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CORRELATION OF WALKING DURATION WITH SPINAL CANAL DIAMETER IN - SUBJECTS HAVING LUMBAR RADICULOPATHY

Physiotherapy

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ABSTRACT

Background: Subjects with lumbar radiculopathy have been found with reduced walking velocities, short stride lengths, and increased periods of double limb support. However, no correlation has been done between walking duration and spinal canal diameter.

Aims of the study: To correlate walking duration and spinal canal diameter in subjects having lumbar radiculopathy and to compare the walking duration between stenotic and astenotic subjects.

Method: A correlational study with 60 randomly selected subjects having lumbar radiculopathy as diagnosed by an orthopedic and having an MRI report was conducted. Those having any other lower limb pathologies present like Osteoarthritis of the hip or knee, any previous history of lower limb surgery, back surgery, Diabetic neuropathy, history of back trauma, spinal fractures, contra-indications to MRI, vascular claudication, limb length discrepancy and spinal tumors were excluded. Subjects were asked to walk at their comfortable speeds up to the point of reproduction of their symptoms. The duration of walking was recorded. Canal diameters were recorded from their MRI reports. Data was analyzed using SPSS 16.0. Level of significance was kept at 5%.

Results: Moderate positive correlation was found between walking duration and canal diameter (ϱ=0.486, $p<0.001$) using Spearman correlation test. Statistically significant difference was found between stenotic and astenotic subjects for walking duration ($p<0.001$) using Mann Whitney U test.

Conclusion: There is moderately positive correlation between walking duration and canal diameter in lumbar radiculopathy subjects. Walking durations in stenotic subjects are significantly lower than those in astenotic subjects.

KEYWORDS

Lumbar radiculopathy; walking duration; canal diameter; Lumbar canal Stenosis

INTRODUCTION

Lumbar radiculopathy is defined as radiating pain in the lower limb along with neurological deficits (sensory, reflex or motor) in the distribution of the lumbosacral nerves.[1-3] Lumbar radiculopathy is caused by the compression of nerve roots in the lumbar spine.[4] This compression may be due to lumbar disc herniation, disc degeneration, hypertrophic facet, buckled/hypertrophic ligament, stenosis of the central canal, lateral recess or proximal foramen, Spondylolisthesis, synovial cyst, scoliosis, tumors – both benign and malignant, etc.[1,4,5]

There are four primary locations for nerve compression: central canal, lateral recess, the neural foramen, and the far lateral/ extraforaminal region. The source of the compression can either be from 1) direct encroachment from displaced material, such as disc herniation, hypertrophic facet, and buckled/hypertrophic ligament; or 2) narrowed corridors as a result of abnormal alignment, such as spondylolisthesis, degenerative disc disease and scoliosis.[4]

Symptoms of Lumbar radiculopathy include neuropathic pain, sensory dysfunction, and motor deficits. Typical symptoms are pain radiating to the leg often but not always along with back pain, often with numbness or paraesthesia. Motor deficits including muscle weakness and diminished reflexes are usually seen in advanced cases. Bladder or bowel disturbances may also be seen. Distribution of pain along dermatomes may be helpful in determining the level of compression.[4-6] The aim of the physical examination is to elucidate motor, sensory, or reflex abnormalities in a radicular distribution relevant to the suspected clinical level. Commonly used physical tests include the straight-leg raise test, tendon reflexes, and signs of weakness, atrophy or sensory deficits.[3,5]

Magnetic Resonance Imaging (MRI) findings in Lumbar radiculopathy are usually suggestive of the underlying pathology giving rise to the compression. In a lumbar stenosis, this may show a reduction in the canal space. In a disc pathology, this may show a prolapse or herniation of the disc. It may also show the degenerative changes occurring in the spine. However, correlating such findings with clinical symptoms has not been done yet in lumbar radiculopathy subjects according to the knowledge of the author.

Patients with lumbar radiculopathy have been found with reduced walking velocities, short stride lengths, and increased periods of double limb support.[7] Such variations in the gait parameters may lead to decreased walking capacities in the subjects ultimately leading to reduced walking distances and durations. Several studies have been done to know the relation between the lumbar canal diameter and physical symptoms in Lumbar canal stenosis. But even then the results have remained inconclusive.[8,9]

Hence, this study was conducted to correlate the walking duration and lumbar spinal canal diameter in subjects with lumbar radiculopathy and to compare the walking duration between stenotic and astenotic subjects.

METHODOLOGY

A correlational study was done in Ahmedabad from January 2018 to March 2018. Male and female subjects diagnosed as having Lumbar radiculopathy by an orthopedic, having an MRI report and referred for physiotherapy were included. The subject was diagnosed with lumbar radiculopathy if the subject presented with pain, numbness or parasthesia in the lower limb that followed a dermatomal pattern with or without back pain, muscle weakness or diminished reflexes that followed a myotomal pattern. Subjects were excluded if they had any other lower limb pathologies present like Osteoarthritis of the hip or knee, any previous history of lower limb surgery, back surgery, Diabetic neuropathy, history of back trauma, spinal fractures, limb length discrepancy, contra-indications to MRI, vascular claudication and spinal tumors.

Subjects were randomly selected using a random number table out of a group of Lumbar radiculopathy subjects. The subjects were explained the nature of the study and the relevance of the study. Oral informed consent was obtained from the subjects. Data was collected only after obtaining the consent. The subjects were asked to walk at their comfortable speed till the presenting symptoms were reproduced. Walking was done on the ground as it is a more functional activity and also because walking on ground detects significantly more symptoms at rest than the treadmill test.[10] The subjects were asked about the location of the symptoms and the type of symptoms in order to confirm that the symptoms were related to lumbar radiculopathy and not some other pathology like knee pain, hip pain, ankle pain, shortness of breath, etc. Total walking duration was recorded.

MRI report was available with each subject to determine the spinal canal diameters. Diameters were recorded at each level. The diameters were recorded using an Axial view T2 weighted MRI. The diameters were recorded using an Axial view T2 weighted MRI. Spinal canal diameters less than or equal to 10 mm were considered to be absolute stenotic.[11]

The data was analyzed using SPSS 16.0. Level of significance was kept at 5%.

RESULTS

A sample of 60 subjects was included in the study. There were 20 females and 40 males in the sample. Table 1 shows the demographic details of the subjects.

Table 1: Demographic details of the subjects

		Females	Males
Number		20	40
Age (years)	Mean	55.80	49.95
	SD	12.42	16.11

The data was analyzed for normal distribution using Kolmogrov Smirnov test and was found to be not normally distributed ($p<0.001$). Hence, non-parametric tests were applied.

Spearman correlation test was used to correlate walking duration with the canal diameter for the level having the least diameter. The mean walking duration was 15.01 ± 8.95 minutes. The mean canal diameter was 9.94 ± 2.78 mm. Spearman correlation co-efficient ϱ was found to be 0.486 with $p<0.001$. This shows a moderate positive correlation between the walking duration and canal diameter. The results are shown in Graph 1.

Graph 1: Correlation between walking duration and Lumbar Spinal canal diameter

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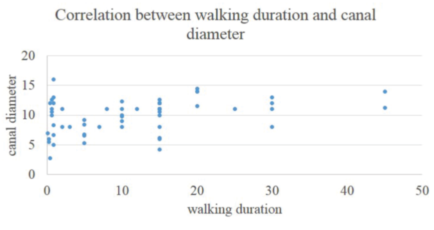

33 had within normal range lumbar spinal canal diameters. The number of stenotic levels ranged from 0-5. 8 subjects had stenosis at 1 level, of which 7 had stenosis at L5-S1 level whereas 1 had stenosis at L3-L4 level. 8 subjects had stenosis at 2 levels – 6 subjects having stenosis at L4-L5 and L5-S1 levels, 1 having stenosis at L4-L5 and L3-L4 levels and 1 having stenosis at L2-L3 and L3-L4 levels. There were 5 subjects who had stenosis at 3 levels – 4 having stenosis at L3-L4, L4-L5 and L5-S1 levels and 1 having stenosis at L2-L3, L3-L4 and L5-S1 levels. 3 subjects had stenosis at 4 levels, with 2 having L1-L2 spared and 1 having L4-L5 spared. The remaining 3 stenotic subjects had stenosis at all 5 lumbar levels. The most common stenotic level was L5-S1 with L4-L5 being the second most common stenotic level.
Comparison was done between stenotic and astenotic subjects for the walking duration using Mann Whitney U test. The test revealed a statistically significant difference between the stenotic and astenotic subjects for walking duration ($p<0.001$, $U=211.00$, $Z=-3.523$). The results are as shown in Table 2 below. Table 3 shows the mean lumbar canal diameters of the stenotic and astenotic subjects.

Table 2: Comparison of walking duration between stenotic and astenotic subjects

		Mean	SD	p value	Z value	U value
Walking duration (minutes)	Stenotic	10.80	1.30	<0.001	-3.523	211.00
	Astenotic	18.46	1.59			

Table 3: Lumbar spinal canal diameters in stenotic and astenotic subjects

		Mean	SD
Lumbar Spinal canal diameter (mm)	Stenotic	7.44	0.37
	Astenotic	11.997	0.22

DISCUSSION:

This study correlated the walking duration and spinal canal diameter in subjects with Lumbar radiculopathy. The results showed that there is a moderate positive correlation between the two. Hence, as the spinal canal diameter decreases, there is a decrease in the walking duration also. To the best of the authors' knowledge, there is no such similar study conducted till date.

This correlation could be attributed to the nerve compression in lumbar radiculopathy. As the canal diameter decreases in Lumbar radiculopathy, there is increasing compression on the nerves. This compression leads to increased sensory and motor deficits. Subjects having low back pain and sciatica often report fear of movement and substantial decreases in activity levels. Several studies have been conducted in animal models and have concluded that lumbar nerve compression in Lumbar radiculopathy may lead to mechanical hyper-sensitivity (allodynia). Molecular changes in the contralateral Dorsal Root Ganglia (DRG) induced by unilateral nerve injuries or inflammation may be responsible for induction of Neuropathic pain.[3]

Lumbar radiculopathy is a multi-factor disease and may involve almost all types of pain, such as ischemic, inflammatory, mechanical, and neuropathic pain. Nerve roots and spinal nerves typically demonstrate 2 to 8 mm of glide within their neural foramen. In compression injury, periradicular fibrosis fixes the nerve in one position, thereby increasing the susceptibility of the nerve root to tension or compression. Mechanical injury elevates the intraneural pressure of the dorsal roots and the DRG, reduces blood flow, and eventually establishes ischemia. Ischemia may trigger ischemic pain and cause nerve damage or death. The subsequent nerve damage or death may further induce neuropathic pain. In contrast, chemical injury predominately induces inflammation surrounding the dorsal roots or DRG and the consequent inflammatory mediators cause inflammatory pain. Furthermore, DRG neurons sensitized by inflammatory mediators will produce a nociceptive signal with application of a mechanical force (stretch or compression). As well, central sensitization in the spinal-cord dorsal horn plays an important role in pain generation of lumbar radiculopathy.[3]

Walking is a combination of a variety of trunk movements. During weight acceptance phase of the gait cycle, there is flexion of the trunk due to the forward acceleration of the Head, arms and trunk at a distance from the hip joint. Also, there is an extension peak of low amplitude during single limb support. 4-8 degrees of trunk rotation occurs on both the sides during swing phase of the gait cycle depending on the supporting limb. Trunk rotation occurs in the direction opposite to the pelvic rotation. Trunk lateral bending also occurs during initial contact and weight acceptance phases.[12]

Since all the trunk movements are occurring during walking, it is going to affect the lumbar canal diameters. Flexion increases the foraminal width (maximum and minimum), height, and area while decreasing the disc bulging and thickness of ligamentum flavum.[13] However, in a subject with lumbar radiculopathy due to disc herniation or prolapse, flexion would cause compression of the disc, making it to bulge more posteriorly, ultimately leading to a decreased canal diameter and an increased impingement upon the nerve roots. This impingement may further sensitize the nerves, causing increased pain while walking due to mechanical and chemical injuries, leading to a reduced walking duration.

Similarly, extension decreases the foraminal width (maximum and minimum), height, and area significantly. Hence, leading to increased compression of the nerve roots and increased pain in stenosis like cases. Lateral bending decreases the foraminal width (maximum and minimum), height, and area at the bending side, whereas lateral bending increases the foraminal width (minimum), height, and area at the opposite side of bending. Likewise, axial rotation decreases the foraminal width (minimum) and area at the rotation side and increases the foraminal height and foraminal area at the opposite side.[13] Rotation and lateral bending may lead to compromised canals in lumbar radiculopathy cases like facet arthropathies and dysfunctions.

Due to increased pain with walking, the duration of walking is going to be reduced. This compression of the nerve roots becomes more prominent when the canal diameter reduces, since then canal is already in a compromised state impinging upon the nerve roots and walking would further reduce the canal space. Similarly, in stenotic subjects the canal spaces have been already compromised to a great extent. Therefore, any further narrowing of the canal would make the compression of the neural structures even more apparent, leading to a further reduced walking duration.

CONCLUSION:

This study concludes that there is a moderate positive correlation between the walking duration and spinal canal diameter in lumbar radiculopathy subjects. Also, the walking duration is statistically significantly lower in stenotic subjects than astenotic subjects. Future studies can be done to evaluate the effect of other variables like age, body mass index, etc. on the walking duration in lumbar radiculopathy subjects. Future studies aimed at interventions to increase walking duration and performance can also be done.

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