in patients suffering from Chronic Low Back Pain (CLBP) [3-5]. Estimate of life time incidence of low back pain range from 60% to 80% [6].

Major concerns are the 5% to 10% of people who became with a chronic back pain condition which accounts for up to 75% to 90% of the cost [1]. Lumbar segmental instability is considered to represent one of the sub groups [7]. Most researchers and clinicians suggest that segmental instability develops when the structure of the intervertebral disc, zygapophyseal joint and their ligaments are damaged and there is altered segmental neuromuscular control of the lumbar spine and it is a possible pathomechanical mechanism underlying mechanical low back pain [8-10]. Traditionally the radiological diagnosis of spondylolisthesis in subjects with chronic low back pain attributable to this finding has been considered to be one of the most obvious manifestations of lumber segmental instability [11,12].

Lumbar instability is associated with abnormal segmental movement and recurrent episodes of low back pain and despite poor level of recognition lumber segmental instability is said to be responsible for 20% to 30% of chronic low back pain [13-15]. Instability of the vertebral segments or excessive vertebral motion beyond normal physiological limits may damage neural tissues, ligaments, joint capsules, annular fiber, and/or vertebral end plates.

Fry Moyer et al. [16] defined segmental instability as a condition where there is loss of spinal stiffness in such a way that normally tolerated external loads will result in pain, deformity and place the neuromuscular structures at risk [16]. The patients with segmental instability complain of chronic and recurrent low back pain and associated high level of functional disability. The back pain is commonly diagnosed or described as recurrent (70%), constant (55%), catching (45%), locking (20%), giving way (20%) or accompanied by a feeling of instability (35%) [5].

Diagnosis of lumbar segmental instability may be based on examination finding or the patient's history. Dellitto et al. [17] stated that data for segmental instability include frequent recurrences of low back pain precipitated by minimal perturbations, deformity in prior episodes of low back pain, short term relief from manipulation and improvement of symptoms with the use of a Brace in previous episode of LBP [17]. Some authors contend that the presence of a ' step off' between the spinous process of adjacent vertebrae felt with palpation or increased mobility with passive intervertebral movement testing of indicative of segmental instability [18,19]. Flexion-extension radiographs have now become the standard tool by which segmental instability is diagnosed. Ponser et al. [20] Frierberg stated that it was the segmental compression produced in the standing position that allowed the most anterior translation [20-22]. Lowe et al. [23] compared static supine with upright views of patients with spondylolisthesis, and agreed that abnormal translation is increased in standing patients; abnormal alignment may be more obvious while patients are standing, but not in the more comfortable reclining position [23]. Penning et al. [24] found total lumbar mobility to be less when subjects were recumbent compared withstanding [24].

Pain is the most common symptom. It's commonly localized to paraspinal region, glutei's and posterior aspect of thigh. In moderate to severe cases, marked limitation of trunk flexion range of motion is seen and also the function. Extension and rotation type movements exacerbate symptoms. Progression results in hamstring tightness. As the vertebral body displaces anteriorly, the individual assumes a lordosis posture above the level of slip to compensate for displacement [25]. Another literature by LEE and EVANS, suggests that, in case of L5-S1 Spondylolisthesis, mobilization of the sacrum is not a contraindication [26]. It's based on biomechanical basis of postero-anterior mobilization that, posterior shear is induced at the motion segments above the vertebra being mobilized and anterior shear at the vertebra below.

In a case report, submitted to the Orthopedic Manipulative Therapists group of African Society of Physiotherapy in 2007, effect of mobilization and stabilization on grade one spondylolisthesis have been seen. Postero-anterior sacral mobilization on sacral apex and re-education of the local pelvic stabilizer muscles were included in physiotherapy intervention. The patient's functional outcome improved by 22% after the treatment and 75% in overall symptoms [27].

Hence, in majority of symptomatic cases of spondylolisthesis, non-operative treatment is recommended. Operative treatment is indicated to alleviate pain in patients not responding to conservative management and the slip >50% of vertebra and young age and traumatic [28].

Physiotherapy as a non-operative treatment is recommended to reduce pain, to restore range of motion and function and to strengthen and stabilize spine. Usual treatment includes modalities to relieve pain, bracing, electrical stimulation and activity modification. The goals for the therapy are to decrease extension stresses of the lumbar spine and to strengthen the elements that promote an anti lordotic posture. Literature surrounding these goals have reported Williams flexion type exercise were used to strengthen the abdominal muscles and flexibility programs to stretch spinal extensor muscle, Hamstrings and thoracolumbar fascia in relieving pain [29-34]. The literature is scarce regarding the applicability of sacral mobilization in patients with low back pain due to spondylolisthesis. Therefore the aim of the study is to find out "effective of sacral mobilization in patients with low back pain due to spondylolisthesis L5 over S1" purpose-To find out the efficacy of Sacral Mobilization in patients with spondylolisthesis L5 over S1 in lumber range of motion, function and radiological changes.

Methodology

Study design - experimental pre and post-test design

Participants: A total of 30 subjects were recruited from Physiotherapy department of Swami Vivekananda National Institute of Rehabilitation Training and Research. The subjects who met the inclusion and exclusion criteria, and wished to participate in the study, were assigned for the 2 different intervention groups by consecutive convenient sampling after getting their inform consent.

Group 1-15 subjects (F-10, M-5) - Sacral mobilization + conventional exercise group. Group 2-15 subjects (F-8, M-7) - Conventional exercise group.

Fifty patients, aged 30 to 50 years with the following criteria were recruited from the outpatient departments of SVNIRTAR, its sub center and Orthopedic out Patient Department of SCB Medical College and Hospital, Cuttack.

Inclusion criteria:

1. Patients with low back pain due to spondylolisthesis with or without radiation to lower limb.

2. Pain aggravates by strenuous activity, and with lifting and bending. Relieved with rest

3. Increase lumbar lordosis, protruded abdomen

4. Walks with Hip and Knee flexed.

5. Tenderness and irregularities in bony alignment, step sign positive

6. Limited spinal flexion

7. Plain Lumbosacral X-rays forward slippage of L5 over S1 (Anterior/posterior/Lateral/oblique views) demonstrates fracture in pars interarticularis in oblique X-ray, Standing lateral X-ray is used to determine magnitude of forward slip.

Exclusion criteria:

1. Neurological deficits, recent trauma, history of smoking, advanced age, weight loss, and history of cancer increase the likelihood of malignancy, loss of lordosis and/or listing suggestive of intervertebral disc prolapsed, vertebral infection occurs most often in patients with diabetes, history of other infection or immunosuppressant, drug abuse, or urogenital instrumentation etc., visceral diseases with history of chronic NSAID use or peptic ulcer may suggest the presence of perforated ulcer with retroperitoneal abscess causing LBP, symptoms such as an escalating, unremitting course of pain not improved by rest, night pain, and the symptoms of cauda equine syndrome - pain, saddle anesthesia bowel or bladder incontinence etc.

Group I - Sacral Mobilization + Conventional Treatment for

Spondylolisthesis

Group II - Conventional Treatment for Spondylolisthesis

Conventional protocol:

1. Passive Stretching of bilateral hip flexors , bilateral hamstrings, bilateral piriformis
2. William Spinal flexion exercises
3. Core strengthening
4. Hotpacks

Mobilization Protocol

A pillow has to be placed under the patient's abdomen with patient's hand at the side in prone lying. Rhythmic oscillatory mobilization with little discomfort but no pain has to be applied to sacral apex for duration of 30 sec and repeated 3 times. Then mobilization is angled inferiorly to the right for 3 sets of 30 seconds and then same repeated on left side [35].

Instrumentation

The oswestry disability index

It's a functional scale that deals with activities of daily living and therefore is based on the patient's response and concerns affecting daily life. It is the most commonly used functional back scale. It consists of 10 sections; each section is worth from 1 to 6 points. The disability Index is calculated by dividing total score by number of sections answered and multiply by 100. ODI is sufficient to reliably detect improvement or worsening of condition in chronic low back pain [36,37].

Lumbar flexion range of motion-schober's test

It is used to measure amount of flexion occurring in the lumbar spine. A point is marked between two PSIS, which is the level of S2, then points 5 cm below and 10 above this level is marked. The distance between 3 points is measured. The patient is asked to flex forward and distance is measured. The distance between 2 measurements is an indication of amount of flexion occurring in lumbar spine [38].

Radiograph

(A) Lumbosacral angle. It is measured in lateral radiograph in standing position. LSA is subtended by superior end plate of L5 with the posterior aspect of S1 [39].

(B) Percentage of slip by using SIMENS will be taken in standing position. The degree of slip will be measured according to a method describing the slip in relative values. The dislocation will be defined as the distance between the lines through the posterior borders of S1 and L5 (A) measured on a line through the most cranial part of S1 perpendicular to the posterior border of S1. The distance will be related to the saggital length of the lower end plate of L5 (B).

% of slip = $A/B \times 100$

Data Collection

Pre-test measurements were taken prior to beginning of therapy and post measurements after 4 weeks of therapy all the dependent variables.

Data Analysis

The data was analyzed with SPSS (Statistical Package for Social Sciences) 16.0 version for windows 7. The dependent variable was analyzed using a mixed design 2 × 2 ANOVA, with repeated measurement in second factor. There was one between factor (group) with two levels (Group 1-Sacral mobilization group and Group 2-conventional group) and one within factor (Time) with two levels (pre and post treatment measure). All pair wise post hoc comparison was done using a 0.05 level of significance.

Results

Flextion range of motion

Graph 1 illustrates that there is improvement in flexion range of motion over time to a greater extent in experimental group patients than patient in control group.

There is main effect for time F 1, 28, 0.05 = 665.037, p=0.00 There is also main effect for group F 1, 28, 0.05 = 36.633, p=0.00.

There is also a main effect for time x group interaction F 1, 28, 0.05 = 111.744, p=0.00.

Tukey's HSD analysis shows the patients showed significantly improvement in flexion range of motion both group over time. But there is mobilization group show significantly better improvement in flexion range of motion.

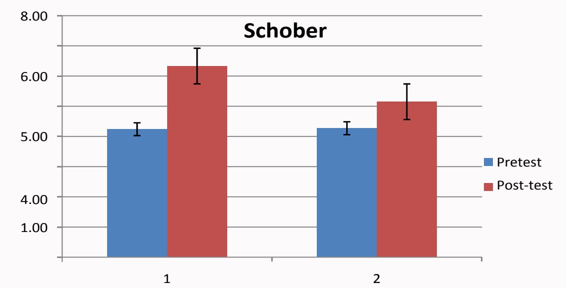
Functions

Graph 2 illustrate that there is improvement in Oswestry low back pain disability score over time to a greater extent in experimental group patient than patient in control group.

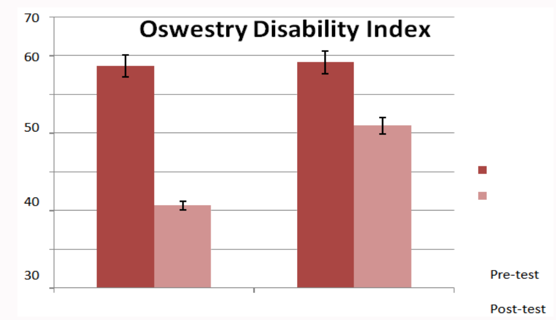
There is a main effect for time F= 1, 28.0.05 = 710.90, p=0.00. There is also main effect for Group F 1, 28, 0.05 = 20.926, p=0.00.

There is also a main effect for Time x Group interaction F 1, 28, 0.05 = 100.608, p=0.00.

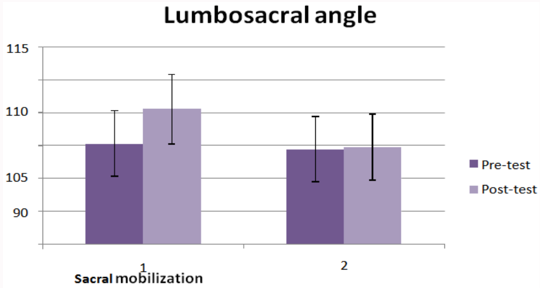
Analysis shows that in experimental group there is significant improvement in Oswestry low back pain disability score from pre to



Graph 1: Lumbar flexion range of motion (CM): Means (± SEM).



Graph 2: Oswestrry disability index: Mean (± SEM).



Graph 3: Total Lumbosacral Angle (LSA): MEAN (± SEM).

post. The patient in control group also shows significant improvement from pre to post.

Tukey's HSD analysis shows patients in experimental group show significantly better improvement in Oswestry low back pain disability score post intervention than control group.

Radiographic Changes in Percentage of Slip

Graph 3 illustrate there is improvement in lumbosacral angle over time to a greater extent in experimental group patient than patient in control group.

There is a main effect for time F= 1, 28.0.05 = 461.607, p=0.00. There is also main effect for group F 1, 28, 0.05 = 5.208, p=0.00.

There is also a main effect for time x group interaction F 1, 28, 0.05 = 358.243, p=0.03.

Analysis shows that in experimental group there is significant improvement in lumbosacral angle from pre to post. The patient in control group shows no significant improvement from pre to post.

Tukey's HSD analysis shows patients in experimental group show significantly improvement in lumbosacral angle post intervention where as control group shows no improvement control group.

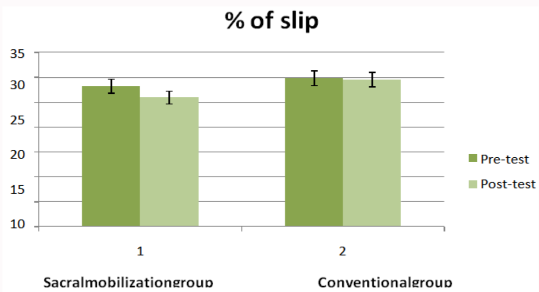
Radiographic Changes in Lumbosacral Angle

Graph 4 shows there is improve in percentage of slip over time to greater extent in extent in experimental group patient than patient in control group.

There is a main effect for time F=1, 28, 0.05 = 246.332, p=0.00. There is also main effect for group F= 1, 28, 0.05 = 1.468, p=0.00.

There is also a main effect for time x group interaction F 1, 28, 0.05 = 156.242, p=0.03.

Analysis shows that in experimental group there is significant improvement in percentage of slip from pre to post. The patient in control group shows no significant improvement from pre to post.



Graph 4: Percentage of slip: MEAN (± SEM).

Tukey's HSD analysis shows patients in experimental group show significantly improvement in percentage of slip post intervention where as control group shows no improvement control group.

Discussion

The overall results of the study suggest that both groups have significant improvement of ROM and function over the period of 4 weeks, but more in experimental group which received sacral mobilization along with flexion exercise, core strengthening, stretching of tight muscle and hot pack shows more significant effects in improvement of Lumbosacral Angle (LSA), percentage of slip compared with control group received flexion exercises along with core strengthening, stretching of tight muscle and hot packs in patients with spondylolisthesis L5 over S1 over period of 4 weeks.

The illiopsoas is the only muscle in the body with direct attachment to spine, pelvis and femur. So it has a potential to influence the movement of both lumbar spine and hip joint and as it is a postural muscles is often observed to demonstrate a striking tendency to get shortened [40]. Others have proposed that Psoas controls the lumbar lordosis and balances the body weight in relaxed upright standing [41,42]. The shear and compressive force exerted by Psoas muscle are considerable. The compressive force at L3-L4, L4-L5, and L5-S1 is approach or even exceed trunk weight, the sheer force exerted L5-S1 is approximately twice that exerted on this joint by trunk weight in upright standing [43]. The forward pull of the Psoas on the anterior aspect of lumbar vertebra increases the lumbar lordosis, lumbosacral sacral angle and consequently the Thoracolumbar fascia, paravertebral musculature are shortened increasing the distance between pubis symphysis and costal arch leading to overstretching and weakening of the abdominal muscles [44]. Rectus femoris shortening is also very commonly associated with psoas shortening and it is further common in muscular imbalances and instability [45].

Tightness particularly of the long head of biceps femoris on the side of predominant of psoas tightness is probably the result of relative increased in distance between the origin and insertion of the Hamstring owing to the anterior in nominate rotation. The Hamstring tightness is also a manifestation of postural reflex that stabilizes the painful segment. With further instability of spine the tight Hamstring readjust the anteriorly displaced pelvic or centre of gravity by extending the pelvis [46]. Hamstring and hip flexors stretching also have been found to be beneficial in a short term to improve painful ROM. Tightness of the piriformis has been implicated in sacroiliac dysfunction. Although tightness in the muscle may be revealed by movement limitation and pain, palpation of the tensed muscle belly over the greater sciatic notch is a more accurate measure [47].

Stretching is one of the safest and most commonly used methods. It is general term used to describe therapeutic maneuver designed to improve the mobility of soft tissue that has adaptively shortened. The literature support the static stretch of 30 sec at a frequency of 3 repeated stretches is sufficient to increase the muscle length. Stretch should be applied slowly and gradually at a relatively constant force to avoid eliciting stretch reflex. Response to stretch is attributed to mechanical factors; the resultant increase in length is related to viscoelastic behavior [48,49].

Recent research has demonstrated that people with back pain have neuromuscular dysfunction and fatigue of the back and abdominal muscle. Stabilizing training is reportedly effective in the management of LBP [50,51]. The aim is to attain adequate dynamic control of lumbar spine forces, thus eliminating repetitive injury of the structures of the spinal segments and related structures. Richardson and Jull (1995, 1999) have described specific stabilizing exercises with co contraction of the deep abdominals (Transverse abdominis and Obliqus internus) and lumbar multifidus muscles [52]. In recent clinical trials, these exercises have proved effective in the management of LBP in the short term as well as in the long term [53,54].

William et al. [55] stated that: "The secondary life of most adults encourages the spinal flexor, mainly the abdominals, to weaken from disuse while their antagonistic back muscles become stronger from overuse." A protrusion of the abdomen occurs, shifting the weight forward and displacing the centre of gravity in the anterior direction. This displacement is compensated by increase in lumbo-sacral lordosis, thereby shifting the weight of the thorax in the posterior direction. During this process, an increasing force is exerted on the posterior lumber and lumbo-sacral structures that tends to shift the vertebra with the vertebral column above it forward over the vertebra below it [55]. The treatment, according to William, should be directed toward reducing lumbosacral spine extension by stretching tight hip flexors, posterior spinal soft tissue structures and strengthening of abdominals and glutei, thereby shifting the centre of gravity forward and relieving the posterior load.

Flexion Range of Motion

Results of present study reveal that both groups have improvement in flexion ROM of lumbar spine but experimental group shows 49.29% improvement whereas control group shows only 20.61% improvement.

The study shows significant improvement in range of motion (spinal forward flexion) from pre to post due to effect of stretching. When a passive stretch force is transmitted to muscle via connective tissue, the most material will be deformed in a time dependent manner and it finally responds by aiding more sarcomeres as a result of viscoelastic properties of material and thus increasing the range of motion. Neural mechanism also contributes significantly in increasing the range of motion about a joint with stretching exercise [56].

Study revealed that the lumbar spine overloaded due to hyperlodotic posture secondary to psoas tightness. The forward pull of the psoas on the anterior aspect of lumbar vertebra increases lumbar lordosis. Due to prolong hyperlodotic posture spinal extensor got tight. Stretching exercise should be focused on restoring proper pelvic alignment, therefore special emphasis should be placed on stretching those muscles e.g. illiopsoas that cause excessive anterior tilt [57].

In our study most of subjects have radiation pain in to unilateral or bilateral lower limb due to piriformis spasm. Over the time this may lead to adaptive shortening of piriformis. This spasm, hypertrophy or fibrous thickening of piriformis may compress the underlying sciatic nerve and may cause sciatica symptom which may inhibit flexion range of lumbar spine due to pain. Stretching of piriformis in both groups break this pain spasm vicious cycle and increase ROM.

All the subjects of spondylolisthesis have lumber
which attribute in increase in torsional and shear forces in pars interarticularis. So role of posterior elements in stabilizing the Functional Spinal Unit (FSU) is significantly reduced. The soft tissue in the defect itself and in the interconnecting ligaments of FUS may undergo plastic deformation [9].

In the Williams flexion exercises as spine flexes, unlike extending it backwards, takes pressure off the nerves. Flexion exercises also strengthen the abdominal and may also help to decrease muscle spasm by stretching deformed tissue for restoring range of motion and normal functional movement both the group. The goals of performing these exercises were to reduce pain and provide lower trunk stability by actively developing the "abdominal, gluteus maximums, and hamstring muscles as well as..." passively stretching the hip flexors and lower back (sacro-spinalis) muscles. Williams said: "The exercises outlined will accomplish a proper balance between the flexor and the extensor groups of postural muscles..." [55,58]. It may be concluded from the result of our study that William flexion exercise may reduce extension stress over the posterior element of spine in all subject.

Improvement in flexion ROM in both groups receiving specific stabilization exercises. Which increase in gamma support for muscle contraction through increased spindle sensitivity and tonic activity? This result in increased sensitivity to stretch in the weight bearing and non-weight bearing muscle group [54]. Additionally the subject in this group also received segmental control exercises which decrease compensatory movements of the lumbo-pelvic region during movement of the adjacent segment. During movement due to lack of segmental stabilizer, global mobilizers first stabilize that segment than acted as a mobilizer so flexion is limited. With segmental stabilization exercises mobilizers act properly so lumbar flexion increased. This exercise also reduces the tightness and over activity of non-weight bearing muscle and improve flexion ROM.

The result of the present study can be further explained by pain adaptation model by Lund et al. [59]. This model stipulates that in the event of pain, the alteration in motor control serves to limit movement [59]. During movement, this involve a decrease in agonist muscle activity and increase antagonist activity to limits the velocity, force and range of movement. An alternative argument can be drawn that the changes in control group may be related to the fear associated with pain. The fear avoidance model has gained considerable support in literature as reviewed by Vlaeyen et al. [60]. Many studies have reported differences in trunk muscle activity between fearful and non-fearful patients with low back pain. If fear of pain can disrupt the normal control of the trunk muscles, this may be providing a link between psychological factor and physiological changes that lead to recurrence of pain. So improvement of pain perception directly and positively correlates with the range of motion.

In the present study the hot fomentation can be attributed to increase flexion ROM in both group controls as well experimental by increase in circulation of the muscle and relieving the spasm, as afferent from muscle spindles in the back muscle converge upon the inhibitory interneuron of apical spinal nucleus [61]. The physiologic responses produced by heat are increased collagen extensibility, increased blood flow. The sense of warmth and comfort helps the patient fully relax which contribute to decrease in tone of muscle and reduction in pain and spasm and thus increasing the ROM [62].

Results present better improvement in ROM in experimental group receiving manual therapy (sacral mobilization) over control group may be due to mobilization of apex of sacrum (Figure 1).

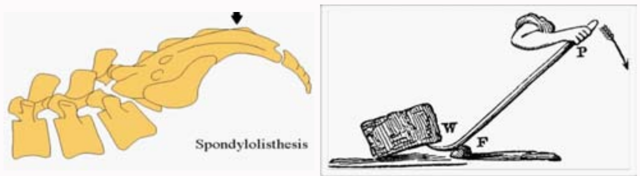


Figure 1: Spondylolisthesis.

On the basis of first order lever principle, where force and weight act on either side of fulcrum, we can understand the situation in spondylolisthesis, where sacrum is tilted with respect to adjacent vertebra L5 which further increases lumber lordosis. In sacral PA mobilization, apex (S4 area) of sacrum is mobilized in PA direction which induces backward tilt of the sacral base which creates counternutation of sacrum which simultaneously realigns the adjacent significantly. According to first order lever, where force is given in S4 and weight passes through base of sacrum and fulcrum lies in between [63].

In our study subject with spondylolisthesis there is increase lordosis, so there is adaptive shortening of posterior structure. When mobilization applied over apex of sacrum with flattening lumbar lordosis, it tends to stretch the posterior structure and flexes the lumbar spine.

Function in ODI

Result demonstrated that the subject of experimental group shows 36.03% improvement in function whereas control group shows 16.34% in function measured by Oswestry low back pain disability questionnaire.

Improvement and restoration of function is a primary aim for Physiotherapy management in patient of chronic LBP. Disability questionnaire are key tools to determine the response to treatment as they provide information about a wide range of functional tasks via pain intensity personal care lifting, walking, sitting, standing, sleeping, social life, traveling and employment are directly related to patient pain. The improvement in function as measured by Oswestry low back questionnaire can be attributed to the reduction in pain, improvement in flexion range of motion and facilitated muscle activation by stabilization exercise. This is supported by Mcgregor et al. [64] who demonstrated an association between reduction of pain and improvement of function as measured by Oswestry low back pain questionnaire [64].

The improvement of functional status in the both groups may be due to overall improvement of flexion range of motion and pain. In the present study subject of both groups received stretching exercises which increased extensibility of soft tissue that resulted in relaxation of structures, improve pain perception and range of motion which finally enhanced the functional ability. Subject of both groups receiving hot fomentation which increase tissue extensibility and promote relaxation and relief of pain and may improve function.

Sinaki et al. [65] concluded that flexion exercises are more beneficial than extension exercises for relief of pain and improvement of function in patient with spondylolisthesis. The significant better improvement in study group receiving sacral mobilization due to effect of manual therapy. PA mobilization of sacral base tends to flex the lumbar spine [65].

Comprehensive model suggested that a mechanical force from manual therapy initiates a cascade of neurophysiological response to imply specific neurophysiological mechanism, it categorizes as those likely originating from a peripheral, spinal cord and/supraspinal mechanism [66].

Spinal manual therapy helps in pain reduction firstly by activation of joint mechanoreceptors thereby producing segmental inhibition of pain pathway at the spinal cord, secondly by activation of descending pain inhibitory system located at dorsolateral PGA, thirdly by producing sympatho excitation induced hypoalgesia [67].

George et al. [67] proposed spinal cord pathway model a lessening of temporal summation following manual mechanism mediated by dorsal horn of spinal cord [68]. Wyke et al. [68] concluded that spinal manual therapy produces pain relief by activating the spinal component of gate control mechanism through stimulation of joint mechanoreceptor [69]. All model of manual therapy explained mechanism of decrease pain and thereby improve function.

Radiological Changes

Results demonstrated that subjects of experimental group showed moderate significant improvement in Lumbosacral Angle (LSA) and percentage of slip as compare to control group.

Hubert et al. [69] suggested that sacral slop, lumbar lordosis and LSA are increased in spondylolisthesis. Patients received PA mobilization in apex of sacrum with flattening of lumbar lordosis by placing may create a flexion torque in lower lumber region which help to correct the lumber lodosis and forward displacement of L5 vertebra.

The increased lumbar lordosis which is associated with lumbar spondylolisthesis may be associated with adaptive shortening of hip flexor, posterior structures of spine, weakness of abdominals, loss of lumbar flexion ROM and sacral nutation. As the lordosis increase the line of gravity moves more backward with relation to lumbar spine and further increase the listhesis i.e. percentage of slip. The aim of physiotherapy in lumbar spondylolisthesis is to correct the posture which can be achieved by stretching of hip flexors, increase lumbar flexion ROM, and strengthen of core muscle and sacral counter nutation.

Pain inhibits muscle action. In our study experimental group shows greater improvement function and lumbar flexion ROM which facilitate the motor control. With sacral mobilization posture passively may be corrected. Stabilization exercise done immediately after sacral mobilization maintain correct posture actively. So there is reduction of lumbar lordosis as well as improvement of LSA.

In the present study patient with spondylolisthesis there is increase lumbar lordosis and reduce lumbar flexion ROM. This abnormal posture and movement send abnormal afferent input which in turn brings abnormal efferent output. Passive correction of abnormal posture and improve ROM by sacral mobilization will stimulate the mechanoreceptor and facilitates normal motor output. That helps in improvement in motor control and correction of abnormal posture and lumbar range of motion.

Conclusion

Overall the study concluded that sacral mobilization added to William flexion exercise, stretching of tight muscle (hamstring, piriformis, and hip flexor) and core stability improves radiological as well more in terms of function and range of motion in patient with spondylolisthesis L5 over S1.

Limitation

Sample size was small and duration of study short period. Instead of using mod. Sphygmomanometer to measure the strength and to train the transverse abdominis during exercise sessions more reliable and sophisticated outcome tool such as real time Ultrasound or surface EMG should have been used in the present study. Further studies can be done by using such reliable outcome measure.

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