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Efficacy of Gravity Lumbar Reduction Therapy in Symptomatic Prolapsed Intervertebral Disc Patients: A Radiological Evaluation Based on Inter-Vertebral Dimensions

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ABSTRACT

Background: Gravity lumbar reduction therapy is one of the traction modality that uses gravitational force created by the lower part of the body while suspending the patient in erect position for treating patients with symptomatic prolapsed inter-vertebral disc. The efficacy of various forms of traction in treating such cases has not been quantitatively analyzed; rather their efficacy is based on empirical information. Objective: The current study was done to observe the changes in inter-vertebral dimensions after gravity lumbar reduction therapy in patients with prolapsed inter-vertebral disc. **Methods:** An interventional clinical trial was done in the Department of Physical Medicine & Rehabilitation, JNIMS, Imphal during the period Oct 2017-June 2018. Thirty (30) consecutive, MRI confirmed symptomatic prolapsed inter-vertebral disc cases who could achieve 900 of inclination on gravity lumbar reduction device were the study-subjects. Measurements of inter-vertebral dimensions were compared in digital x-ray lateral views taken before and after 30 minutes of suspension on specially designed gravity lumbar reduction device. **Results:** Gravity lumbar reduction therapy produces significant changes in mean inter-vertebral heights at L2-L3, L3-L4, L4-L5, L5-S1 levels with mean (SD) changes in anterior, middle, posterior and foramina heights (in mm) of 0.92 (2.14), 1.87 (1.82), 2.28 (1.44), 3.65 (2.19) respectively with improvement in disability, pain and other clinical parameters. Most prominent separation was seen in posterior margin L4-L5, and least separation at anterior margin at L4-L5. **Conclusion:** Gravity Lumbar Reduction Therapy could be an effective, low cost easy method of lumbar traction in symptomatic lumbar inter-vertebral disc prolapsed cases.

Keywords: Efficacy, Gravity Lumbar Reduction Therapy, Symptomatic PIVD.

INTRODUCTION

Low back pain (LBP) associated with leg pain is one of the most frequent problems affecting about 70-80% of the population at some point in life time and is a major source of discomfort and demoralizing health problem causing disability in economically most productive age group, indirectly giving a negative impact in the national economy.[1-3] Common causes of LBP with leg symptoms are inter-vertebral disc herniation, spinal stenosis, inter-vertebral disc degeneration without disc herniation, degenerative spondylolisthesis with stenosis and post lumbar surgery syndrome.[4-6]

Management of these conditions comprises of a wide range of different interventions like medications, physical therapies including different traction modalities, epidural injection, ozone therapy and surgery. Spinal traction has been used since the time of Hippocrates for the treatment of various back problems and lumbar traction is one of the widely used treatment modality for low back pain with or without leg pain. There are different forms of lumbar traction like auto-traction, mechanical traction, continuous lumbar traction, intermittent traction, gravity assisted lumbar traction etc.[7]

The exact mechanism through which traction may be effective is still unclear. It has been suggested that possible mechanical effects of traction could be stretching of ligaments and muscles, widening of inter-vertebral space, tightening the posterior longitudinal ligament to generate a centripetal force on the inter-vertebral disk and widening of inter-vertebral foramina and separate apophyseal joints.[8-12] Yet, so far, the proposed mechanisms have not been supported by sufficient empirical information.

Gravity lumbar reduction therapy (GLRT) is one of the traction modality that uses gravitational force created by the lower part of the body while suspending the patient in erect position. For a

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therapeutically effective traction, the traction force must be great enough to cause structural change at the spinal segment.[13] Grays stated that radiographic proof of a significant degree of distraction would support the argument for its adoption in refractory cases of lumbar disc protrusion.[14] If the proclaimed mechanisms of pain relief are true, then maximum distraction of the lumbar segments would seem desirable. Several scholars have tried to estimate the mechanical effects of lumbar traction while others used radiographic evaluation to reveal the mechanical effects of lumbar traction on widening the inter-vertebral foramen and inter-vertebral space but quantitative analysis of the changes was not performed.[15,16]

GLRT in erect position appears to be a convenient, efficient and low cost means of creating tractive force in lumbar spine. We aimed to assess quantitatively the changes in lumbar inter-vertebral dimensions of lumbar spine in patients with symptoms of prolapsed inter-vertebral disc with leg pain during GLRT using lateral lumbo-sacral x-ray.

Objective:

The present study was done to observe the changes in lumbar inter-vertebral disc dimensions during GLRT in patients with prolapsed inter-vertebral disc (PIVD) and to assess the medium term response of the patients with this method of treatment.

MATERIALS AND METHODS

A clinical trial was done in the Department of Physical Medicine & Rehabilitation (PMR), JNIMS during the period October 2017 – June 2018. PIVD patients with leg pain were the study-subjects. They were recruited consecutively out of all the patients attending the PMR OPD who satisfied the pre-set inclusion criteria of low back pain with leg pain of duration > one month, clinically diagnosed as PIVD with radicular pain on either of the lower limbs and confirmed by MRI and could achieve 900 of suspension for 30 minutes in a GLRT device. Patients who were contraindicated to gravity lumbar reduction therapy because of obesity, pregnancy, hernia, recent abdominal surgery, previous back surgery, unstable spondylolisthesis, hemorrhoids, severe osteoporosis and co-morbid conditions like uncontrolled hypertension, heart disease, stroke, bleeding disorders were excluded from the study.

GLRT was done by suspending the patients on a tilt table with the help of a chest harness. Angle of inclination was gradually increased from initial 350 to 900. Digital X-ray lumbo-sacral (LS) spine lateral view was taken prior to application of GLRT and another x-ray LS spine taken during GLRT at 90 degree after 30 minutes of suspension in a GLRT device specially designed for the procedure, for each subject.

Inter-vertebral dimensions namely inter-vertebral heights of anterior, mid, posterior vertebral end plates (margin) and superior and inferior margins of inter-vertebral foramina were measured from the digital x-ray. These measurements in the x-ray pre- and post-GLRT at different levels of vertebrae L2-L3, L3-L4, L4-L5, L5-S1 were compared.

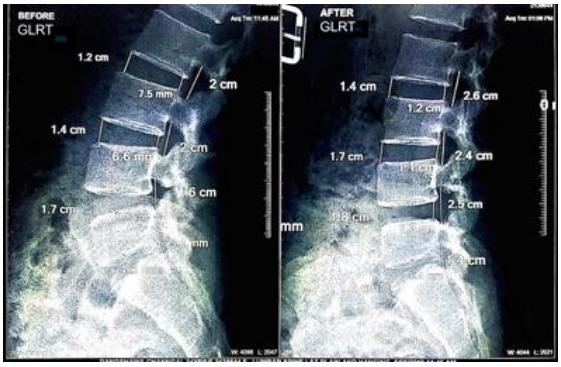

Figure 1: Measurement of inter-vertebral dimensions pre- and post-GLRT in digital x-ray

All the patients were demonstrated on how to suspend themselves in the home environment and were advised to continue traction two or three times daily for consecutive two months. Patient outcome measures were assessed clinically by using straight leg rising test (SLRT) in degrees, range of movement of spine forward flexion (ROMFF) expressed as distance of fingertip from floor in inches, claudication distance (CD) in meters and pain by visual analogue scale (VAS). Bio-psychosocial assessment was also done by using spine specific function Oswestry Disability index (ODI) and patient satisfaction (PS) in grades as subjective improvement in terms of percentage. Adequate response was taken as 50% reduction in VAS pain score, 300 increase in SLRT, 1 level improvement in ODI, 50% improvement in ROM, and 50% improvement in self-satisfaction. Assessments were done initially before starting GLRT, then, at one month and two months after starting GLRT.

Prior approval for the study was obtained from the Institutional Ethics Committee, JNIMS, Imphal. Confidentiality of the patients was maintained by using patient-code numbers and not their names. Written informed consent was taken from each of the participating study-subject.

RESULTS

Completed data sets could be collected from 30 study-subjects which comprised of 16 males and 14 females with their ages ranging from 21 to 67 years and the mean (SD) being 39.13 (14.004) years. There was no refusal. The mean (SD) Body mass index was 24.09 (3.19). The mean duration (SD) of their pain in the back and/ leg was 23.2 (10.26)

weeks. All of them had pain both in the back and leg. Involvement of the leg pain was confined to right side only, left side only and both legs in 14 (46.67%), 10 (33.3%) and 6 (20.0%) respectively.
Intervertebral space reduction was found in all the patients after the intervention. Space reduction as confirmed by MRI was found mainly in the L4-L5, L5-S1 area (12; 40.0%). This was followed by space reduction in the L4-L5 (10; 33.33%). Four cases (13.33%) each had space reductions in L5-S1 and L3-L4, L5-S1 areas.

Before GLRT and post-GLRT for one month and two months, the following measurements based on VAS, SLRT, CD in meters, ROMFF, ODI and PS were noticed [Table 1].

Table 1: Mean changes in outcome measures pre- and post-GLRT.

Parameters	Initial (SD)	After1 mnth (SD)	Change from baseline	After 2 mnth (SD)	Change from baseline
VAS	6.67 (1.92)	4.47 (1.33)	-32.98%	2.73 (1.20)	-59.07%
ODI	44.02 (19.62)	37.12 (16.57)	-15.67%	23.17 (12.03)	-47.37%
CD (meter)	362.67 (364.62)	433.33 (332.01)	19.48%	646.67 (399.77)	43.92%
ROMFF (inches)	5.4 (6.41)	3.47 (5.59)	-35.74%	1.87 (2.99)	-65.37%
SLRT (degree)	69.33 (15.41)	72.66 (15.07)	4.58%	79 (13.92)	12.24%
PS (%)	0 (0.0)	28 (20.24)	-	60.33 (29.16)	-

Table 2: Mean Changes in vertebral heights at different vertebral levels pre- and post-GLRT (in mm)

Vertebral level/plane	N	Initial (SD)	On GLRT (SD)	% change
L2-L3				
• Anterior	30	12.93 (2.30)	14.06 (2.02)	8.04
• Middle	30	11.31 (2.36)	12.90 (2.76)	12.33
• Posterior	30	7.00 (1.62)	8.87 (1.70)	21.08
• Foramina	30	22.41 (2.98)	25.27 (3.67)	11.31
L3-4				
• Anterior	30	16.40 (2.31)	17.13 (2.74)	4.26
• Middle	30	11.67 (2.67)	13.73 (3.18)	15.0
• Posterior	30	8.07 (1.55)	10.13 (1.96)	20.34
• Foramina	30	22.20 (2.71)	26.27 (3.74)	15.5
L4-5				
• Anterior	30	15.53 (3.17)	15.80 (3.37)	1.74
• Middle	30	10.20 (2.66)	12.27 (2.08)	16.9
• Posterior	30	7.33 (1.69)	10.67 (3.10)	31.3
• Foramina	30	19.93 (3.51)	24.60 (3.64)	18.98
L5-S1				
• Anterior	30	17.20 (4.35)	18.67 (2.99)	7.87
• Middle	30	8.20 (2.35)	9.87 (1.89)	16.92
• Posterior	30	6.47 (1.61)	8.33 (2.45)	22.33
• Foramina	24	16.42 (3.53)	19.17 (3.53)	14.35

Table 3: Total mean changes in inter-vertebral dimensions after 30 minutes of GLRT at L2-L3, L3-L4, L4-L5, L5-S1

Inter-vertebral Dimension	N	Pre GLRT (SD)	Post GLRT (SD)	Mean Change (SD)
Ant. Inter-vertebral height	120	15.52 (3.50)	16.43 (3.27)	0.92 (2.14)
Mid Inter-vertebral height	120	10.33 (2.82)	12.20 (2.88)	1.87 (1.82)
Post. Inter-vertebral height	120	7.22 (1.70)	9.50 (2.52)	2.28 (1.44)
Inter-vertebral foramina height	114	20.47 (3.92)	24.12 (4.48)	3.65 (2.19)

On the average, after one month of traction there was mild to moderate improvement in terms of 33% reduction in VAS, 15.7% reduction in ODI, 19% improvement in CD, 36% reduction of ROMFF, improvement in SLRT by 3.34 degrees and 28% of patients having a subjective feeling of improvement. Yet none of the patients could achieve 50% reduction in VAS, 300 increased in SLRT, 50% improvement in ROM or 50% improvement in self-satisfaction at the end of one month.
At the end of two months' traction, there was 59% VAS reduction and 65% improvement in ROMFF which was complemented with 60% of the patients feeling satisfied. Although CD was increased by 44% it was not up-to the expected level of ≥50%. 47% ODI reduction could be noticed when compared to the baseline figure of 44.02 before traction was applied. SLRT was increased from 69.33 to 790, which was again not up-to the desired landmark.
At the individual level, three of the patients (10%) had ≥ 50% reduction in VAS after one month of traction. The number rose to 21 (70%) at the end of two months' traction. Four patients (13.33%) only were SLRT negative at baseline as well as at the end of one month's traction. At the end of two months' traction this number went up to eight (26.67%). Out of the remaining 24 patients, none could have the desired increase of ≥ 300. At least 50% improvement in ROM could be noticed in five patients (16.67%) at the end of one month's traction. This came up to 17 (56.67%) at the end of two months' traction.

The mean changes of the vertebral dimensions/heights measured at the anterior, middle part, posterior margins and foramina heights before and after traction are depicted below [Table 2].

At L2-3 area, there was a mean increase in the vertebral heights by 8.0%, 12.3%, 21.1% and 11.3% at the anterior, middle, posterior and foramen height respectively. At L3-4 area the vertebral heights at the anterior, middle, posterior parts and at the foramen were increased to 4.3%, 15%, 20.3% and 15.5% respectively after traction. At L4-5 area the corresponding figures were 1.7%, 16.9%, 31.3% and 19% respectively. And at L5-S1 area, the percentage changes at the different parts were 7.9%, 16.9%, 22.3% and 14.4% respectively. At the level of L5-S1foramen height could not be measured in six cases as they could not be properly visualized. In all the levels of vertebrae the greatest increase in height was seen at the posterior plane, most prominent separation at the level of L4-L5 and least gain in height was seen at the anterior plane with smallest degree of separation at the level of L4-L5. There were significant mean changes between pre-GLRT and post-GLRT measurements for total anterior separation, mid-separation, posterior separation and foramen separation.

DISCUSSION

Although different forms of traction have been used for the treatment of low back pain with or without leg symptoms, its efficacy had been in question and previous studies examining the efficacy of lumbar traction yielded conflicting results.[17,-22] In 2006, Ozturk et al concluded that lumbar traction is both effective in improving symptoms and clinical findings in patients with lumbar disc herniation and also in decreasing the size of the herniated disc material as measured by CT.[23]

How much traction force was necessary to have an effective separation in the lumbar spine was a question but the traction force applied must be of sufficient magnitude and duration in the proper direction with an equal and opposite force for counter-traction. In one study, it was estimated that a tractive force of 810 pounds was required to obtain a separation of 2 mm at L3-L4 level and 730 pounds to a separation of 1.5 mm at the L4-L5 level.[24] The use of percentage of body weight is a better method to individualize, quantify and standardize the traction force than use of predetermined amount of weight. Although there were varied opinions of the use of percentage of body weight, traction force of at least 25% of body weight is reported to create separation between lumbar vertebrae.[25]

In the present study, the method of traction i.e., GLRT, which was first introduced in Meneapolis: Sister Kenny Rehabilitation institute in 1976 by Charles V Burton, with suspension of body in erect position was used. All patients who could attain inclination of 900 were examined. With this method, there is no question of friction between patient's body and the table and more effective traction force could be created by the lower part of the body providing 25% to 40% of the body weight. Also, there was no dispersion of tractive force to overcome the surface resistance created while doing traction in horizontal position. The traction force is likely to be more consistent and tailored to each patient creating more individualized traction force than conventional traction methods in horizontal position. Although there were some studies that demonstrated the mechanical effects of lumbar traction by radiography, myelography, stature measurement, intra-discal pressure measurement, CT and MRI,[26-32] We did not find any study to see the radiographic changes in the inter-vertebral dimensions while under traction during GLRT in erect position.

Our study demonstrated that after 30 minutes of GLRT there was significant increase in mean inter-vertebral heights at anterior, mid, posterior and foramina measurement at L2-L3, L3-L4, L4-L5, L5-S1 levels, with most significant mean changes of 2.28 (+1.44) and 3.65 (+2.19) respectively at posterior inter-vertebral height and foramina height. The most prominent separation was seen at L4-L5 posterior inter-vertebral height (31.3%) and least change at L4-L5 anterior inter-vertebral height (1.74%), in contrast to previous findings made by other researchers while doing gravity facilitated traction in inverted position with greatest separation found at L3-L4 foramina height.[33]

In all the vertebral levels L2-L3, L3-L4, L4-L5, L5-S1 more separation was observed at the posterior plane and lesser degree of separation at the anterior plane. The increases that were observed more in mean posterior plane, posterior inter-vertebral height and foramina height after GLRT should produce increased space for the compressed nerve roots thereby relieving pressure to the spinal nerves. This might also produce potential volumetric increases and subsequent intra-discal pressure decrease. Although the mean changes in heights were not uniform the separations resulted at particular levels after traction might be of clinical significance.

Improvement in outcome measures after two months of continuing GLRT in terms of increasing ODI by 47%, VAS by 59%, SLRT by 12%, CD by 43% with 60% personal satisfaction suggests a role of this therapy in reducing disability and pain. In all the patients we did not come across any complications except some discomforts in chest because of tight harness which could be adjusted easily. This might be because we included only those patients who could attain 900 of inclination. We could not detect complications which could be produced in inverted position like change in heart rate, increased blood pressure and other discomforts that could be experienced by the patients in inverted position.

CONCLUSION

Gravity lumbar reduction therapy produces significant changes in the inter-vertebral dimensions relieving pressure to the compressed nerve roots, decreasing intra-discal pressure thereby reducing pain and disability caused by prolapsed lumbar disc. It might be an effective and easily applicable technique that can be done in any home environment without any weight or mechanical pulley and also, non-traumatic and low cost device. It can be considered as one of the treatment options for prolapsed inter-vertebral disc patients with or without leg pain.

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