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Changes in motor and sensory parameters in patients with lumbar disc herniation

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Abstract

Aim: Our main aim is to research whether there is motor and sensory loss between the healthy and the affected part in patients with unilateral L5 root compression. It is also to specify the pain and quality of life of patients.

Materials and Methods: Muscle strength were evaluated with a manual dynamometer, Light touch/pressure sense in the L5 dermatome was measured by Semmes Weinstein Monofilament, two-point discrimination sense was discriminated and ankle proprioception sense was measured with a goniometer. Pain severity of the patients was utilized with Visual Analogue Scale and quality of life was evaluated with Short Form-36.

Results: A significant difference was found between the affected-unaffected parts of patients with spinal disc herniation in terms of motor and sensory measurements, ($p<0.05$). There was a significant difference in favor of males in the sensory and motor measurements of the affected side between the genders, ($p<0.05$). The patients' quality of life values were found to be low. The mean pain score of patients was found to be 6.53 ± 1.66.

Conclusion: It has been determined that patients with spinal disc herniation have sensory and motor losses on the affected parts, their pain levels are above moderate and their quality of life is also affected.

Introduction

Low back pain and radicular pain is a major socioeconomic problem affecting many segments of society [1]. It is stated that 80% of people practice low back pain at least once in their lifetime [2]. Low back pain is among the first diseases in terms of loss of social activity and labor force [3]. It is more common especially in industry and service sector workers. Therefore, knowing the importance of low back pain, which causes great economic and labor losses, and making a timely and correct diagnosis will minimize these losses [1].

One of the main reasons of radiculopathy is intervertebral disc herniation. The reason of low back and leg pain is compression and inflammation of the herniated disc on the nerve root [4]. Accordingly, in addition to symptoms such as low back pain, leg pain and pins and needles; patients may experience loss of strength, sensation and reflexes in the lower extremities on physical examination [5]. Patients with LDH put as little weight as possible on the affected side because of pain. This asymmetrical load results from creeping back pain and decreased proprioceptive input and this causes postural instability/motor deficit [6].

Lumbar disc hernias are seen at L4-L5 and L5-S1 planes with a high rate of 95%. Accordingly, neurological examinations should focus more on L5 and S1 nerve roots [4]. Pain caused by L5 root compression radiates from the lumbosacral region to the posterolateral thigh and lateral malleolus. The pain is usually felt most severely on the lateral of the ankle. The most important and common motor loss occurs in dorsiflexion of the foot and toe. So that progressive motor loss can lead to gait disturbances over time [7]. Back and leg pain have a significant impact on the person's functions. It affects many activities from standing to walking, bending, traveling, social life and clothing [3,6].

Our main aim is to research whether there is sensory and motor loss between the affected and unaffected sides in patients with unilateral L5 root compression. At the same time, it is to designate the level of quality of life (QoL) of them. In this context; light touch/pressure sense in L5 dermatome, two-point discrimination sense and proprioception sense in ankle were evaluated by measuring. Pain level and QoL of patients were seized on.

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Materials and Methods

Study design and participants

Ethical approval of the study was obtained from Non-Invasive Clinical Research Ethics Committee, Kocaeli University (2018/325). Changes in Motor and Sensory Parameters in Patients with Lumbar Disc Herniation will be determined through relevant methods. Patients who had been diagnosed with disc herniation for at least 3 months and had unilateral L5 root compression were included in the study. The diagnoses of the patients were made by clinical anamnesis and radiological imaging. Participants, it consists of patients with L5 root compression in MRI reports and referred to the Physical Therapy Clinic. It was performed on 32 patients in total. Study participants consisted of 14 women (43.75%) and 18 men (56.25%) aged 25 to 65 years. Demographic data of the patients are given in Table-1. Participants who had diabetes mellitus, history of spinal or disc surgery, polyneuropathy, spinal cord disease (such as tumors, infections), skin integrity issues in the L5 dermatome area on the dorsum of the foot, or trauma and restricted movement in the ankle joint were not included in the study.

Ankle extension (Dorsiflexion) assessment

As patients were in the supine position, measurements were made by a manual muscle measurement dynamometer device. Patients were asked to pull their feet towards themselves and maintain the position. Resistance was applied from the back of the foot with a manual dynamometer (8). When the patients lost their position or after resistance was applied for 5 seconds, the highest value was recorded as 'kg'.

Toe extension assessment

While the patients were in the supine position, measurements were made with a manual muscle dynamometer. Patients were asked to pull the toe towards themselves and keep it still. Resistance was applied from the back of the toe with a digital dynamometer (Geratech SH-500 Digital Force Gauge, Geratech-Taiwan) [8]. When the patients lost their position or after resistance was applied for 5 seconds, the highest value was recorded as 'kg'.

Assessment of light touch/pressure sensation

Light touch-pressure sense was interpreted with the Semmes-Weinstein Monofilament (SWM) assay, which is a common clinical method [8]. The filament was pressed against the skin at an angle of 90 until it was bent and was removed after waiting for 1.5 seconds. 3 replications were made for each monofilament. It was recorded in terms of monofilament-gr that the patient gave at least one correct answer out of three answers. Switched to the next filament for patients who answered incorrectly on all three [9].

Evaluation of two point discrimination

TPD test is a quantitative assay for consideration tactile acuity. It is extensively used in clinic to assess the severity of peripheral nerve injuries and to monitor patients' recovery and response to treatment [10]. We used a discriminator for the two-point discrimination test. The test was started with a distance of 16 mm in the L5 dermatome on the dorsum of the foot. After each trial, it was waited for 3-4 seconds. The minimum distance in which the patient answered correctly in two of the 3 trials was recorded as -mm.

Evaluation of proprioception sense

We evaluated the ankle joint position sense with a universal goniometer [8,11]. A neutral position was maintained for the ankle. The lateral malleolus was taken as a pivot point. Goniometer was placed to this point. The fixed arm of the device was kept parallel to lateral midline of fibula and the movable arm was adjusted to follow midline of 5th metatarsal bone. The ankle was fixed in 10° plantar flexion for 5 seconds. Patients were allowed to bring it to the specified target angle (10° plantar flexion). The absolute value of differences between ankle position and than the target angle was recorded as deviation angle (°). The arithmetic mean of the deviation angles from each measurement (3 repetitions) was taken.

Evaluation of pain intensity

Visual Analogue Scale (VAS) was used to estimate pain level of patients. Patients were asked to sign their current pain level on the scale. (0: I have no pain, 10: The most severe pain possible). The distance between the place where there is no pain (0) and the place marked by the patient was measured as 'cm'. This numerical value obtained expresses the patient's pain level [12].

Quality of life Assessment The patients' quality of life (QoL) was put to good use with the Short Form-36 (SF-36) QoL Scale. SF-36 evaluates 'energy-vitality, physical functioning, bodily pain, Role Physical (Role restriction due to physical problems), Role Emotional (Role restriction due to emotional problems), social functioning, mental health and general health perception' under 8 subparameters [13].

Statistical analysis

In the statistical evaluation of our results, Kolmogorov-Smirnov analysis was performed for the normal distribution test. Independent T-Test was applied for those with normal distribution. Standard deviation, minimum and maximum values were calculated in variable measurements. The sample size calculation was performed using G Power software (version 3.1.9.6). We estimated the effect size as 0.8, alpha error probability as 0.05, and power as 0.80. Based on these assumptions, the sample size was calculated to be 32 participants. The single-blind method was used. Statistical analysis SPSS 22.0 (IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM. Corp) was used.

Results

A total of 32 participants; 14 (43.6%) female and 18 (56.3%) male participated in the study. It was observed that right side was affected in 17 (53.1%) and left side was affected in 15 (46.9%) patients. The mean age was 45.09 ± 10.88 years, the mean height was 167.56 ± 9.46 cm, the mean weight was 77.39 ± 11.62 kg, and the mean BMI was

Table 1. Demographic data of patients.

Variables	Gender	Number	Minimum	Maximum	X±SD
Age	Female	14	34	65	47.64±9.69
	Male	18	25	64	43.11±11.6
Height	Female	14	150	168	158.57±6.07
	Male	18	168	185	174.56±4.20
Weight	Female	14	55	87	72.42 ± 9.92
	Male	18	61	100	81.25 ± 11.62
BMI	Female	14	23.04	33.2	28.45 ± 2.87
	Male	18	20.04	33.3	26.66 ± 3.63

*BMI: Body Mass Index. X±SD: Mean and standard deviation.

Table 2. Comparison of healthy and affected side sensory and motor values by gender.

Measurements	Side	Gender		P value
		Male (X=SD)	Female (X=SD)	
Ankle dorsiflexion muscle strength	Unaffected side	34.82±4.60	25.70±4.77	**0.0001**
	Affected side	32.17±6.06	22.18±4.94	**0.0001**
Toe extension muscle strength	Unaffected side	6.60±1.77	4.56±0.74	**0.0001**
	Affected side	5.45±1.82	3.64±0.91	**0.001**
Light touch/ pressure sense	Unaffected side	0.18±0.16	0.25±0.16	0.185
	Affected side	0.36±0.44	0.71±0.69	**0.027**
Two-point discrimination sense	Unaffected side	22.67±4.55	23.86±3.54	0.283
	Affected side	24.00±4.99	27.57±5.09	**0.041**
Proprioceptive sense	Unaffected side	2.68±1.39	4.15±2.65	0.065
	Affected side	3.09±1.55	5.87±2.83	**0.004**

X±SD: Mean and standard deviation.

27.45 ± 3.39 kg/m^2. Demographic data of the patients are given in Table 1. Disc herniation was observed at L4-L5 level in 29 (90.6%) patients and at L5-S1 level in 3 (9.4%).

When patients were evaluated in terms of ankle dorsiflexion muscle strength, toe extension muscle strength, light touch/pressure sense, two-point discrimination sense, a high level of significant difference was found between the healthy/the affected side ($p<0.01$). In terms of proprioception sense, a statistically significant difference was found between the healthy/affected side ($p<0.05$).

When we compare motor and sensory values of the healthy/affected side between genders; ankle dorsiflexion and toe extension muscle strength were statistically significantly different in favor of males on both the healthy and affected sides ($p<0.01$).

As there was no significant difference between genders in sense of light touch/pressure and two-point discrimination on the unaffected side ($p>0.05$), there was a significant difference in favor of males on the affected part ($p<0.05$). In terms of proprioception sense; while there was no significant difference in unaffected side ($p>0.05$), a high level of significant difference was found in favor of males in affected side ($p<0.01$), (Table 2).

Table 3. Comparison of VAS and SF-36 Quality of Life Scale sub-parameters values by gender.

VAS and SF-36 Sub-Parameters	Gender		P value
	Male (X±SD)	Female (X±SD)	
Visual Analogue Scale (VAS)	6.28±1.84	6.86±1.41	0.43
Physical functioning	68.89±21.04	51.43±27.83	0.052
Role-Physical	31.94±39.11	10.71±28.95	0.156
Role-Emotional	62.89±37.83	4.79±17.91	**0.0001**
Energy/Vitality	54.17±13.20	39.29±11.74	**0.006**
Mental health	73.11±12.41	63.43±17.32	0.193
Social functioning	47.50±30.54	42.29±27.54	0.621
Bodily pain	36.83±24.09	30.79±24.66	0.491
General health perception	68.06±11.13	47.86±10.69	**0.0001**
Health change	40.28±22.91	25.00±19.61	0.054

* X±SD: Mean and standard deviation.

Table 4. Relationship between age and SF-36 Quality of Life Scale Sub-Parameters.

SF-36 Sub-Parameters	X±SD	Age	
		r value	p value
Physical functioning	61.25±25.40	-0.18	0.32
Role-Physical	22.66±36.12	0.19	0.30
Role-Emotional	37.47±42.15	-0.12	0.50
Energy/Vitality	47.66±14.48	0.06	0.74
Mental health	68.88±15.30	-0.27	0.13
Social functioning	45.22±28.92	0.02	0.88
Bodily pain	34.19±24.14	0.04	0.84
General health perception	59.22±14.82	-0.29	0.10
Health change	33.59±22.55	0.15	0.42

* X±SD: Mean and standard deviation.

Table 5. Relationship Between VAS and SF-36 Quality of Life Scale Sub-Parameters.

SF-36 Sub-Parameters	X±SD	VAS	
		r value	p value
Physical functioning	61.25±25.40	**-0.38**	**0.03**
Role-Physical	22.66±36.12	**-0.57**	**0.001**
Role-Emotional	37.47±42.15	0.07	0.72
Energy/Vitality	47.66±14.48	-0.34	0.06
Mental health	68.88±15.30	0.03	0.88
Social functioning	45.22±28.92	**-0.44**	**0.01**
Bodily pain	34.19±24.14	**-0.68**	**0.0001**
General health perception	59.22±14.82	-0.15	0.43
Health change	33.59±22.55	-0.23	0.21

* X±SD: Mean and standard deviation.

Comparison of VAS and SF36 QoL Scale sub-parameter values by gender is shown in Table 3.

Accordingly, there was no significant difference between genders in terms of VAS ($p>0.05$). Although there are differences between SF-36 sub-parameters 'physical functioning, role restriction due to physical problems, mental health, social functioning, physical pain and health change values' no statistically significant difference was found ($p>0.05$). There was a statistically significant difference in favor of males in the sub-parameters of role restriction due to emotional problems, general health perception and energy/vitality ($p<0.01$), (Table 3). No statistical correlation was found between age and SF36 sub-parameters ($p>0.05$) (Table 4).

In the examination made between VAS and SF-36 sub-parameters; negative correlation with physical functioning ($r= -0.38$; $P= 0.03$), high negative correlation with restriction due to physical problems ($r= -0.57$; $P= 0.001$), negative correlation with social functioning ($r= -0.44$; $P= 0.01$), a high negative correlation with physical pain ($r= -0.68$; $P= 0.000$). No statistically significant relationship was found between VAS and role restriction due to emotional problems, energy/vitality, general health perception, mental health and health change sub-parameters ($P>0.05$), (Table 5).

Discussion

Low back pain is a prevalent health issue that can lead to significant impairment and disability. Approximately 80% of individuals will experience low back pain at some point in their lifetime, with over 50% of those affected also reporting accompanying leg pain [2]. This condition constitutes a costly sociomedical challenge, as it necessitates repeated treatments, prolonged work absences, and social support [1]. We are of the opinion that it would be more accurate to evaluate the patient's sensory, motor and psychosocial aspects along with pain in the approach to patients with chronic LDH. In addition, we examined the effect of gender difference on quality of life, pain level and deep sensory values. We are of the opinion that multidimensional follow-up of patients will be more effective in terms of treatment plan and this may also be effective in increasing the QoL of patients.

LDH is most common between the ages of 30-50 and is usually seen at L4/L5, L5/S1 levels. Displacement of the intervertebral disc causes compression on the spinal cord, spinal nerve roots and pain-sensitive structures [4,5]. Inflammation and edema develop in the nerve root as a result of the disruption of endoneural blood circulation as a result of mechanical compression or chemical irritation of proteoglycans coming out of the herniated disc in LDH [7]. Lumbar-leg pain, spasm in the lumbar region muscles, and sensory-motor reflex defects in the lower extremities due to the compression of the herniated disc on the nerve root can be seen in patients with LDH [6].

Locomotor impairments caused by LDH can restrict muscle strength and joint movements. Through a three-dimensional gait analysis, researchers compared the ankle dorsiflexion muscle strength of 19 patients with unilateral L5 root compression to that of 16 healthy individuals. The study divulged that patients with L5 root compression possessed significantly weaker ankle dorsiflexion on the affected side compared to the unaffected side. This discovery corroborated with prior research, which similarly found a correlation between L5 root compression and a reduction in ankle dorsiflexion muscle strength [14]. In our study, we compared the dorsiflexion muscle strength of the affected and unaffected side of patients with unilateral L5 root compression, and a highly significant difference was found between both sides in favor of the unaffected side ($p<0.01$).

Conducting similar assessments holds great significance in the realm of clinical practice. Prior to their operation, 30 patients with LDH underwent a manual muscle test (using a rating scale of 1-5) to evaluate the strength of their extensor hallucis longus (L5) and flexor hallucis longus (FHL) muscles. Of the 30 patients, 17 were diagnosed with L4-L5 LDH and 13 with L5-S1 LDH. The majority of the patients (70%) reported experiencing pain, numbness, and muscle weakness in their right leg, while 30% reported similar symptoms in their left leg. In terms of muscle strength, 40% of the extensor hallucis longus muscles were rated as grade 4, 36.7% as grade 3, 13.3% as grade 2, 6.7% as grade 5, and 3.3% as grade 1. Similarly, 33.3% of the flexor hallucis longus muscles were rated as grade 3, 30% as grade 4, 23.3% as grade 5, and 13.4% as grade 2. As can be seen, weakness in both muscles draws attention due to radiculopathy [15]. In another study [16], 116 patients with muscle weakness due to LDH were evaluated with manual muscle testing before microdiscectomy; 67% mild (grade 4), 21% severe (grade 3) and 12% rate of very severe (grade 2 or 1) muscle weakness was found. The most severe muscle involvement was detected in the EHL muscle and it was also observed that the EHL muscle was the most affected among the patients. In our study, we compared the muscle strength of the healthy and the affected side with a manual muscle dynamometer and a highly significant difference was found between the two sides in favor of the unaffected side ($p<0.01$). Our study is compatible with the literature in terms of toe extension muscle strength, with a significant difference between the affected side and the unaffected side.

By applying Quantitative Sensory Test (QST) in the L5 dermatome of 56 patients diagnosed with LDH at the L4-L5 level; VDT (vibration detection threshold), HDT (hot detection threshold), CDT (cold detection threshold) and HPT (hot pain threshold) parameters of the patients were evaluated. A statistically significant difference was found between the parameters of the affected and unaffected side [17]. Saeidian et al. [18] conducted a study evaluating the sense of two-point discrimination in the dermatome regions (L4, L5, or S1) of the affected and unaffected sides of 20 patients diagnosed with unilateral LDH. In the study, TPD sense values were evaluated between the unaffected side and the affected side before the treatment, and a statistically significant difference was found in favor of the unaffected side. All these studies show the degree of sensory loss in the relevant dermatomes in patients with LDH. In our study, TPD and light touch sensation were evaluated and a statistically significant difference was found between the unaffected side and the affected side in favor

of the unaffected side ($p<0.01$).

In patients with herniation, sensory disturbances are also common in addition to muscle weakness. A study was conducted to evaluate the lumbar proprioception and postural control of individuals with low back pain caused by lumbar disc herniation (LDH) compared to healthy individuals. The study involved 20 patients with LDH and 15 healthy individuals, and their ability to sense lumbar rotation was assessed using a validated motor trunk rotation unit. The study revealed a significant difference between the two groups in terms of lumbar proprioception and postural control, with patients with LDH showing impaired functioning in these areas [19]. In our study, we evaluated the sense of proprioception in the ankle with a universal goniometer. A statistically significant difference was found between the affected side and the unaffected side in terms of proprioception ($p<0.05$). Our study is compatible with the literature in terms of impaired proprioception on the affected side.

The SF-36 QoL scale was used to measure the QoL of 50 patients with lumbar radiculopathy. As a result of the study; physical functioning 38.5, role limitation due to physical problems 31.4, role limitation due to emotional problems 64.3, energy/vitality 51.9, mental health 61.3, social functioning 47.5, physical pain 30.1, general health perception 57.9 has been obtained. It is stated that long-term follow-up of the treatment of patients with radiculopathy is important in terms of the course of the disease. In our study, the results we obtained from the sub-parameters of the SF-36 QoL scale; physical functioning 61.25±25.40, role limitation due to physical problems 22.66±36.12, role limitation due to emotional problems 37.47±42.15, energy/vitality 47.66±14.47, mental health 68 88±15.29, social functioning 45.22±28.92, somatic pain 34.19±24.13, general health perception 59.22±14.81 [20]. When our study and Bošković's study [20] are compared, other sub-parameter values are close to each other, except for the role restriction due to physical function and emotional problems. Moreover; there was no statistically significant difference between men and women in physical functioning, role restriction due to physical problems, mental health, social functioning and bodily pain parameters. Role restriction due to emotional problems, general health perception and energy/vitality parameters were found to be statistically significantly different between men and women in favor of men ($p < 0.01$).

VAS was used to measure the pain level of a total of 77 patients (72.7% male, 27.3% female) diagnosed with LDH. The mean VAS value was determined as 7.32±2.44. It was determined that the VAS value was above moderate severity and higher in the female, and the VAS value increased as the age increased [21]. In another study, the VAS was used to measure the pain level of 55 patients (38 women / 17 men) with unilateral chronic lumbar radiculopathy with a mean age of 45.6 years, and the mean VAS value was found to be 7.43 ± 1.68 at the end of the study [22]. In our study, the mean VAS value was found to be 6.53±1.66, above moderate severity. The mean VAS value of female patients was 6.86±1.41 and the mean VAS value of male patients was 6.28±1.84 in our study. There was no statistically significant difference between male and female patients in terms of VAS value.

Tracking patients in multiple dimensions allows for the possibility of observing the treatment process and its effects. It was discovered that patients suffering from chronic low back pain had VAS values and sub-parameters of SF-36 that were positively correlated with role restriction and bodily pain due to physical problems. On the other hand, moderate negative correlations were found with physical functioning, general health perception, and social functioning, while no significant relationships were found with other sub-parameters [23]. Our study is in line with the existing literature, as we also found a statistically negative correlation between VAS and SF-36 subparameters with role restriction due to physical problems, physical pain, physical functioning, and social functioning parameters. It is worth noting that many patients with lumbar disc herniation can recover with conservative treatment. Therefore, it is believed that the multi-dimensional monitoring of the disease could provide significant benefits to clinicians in terms of monitoring recovery and preventing recurrence.

Conclusion

It has been determined that patients with LDH have sensory and motor losses in the affected sides, their pain values are above moderate intensity, and their QoL is also affected. In the approach to patients with chronic LDH, we consider that it would be more accurate to evaluate the patient's sensory, motor and psychosocial aspects along with pain. In our study, we conducted in order to determine whether there are motor and sensory losses between the affected side and the unaffected side of patients with unilateral L5 root compression, and also to examine their QoL;

-A high level of significant difference was found in favor of males in the patients' affected side light touch/pressure, two-point discrimination and proprioception (joint position sense) sense values.

- Female's QoL values were found to be lower than men. A high level of significant difference was found between male and female patients in favor of males in role restriction, energy/vitality, and general health perception due to emotional problems.

- The mean pain score of patients with LDH was found to be above moderate intensity. There was no statistically significant difference between female and male patients in terms of pain values.

- There was no statistically significant correlation between age and QoL in patients. A statistically negative correlation was found between pain and physical functioning/social functioning in patients with LDH.

We are of the opinion that multidimensional follow-up of patients will be more effective in terms of treatment plan and this may also be effective in increasing the QoL of patients. We also think that sensory and muscle strength measurements of LDH patients may be useful.

Ethical approval

Ethical approval of the study was obtained from Non-Invasive Clinical Research Ethics Committee, Kocaeli University (2018/325).

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