The Effect of Back Extension Exercise on H-reflex in Patients with Lumbosacral Radiculopathy

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Abstract

Background: McKenzie back extension exercises from prone position has been widely prescribed for patients with lumbosacral radiculopathy (LSR). It has been reported to reduce radicular symptoms. Such reduction could indicate that decompression effect of this exercise on the compromised nerve root. The purpose of this study was to evaluate the effect of McKenzie back extension exercise from prone position on soleus H-reflex of patients with LSR.

Patient and method: 19 male and 11 female patients (38±8.4 years) with confirmed chronic unilateral LSR participated in the study. All patients had done 30 repetitions of McKenzie back exercise from prone position. The soleus H-reflex was measured before and after the exercise. The H-reflex was elicited by electrical stimulation of the tibial nerve on the poplitial fossa of both legs. The non-involved leg of the patient was used as a control. Subjective pain intensity and sit-to-stand performance were also measured before and after back extension exercise using numerical pain analog scale and a stopwatch respectively**.**

Results: The H-reflex latency and amplitude in the involved leg showed no significant difference after the exercise ($p < 0.56$ and < 0.81). The pain intensity and the sit-to-stand test had not shown any significant changes following exercise (p 0<.82 and <0.43).

Conclusion: This study could indicate that the McKenzie repeated back extension exercises the manner performed in this study had not improved the H-reflex, pain intensity nor functional level of the patients. Therefore, it can be concluded that single session of repeated back extension exercise is not enough to alter the neurophysiology of the compromised nerve root in patients with chronic LSR.

Chapter 1

Introduction

Introduction

Radiculopathy is not a specific condition, but rather a description of a problem in which one or more spinal nerves are affected. The nerve or nerves may be inflamed, had lack of blood flow, or may be affected by a disease in part or totally. Lumbosacral radiculopathy (LSR) is a common clinical problem that involves L5and S1 nerve roots.[1,2] It may affect anyone at any time in their lives, regardless of their sex, age and profession.[3,4] LSR comprises 62% to 90% of all radiculopathies.[5,6]

Although LSR is a common problem world wide, no prevalence study has been reported in Saudi Arabian community. It was reported to be 9.8 per 1,000 populations in Sicily, Italy.[7] It was found to be higher in factory workers, housewives, and clerks.[7]

Generally, LSR occurs as a result of disc herniation or acute injury in younger population and as a result of foraminal narrowing from osteophyte formation in older population.[2] It may also result from spinal cord injuries, spinal stenosis, spinal diseases and other conditions.[8]

LSR often results in persistent disability, extensive medical evaluation and aggressive treatment.[9,10,11]

In the field of physiotherapy there is a growing interest toward developing an evidence based practice of common procedures used in the physiotherapy treatment programs. Low back pain and LSR constitute a major part of daily load for physiotherapists worldwide, and have been managed with various methods. Among these methods is McKenzie technique, which is very popular in the field of physiotherapy. McKenzie method utilizes back extension exercise for the management of LSR. The way patients are assessed and treated in the McKenzie method depends entirely on repeating movements in different directions in order to induce or abolish the symptoms and thus utilize these findings to assess and treat patients. Patients' feedback of pain perception is the essential guide for treatment in McKenzie method. As this is subjective, a need for a more objective method for evaluating the efficacy of the McKenzie back extension exercises has been a concern for researchers. Neurophysiologic testing and H-reflex in particular provides an objective assessment of nerve root compression or entrapment. It has been found to be a clinically useful method in the diagnosis of radiculopathies and assessing of the McKenzie neck retraction exercise in patients with cervical radiculopathy[2]. It is also reported to be an objective tool in measuring the degree of compression and decompression on the compromised nerve root in patients with radiculopathy. Therefore this study was designed to use the H-reflex to evaluate the effect of the commonly practiced word-wide McKenzie back extension exercises on patients with chronic unilateral lumbosacral radiculopathy.

1.1 – Study objectives

1- To determine the effect of repeated back extension exercise (RBEE) on H-reflex in patients with lumbosacral radiculopathy.

2- To determine the effect of RBEE on pain intensity and functional ability.

3- To determine the relationship between H-reflex, pain intensity and functional ability in patients with lumbosacral radiculopathy .

1.2 – Hypothesis

1- RBEE has no effect on H-reflex in patients with LSR.

2- RBEE has no effect on pain intensity.

3- RBEE has no effect on functional ability.

4- There is no significant relationship between changes in H-reflex, pain intensity and functional ability in patients with LSR after RBEE .

1.3 - Clinical significant

1 - This study could provide a clinical evidence base of the efficacy of repeated back extension exercise in the management of radicular symptoms in patients with LSR.

2- This study could determine the degree of change in the neural conduction after RBEE.

Chapter 2

Literature Review

Literature Review

LSR results from either degenerative changes or intervertebral disc herniation.[12,13,14] Degenerative changes in the spine including lumbosacral region are being found virtually in the older people. These changes may consist of bone enlargement and entophyte encroachment either into the spinal canal, causing central stenosis, or into the vertebral foramen, leading to foraminal stenosis.[9] Both central and foraminal stenosis are most likely to cause various degrees of LSR.

Furthermore, degenerative changes in the spine are associated with the obstruction of the epidural veins and fibrosis in and around the nerve roots .Venous obstruction may lead to perineural anoxia and the development of perineural fibrosis and neural atrophy. Distended veins in the epidural plexus, damaged pain receptors in the nerve root sheaths, and loss of neurons could lead to chronic radicular symptoms.[15]

The lumbosacral intervertebral disc changes result either from annulus fibrosis or nucleus pulposus changes.[14] Several types of annulus fibrosis changes have been identified. One type is characterized by intact fibers in the periphery of the disc. Another type of annulus-contained tears is longitudinal annular fibers. A third type contain a radial tear that involves all layers of the annulus from the nucleus to the surface of the disc. Another type of tear, designated the transverse tear, involves the insertion of sharply fibers into the ring apophaysis.[16] The radial tear in the annulus fibrosis and progressive loss of cartilage from nucleus pulposus characterize degeneration of the intervertebral disc. It was emphasized that the significance of the radial tear in producing spinal instability, disc space narrowing, osteophytes and histopathologic changes of disc degeneration.[14,17]

Disc herniations in lumbosacral region were classified as central, paracentral, intraforaminal, extraforaminal and multiregional broad-based protrusions.[18] Anatomical position and form of the disc herniation are of prognostic value for the clinical outcome.[18] Pressure on the lumbosacral nerve root associated with herniated disc or contusion of the sciatic nerve can result in pain radiating down the lower extremity to the foot. This pain is sharp and severe, traveling quickly down the back of the leg, sometimes to the ankle or foot. It may be brought on by a coughing or sneezing fit, or may simply attack while sitting. Muscle weakness or spasm may also be present, either during the attack of pain or afterwards. Numbness or tingling may be felt in the leg, ankle or foot, depending on which nerve root is involved.[19]

LSR is most likely to present with pain and other sensory symptoms more than motor symptoms.[1] It has been reported to cause functional disability, emotional stress and sleep disturbance.[20]

LSR is one of the major causes of back pain affecting workers of all ages, with high management cost.[7,21] It can be managed surgically or non-surgically. The surgical management mainly includes discectomies and laminectomies. The non-surgical management includes medications, rest and physiotherapy. It has been estimated that 10 to 50 % of patients with LBP receive physiotherapy .[22-25] Recovery from LSR is less frequent than localized lower back pain.[26] Clinically, physiotherapy treatment for back pain and radiculopathy is provided in the form of cold, heat, electromagnetic waves, ultrasound, mobilization, manipulation, massage, corset use, traction, electrical stimulation, acupuncture, Maitland technique, Cyriax technique, McKenzie method and home instruction.

A survey in USA showed that the McKenzie method was deemed the most useful method of managing patients with radiculopathy among physiotherapists, and was said to be a very common means of evaluating patients with radiculopathy .[27] The McKenzie method has been reported to be the second most common treatment approach for back pain including radiculopathy used by physical therapists in Britain and Ireland. The Maitland approach was used by 59% and McKenzie method by 47% of the surveyed therapists.[28] However, combined approaches were common. In a survey of the treatment categories used by physical therapists in USA, seven different treatment categories were proposed. McKenzie treatment category was the most commonly used to manage patient with radiculopathy.[29]

McKenzie method has several aspects that are unique. It is a method that uses repeated movements to classify subgroups in the non-specific spectrum of low back pain and uses pain behavior and its relationship to spinal movements and positions to determine appropriate physical treatment.[30]

McKenzie claims that most LBP is of mechanical origin, arising from poor posture, especially poor sitting posture, and from repetitive and continuous flexion activity.[31,32] Both poor posture and continuous flexion activity are common in today's society. [31, 32] Prolonged poor sitting posture reduces lumber lordosis and facilitate elongation of the posterior structures, including ligaments, fascia, and muscles. This sets the stage for abnormal mechanical stress on the spine and intervertebral disc resulting in facet joint and nerve root irritation.[31, 32] Posterior/posterolateral migration and buldging of the nucleus pulposus are reported to cause impingement on the posterior longitudinal ligament and/or the nerve roots.[31,32] To counteract such negative effects of nucleus pulposus bulging, McKenzie developed his treatment program that uses repeated back extension exercise.[31, 32] The McKenzie repeated back extensions are usually performed in prone position. It is the third progression in the McKenzie technique that is frequently used to effectively manage the bulging of nucleus pulposus.[31]

RBEE and correct sitting posture have been shown to improve and resolve symptoms in patients with specific and nonspecific low back pain and radiculopathy.[33-40] In studies conducted in vitro and in vivo, repeated back extension movement have been shown to cause an anterior migration of the nuclear tissue, which conversely displaces posteriorly during flexion and prolonged poor sitting in lumber and lumbosacral intervertebral discs.[37-42] This may explain the success of RBEE in reducing posterior protrusions in some intervertebral discs.[34,37] Alternatively, repeated back extension movements may relieve pain and radicular symptoms by reducing the forces acting on sensitive tissues. Furthermore RBEE acts to transfer compressive forces from the disc-vertebral body unit to the apophyseal joints, which lie posterior to the discs and thus reduce intervertebral pressure.[47-50] Moreover, Magnusson et al [51] have further demonstrated how sustained and repeated trunk extension movements increase the height of the spine in vivo, presumably by unloading and permitting rehydration. This implies that under certain circumstances the vertebrae can pivot around the apophyseal joints, so that back extension movements unloads the entire disc. Within the disc itself, extension movement causes a transfer of load from the anterior annulus to the posterior annulus, moving nuclear tissue interiorly.[49,52] This dynamic internal disc movement may give an explanation for the commonly noted centralization phenomenon.

Centralization of pain (CP) is a phenomenon initially observed by Robin McKenzie in 1956.[31] He noted this phenomenon to be quite helpful in evaluating and treating patients with radicular symptom.[53] Centralization as defined by McKenzie is the rapid change in the location of pain from a distal or peripheral location to a more proximal or central position.[31,53] Interest in CP has increased because of its high predictive value in identifying patients who will respond to conservative treatment and usefulness in guiding treatment planning.[54]

Denelson et al [53] studied the usefulness of centralization phenomenon in evaluating and treating referred pain. In this study, 87 patients with acute, subacute and chronic low back pain associated with radiating symptoms to buttock, thigh, or calf were treated with McKenzie exercises. Eighty seven percent of patients reported rapid centralization of peripheral pain. This improvement in pain could indicate decompression of neural tissue of the compromised nerve root. But this study used various repeated direction of movements for treatment purpose. It is obvious that the study sample was not homogenous, only 21% of them had chronic LBP. It is not clear how many patients with chronic LBP improved after the program. It is not clear if LBP was constant or intermittent.

Randomized studies indicate that the efficacy of the McKenzie method in the treatment of patients with acute or subacute low back pain is in debate until recently.[54] Peterson et al [54] compared McKenzie treatment method with that of intensive dynamic strengthening training on patients with subacute or chronic low back pain. In this study, 260 consecutive patients with at least eight weeks duration of low back pain were randomized into A and B groups. Group A was treated with the McKenzie methods, and group B was treated with intensive dynamic strengthening training. The treatment period for both groups was eight weeks at an outpatient clinic, followed by two months of self training at home. The main outcome variables used in this study were disability and pain, which were assessed by Manniche's Low Back Pain Rating Scale. The results showed a tendency toward a difference in reduction of disability in favor of the McKenzie group at the two-month follow-up assessment ($p \leq 0.04$), but no significant differences at the end of treatment and at the eight month follow-up evaluation. No differences in reduction of pain were observed at any time between the two groups. The supplementary analysis of the patient who had completed the full intervention showed a tendency toward a difference in favor of the McKenzie method in reduction of pain at the end of treatment ($p \leq 0.02$). This difference reached statistical significance at the two month follow-up assessment ($p \leq 0.01$), yet no significant difference was found after eight months. The supplementary analysis showed no obvious differences between the two groups with regard to reduction of disability. This study has indicated that long term McKenzie application and intensive dynamic strengthening training seemed to be equally effective in the treatment of patient with subacute or chronic low back pain. It is not clear how effective the single session application of McKenzie method compared to long application of McKenzie method.

Razmjou et al [55] investigated intertester agreement in determining McKenzie diagnostic syndromes, subsyndroms, presence and relevance of the spinal deformities. In this study, patients with acute, subacute, or chronic low back pain were assessed simultaneously by two physical therapists trained in the McKenzie evaluation system. The therapists were randomly assigned as examiner and observer. The result of this study showed that therapists trained in the use of the McKenzie evaluation system could be highly reliable in reaching the same conclusion with respect to classifying patients into diagnostic syndromes and subsyndromes, especially in patients under the age of fifty-five. In contrast, other published studies showed that only therapists with advanced training are capable of giving interpretation of symptoms behavior, leading to selection of the right diagnosis.

Centralization and decrease in radicular symptoms are the measure for improvements in McKenzie assessment.[31] This means that McKenzie assessment method is based on patients' self-report of symptom. Self-report of symptoms is too subjective to be reliable, largely basing this generalization of improvement on the relatively small percentage of LBP population in whom psychosocial factors influence the reporting, character, intensity and location of their pain.[28]

Spinal imaging procedures including radiography, CT, MRI, myelography, objectively provide detailed visualization of spinal anatomy, but are unable to determine which findings are the sources of pain.[28]

Poor correlation was reported between back pain and degenerative changes seen in radiographs and magnetic resonance imaging scans.[56, 57]

Spinal imaging has been used to study the movement of nucleus pulposes during back extension, never correlated with centralization phenomenon or disability or of the McKenzie method. Both the McKenzie testing and the spinal imaging do not provide proper information about the changes in nerve roots in cases of radiculopathy. [44, 45]

Although the centralization phenomenon is an indication of neurophysiological changes in the compromised nerve root, there has been no objective neurophysiological study to determine the effect of RBEE on the compromised nerve root.

Neurophysiological testing, in particular H-reflex described by Hoffman,[58] has been used recently to assess the neurophysiological changes in the compromised nerve root and to evaluate the efficacy of some of non-surgical managements on patients with radiculopathy.[2,3,59-62] H-reflex has two parameters, amplitude and latency. The amplitude is used to monitor spinal activity whereas, latency usually assess the sensory and motor conductivity. The H-reflex has also been used to determine the position causing maximum spinal root decompression in cervical and lumbosacral radiculopathies and to determine the effect of prone position and IF in patients with LSR [63] as well as to determine the effects of traction and retraction on compressed spinal root in patients with cervical radiculopathy.[59, 64]

Abdulwahab [2] studied the effect of neck reading posture and cervical traction on the flexor carpi radialis H-reflex of 10 patients with confirmed unilateral C7 radiculopathy. The H-reflex was elicited by electrical stimulation of the median nerve in the cubital fossa and recorded from flexor carpi radialis at rest, after 30 minutes of reading, and after cervical traction. The study showed a significant increase in the H-reflex amplitude and a decrease in the intensity of the radicular symptoms after cervical traction based on the numerical visual scale, while reading caused the opposite. No measurable changes were recorded in the H-reflex latency after cervical traction.

Furthermore, Abdulwahab and Sabbahi[59] studied the changes in the flexor carpi radialis H-reflex after reading and neck retraction exercises and correlated reflex changes with intensity of radicular pain. They examined 10 non-impaired subjects and 13 patients with C7 radiculopathy. The flexor carpi radialis H-reflex was elicited by electrical stimulation of the median nerve at the cubital fossa before and after 20 minutes of reading, and after 20 repetitive neck retractions. Subjective intensity of the radicular pain was recorded before and after each condition using visual analog scale. They reported a significant decrease in H-reflex amplitude associated with increase in radicular symptoms after reading, and a significant increase in the H-reflex amplitude associated with decrease in pain intensity after repeated neck retraction. No significant changes were noted in H-reflex amplitude in the healthy group after reading and retraction exercises. They concluded that neck retraction appeared to alter H-reflex amplitude to promote cervical root decompression and to reduce radicular pain in patients with C7 radiculopathy. The opposite effects were found with the reading posture.

Moreover, Sabahhi and Khalil [65] investigated the segmental H-reflex in upper and lower limbs of patients with radiculopathy. Of the 107 patients with confirmed radiculopathy, thirty-seven had radiculopathy at C7, forty at L4, and thirty at S1. The H-reflex was recorded from the flexor carpi radialis, vastus medialis and soleus muscles in patients with radiculopathy at C7, L4, and S1 roots respectively. They found that the H-reflex had significantly smaller peak-to-peak amplitude and longer latency than normal. They also reported that the stimulus threshold for eliciting the H-reflexes was substantially higher than normal. A strong correlation was also reported between the pathological changes in H- reflex parameters, magnetic resonance imaging (MRI) and clinical findings of different segmental lesion. The results indicated that the flexor carpi radialis, vastus medialis and soleus H-reflexes are useful and valid methods for testing the neuropathological changes in C7, L4 and S1 radiculopathy.

Sabbahi[60] has introduced a technique to numerically evaluating and treating patients with lumbosacral radiculopathy by utilizing H-reflex parameters. In his study, 20 patients with a confirmed clinical diagnosis of Radiculopathy at L4, L5 and S1 levels ranging from 3 weeks to 2 years. H-reflex first recorded with patients in prone lying position and then during freestanding. Patients were then requested to forward bend, backward bend, right or left-side bend, and rotate the trunk toward the right or the left side while the maximum H-reflexes from the affected lower extremity were recorded. Patients were also requested to adopt a combination of the above posture while the compromised reflex was being recorded. This was carried out until the optimal spinal posture (OSP) was identified.

OSP was defined as that posture that caused the maximum recovery of the compromised H-reflex. Results showed that peak-to-peak amplitude of the compromised H-reflex was significantly decreased during standing when compared during lying position ($p<0.05$). H-reflex latency showed no measurable changes. The peak-to-peak amplitude of the compromised H-reflex showed further reduction in most postural positions. It is called the Incorrect OSP. It is found that there is only one posture in which the H-reflex showed maximum recovery. This single OSP was found to be different for each patient and different for every level or root involvement. L4 nerve root involvement was usually responsive to OSP of backward with or without side bend. S1 radiculopathy showed a more favorable response to the OSP of forward bend with or without side bend. L5 radiculopathy showed a more favorable response to side bends associated with rotation. Pain intensity was measured by the VAS before and after maintenance of the OSP. Seventeen of 20 patients reported significant reduction in the value of VAS after OSP .

Moreover, Thomas et al [66] studied the diagnostic utility of upper limb segmental reflexes in fifty three patients with suspected cervical radiculopathy, who were positive for at least one of the following clinical criteria for cervical radiculopathy: (1) history, (2) motor examination, (3) sensory examination, and (4) change in deep tendon reflex. All underwent electrodiagnostic assessment including needle electrode examination (NEE), H-reflex, and neuroimaging. The clinical diagnosis was supported in 32 patients who entered the study with two or more clinical signs for cervical radiculopathy. Abnormal NEE was found in 90% of subjects with three clinical signs, and only 10% of those with one sign. H-reflex demonstrated a sensitivity of 72% and specificity of 85%

for detection of cervical radiculopathy and was particularly helpful when forming conclusion in the 21 patients with only one clinical sign for cervical radiculopathy. They concluded that the H-reflex studies of the upper limb were as sensitive and specific as MRI.

Furthermore, H-reflex has been used to assess the effect of loading and unloading of the spine in healthy subjects.[64] Ali and Sabbahi [64] measured the changes in the H-reflex of 20 healthy subjects under four different loading conditions which were prone lying, free standing, standing while lifting 20% of body weight and standing while unloaded by 25% of body weight. The H-reflex was elicited from the tibial nerve at the popliteal fossa using 1 ms pulse at 0.2 pps of H-max. Each subject was tested under the four different conditions. They found that the H-reflex mean amplitude of the left side decreased by 32% during standing, 24% during loading and 31% during standing unloading, while in the right side decreased by 16% during standing, 13% during loading and 25% during unloading as compared with prone lying. There were no significant changes in H-reflex latency under the four different conditions. They observed that both lower extremities had similar pattern of change in the H-reflex. They concluded that these results imply a significant interplay between peripheral and central mechanisms and their effect on the spinal motoneurons. This, in turn, suggests that testing of H-reflex amplitude and latency under functional conditions, such as standing may be useful in detecting suitable changes in root impingement.

The flexor carpi radialis, vastus medialis and soleus H-reflexes are proven to be a useful, valid[67], reliable[68,69] and sensitive [70,71] methods for testing neuropathological changes in C7, L4, and S1 roots respectively.[65,72] A test of specificity showed that soleus and vastus medialis H-reflexes were 100% specific for lumbosacral segments.[65]

Abnormal soleus H-reflex showed good correlation with S1 sensory impairment and equally useful in acute or chronic S1 radiculopathy.[73] A prolonged onset latency, absence of or both of H-reflex on the affected side are the most commonly used measures of the H-reflex.[74-80] H-reflex latency is considered abnormal in case of a side to side difference of more than 2 msec,[1] while a two- to four- fold side-to-side difference can be seen in H-reflex amplitude.[5, 81]

H-reflex can be used to assess the neurophysiological changes in the compromised nerve root and centralization phenomenon after RBEE from prone position. Therefore, the purpose of this study was to investigate the efficacy of RBEE on H-reflex, pain intensity and functional ability in patients with lumbosacral radiculopathy.

Chapter 3

Patients and Methods

Patients and Methods

3.1-Patients:

Thirty patients (19 males and 11 females) with mean age of 38± 8.4 years had a chronic confirmed unilateral lumbosacral radiculopathy as a result of discal herniation. They were voluntary participated in this study, and were randomly selected from patients referred to physiotherapy department in Security Forces Hospital from orthopedic, neurology and neurosurgery outpatient clinics. All complained of constant low back pain with sciatic distribution to buttocks, back of thigh, leg, and ankle described as stabbing, burning, parasthesia and a" pin and needles" type of pain, and had weakness in calf muscle or reduction in calf muscle tendon reflexes.

Patient's symptoms onset in last episode lasted for 45±16 weeks. They had no lumbosacral surgery, scoliosis, stenosis, metabolic system disorder, cancer, cardiac problem, peripheral neuropathy and history of upper motor neuron lesion. Patient characteristics are listed in table 3.1-3.3.

3.2-Experimental procedure :

The experimental procedure was ethically revised and approved by Rehabilitation Department, at King Saud University. Then Patients were asked to sign a consent form for participation and informed they had the right to withdraw any time without obligation.

Sit to stand functional test, pain intensity and soleus H-reflex were measured subsequently before RBEE from prone position. The soleus H-reflex stimulation and recording electrodes were adjusted and fitted immediately after sit-to-stand testing.

After 30 repetitions of back extension exercise, the previous outcome measures were again assessed. The sequence of testing changed, starting with pain intensity, H-reflex parameters, then sit-to-stand test to avoid any displacement of the H-reflex recording and stimulating electrodes. The non-involved leg was used as control for H-reflex parameters.

3.2.1- Sit to stand test:

The patient was asked to sit on a standard chair with hips and knees approximately 90° and feet relaxed on the floor. The patient was then instructed to rise to standing and return to sitting as quickly as possible five times with the arm across chest. The time taken for the patient to perform this task was measured with a stopwatch. Sit-to-stand test was measured twice before and after RBEE. (Fig 3.1)

3.2.2-Pain intensity recording:

Numerical Pain Intensity Scale was used to measure the patient pain intensity before and after the repeated back extension exercises (Fig 3.2). The scale was composed of the numbers zero to ten. The patient was asked to assign a number on the scale to the intensity of pain he or she feels; zero reflecting "No Pain" and ten reflecting the" Worst Pain Possible". A separate scale was filled in before and after RBEE while patients in prone position.

3.2.3 H-reflex stimulation and recording:

The patient was asked to adopt prone position, with upper extremities positioned symmetrically at side. The patient's face was turned to one side throughout the testing procedure to assure standardization of head position and patient comfort. The distal part of the legs was placed on a comfortable small pillow with feet suspended over the edge of the table and remained immobilized (Fig 3.3). Then the skin of poplitial fossa, soleus and midway between poplitial fossa and soleus for both legs was gently abraded with fine grade sandpaper and cleaned with alcohol.

The Nicolet Viking Quest electromyography unit from Nicolet Biomedical was used to elicit and record the soleus H-reflex of both legs (Fig 3.4).

An electrical stimulation surface bar electrode was placed with coupling gel on the poplitial fossa of both legs with the cathode electrode proximal to the anode electrode and in line with the posterior tibial nerve (Fig 3.5). A recording surface bar electrode was positioned over the soleus muscle 3 cm below the bifurcation of the gastrocnemius tendon; the cathode electrode was proximal to anode with a fixed distance (Fig 3.5). A ground surface metal electrodes positioned midway between the stimulation and recording electrodes (Fig 3.6). Electrodes were firmly secured with adhesive tape to maximize skin electrode contact. The used stimulation parameters were 1.0 ms pulse duration and intensity that elicited H-maximum with minimum and stable M-response. Two minutes practice trials to elicit H-reflex were obtained to familiarize the patients with the H-reflex stimulation and recordings procedures. Then four readings of the maximum H-reflex and stable minimum M-response with constant intensity were recorded and averaged from each leg.(Fig 3.7). H-reflex recording was measured first from left leg followed by right leg.

The signals were amplified 500-2000 using differential amplification and filtered at 20-10,000 Hz bandwidth, digitized, stored on computer and printed for analysis.

3.2.4-Repeated Back Extension Exercise:

Three sets of ten repetitions were performed in prone position with 1 min rest between the sets (Fig 3.8). The patient was asked to reach the maximum extension possible in all attempts and maintain for one second as described by McKenzie.[31]

3.3-Data analysis:

Data analysis was performed using SPSS for windows (v.10). A paired test was used to analyze the data of the study with $p<0.05$. Pearson correlation coefficient was used to determine the relationship between the recorded variables.

Table 3.1- The characteristics of patients.

	Mean ± SD
Age (year)	38±8
Weight (kg)	73±13
Height (cm)	165±8

Table 3.2- Occupation of patients.

Occupation	Frequency	Percent
Clerk	16	53.3
Military	4	13.3
House wife	8	26.7
Teacher	2	6.7

Table 3.3- Frequency and percentage of causes of radicular pain.

Cause	Frequency	Percent
Falling down	5	16.7
Lifting heavy object	9	30
Road traffic accident	2	6.7
Twisting injury	3	10
Post partum	3	10
Unknown reason	8	26.7
Total	30	100

Figure 3.1 : A patient during sit-to-stand test.

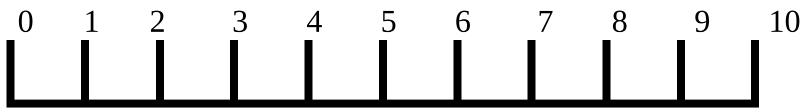

Figure 3.2 Numerical Visual analog scale for pain intensity.

Figure 3.3 Patient and electrodes positions during H-reflex recording before and after RBEE.

Figure 3.4: The Nicolet Viking Quest electromyography unit from Nicolet Biomedical.

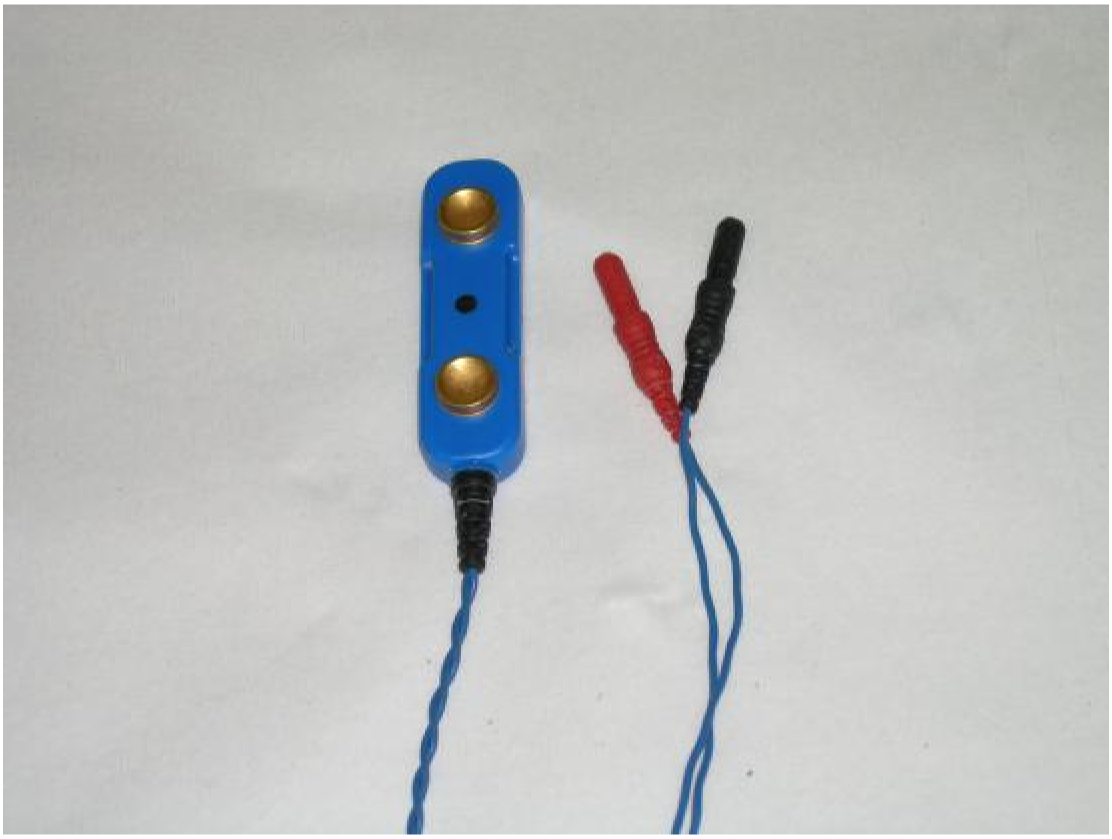

Figure 3.5 : Stimulating and recording bar electrode used in the study.

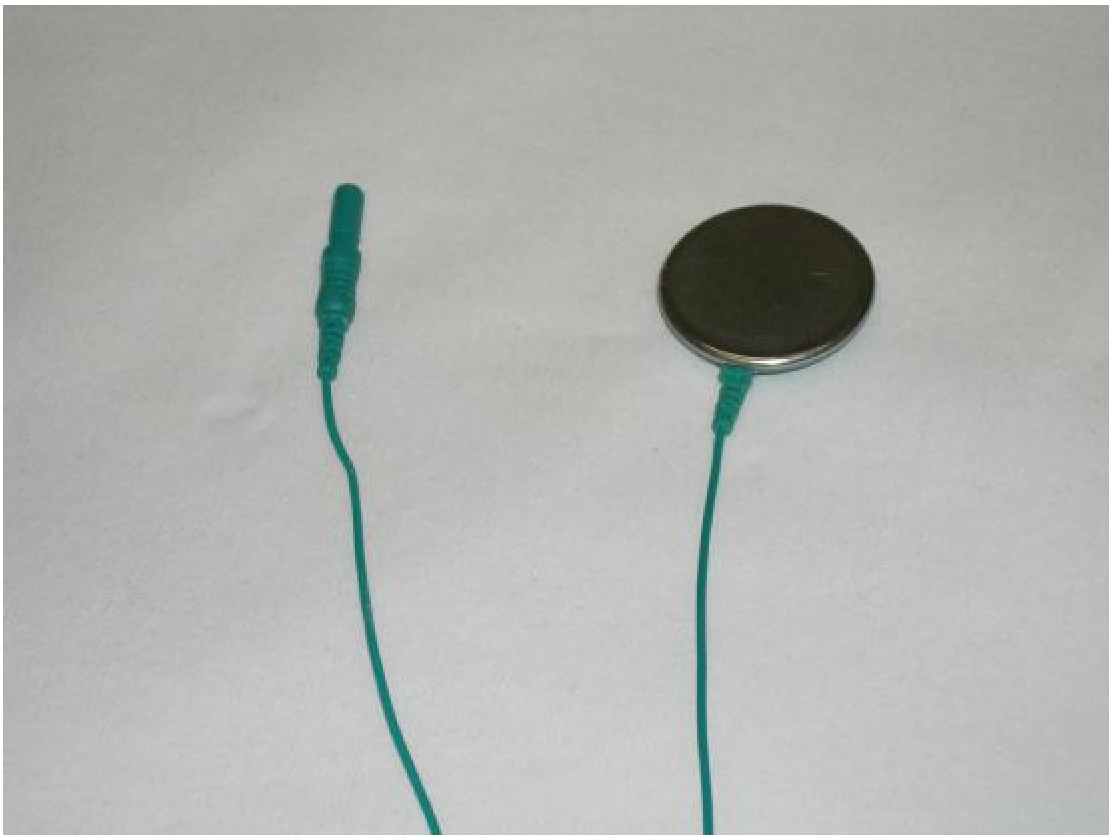

Figure 3.6 : Ground electrode used in the study.

Before

After

Figure 3.7 Four readings of the maximum H-reflex were recorded and averaged for patients in both legs before and after RBEE.

Figure 3.8 A patient performing RBEE while the electrodes are fixed to both legs.

Chapter 4

Results

Results

4.1 – H-reflex latency

The mean H-reflex latency recorded from patients in the involved leg (31±2 ms) was longer than that recorded from the non-involved leg (29±2 ms). The difference was statically significant different with $p < 0.001$ (Table 4.1). In fact, the difference was 2 ms. The H-reflex latencies recorded from the involved leg after RBEE did not change significantly from the recorded before RBEE with $p < 0.56$ (Table 4.1). The latencies recorded from the non-involved leg before and after RBEE were consistent ($p< 0.87$).

4.2 – H-reflex amplitude

The difference between the soleus mean H-reflex amplitudes recorded from patients in the involved (4.51 ± 2.6 mV) and non-involved (7.77 ± 3.2 mV) legs was 3.26 mV and big enough to be statistically significant ($p< 0.001$) (Table 4.2). The soleus H-reflex amplitudes recorded from involved and non-involved legs before and after RBEE were stable with $p<0.81$, $p<0.14$ respectively (Table 4.2).

4.3-Pain intensity

The pain intensity before and after RBEE were consistent and not significant different ($p<0.82$). The pain intensity before and after RBEE were 6.6±2.4 and 6.5±2.4 respectively (Table 4.3). Pearson correlation coefficient showed a poor correlation $r= .04$ ($p<.85$) between H-reflex latency and pain Intensity (Table 4.4).

4.4- Sit-to-Stand test

No significant change in the sit–to-stand score was observed before and after RBEE ($p<0.43$). The scores mean values before and after RBEE were 15.3±13.0 sec and 15.9±15.4 sec respectively (Table 4.5). However, the standard deviation of the test before and after RBEE was obviously large. Sit-to-stand test showed no significant correlation with pain intensity before RBEE $r = 0.02$; $p<0.10$ (Table 4.6).

4.5-H-reflex and Anthropometrics data correlations

Pearson correlation coefficient showed significant strong correlation between H-reflex latency recorded from non-involved leg and patient height $r = 0.60$ ($p<0.001$) and Age $r = 0.49$ ($p<0.006$) (Table 4.7**).**

Table 4.1- Mean and standard deviation of H-reflex latency, in milliseconds of involved and non-involved legs before and after RBEE.

Leg	Before RBEE X± SD	After RBEE X± SD	p-value
Involved	31±2 ms	31±2 ms	0.56
Non-involved	29±2 ms	29±2 ms	0.87
p-value	0.001	0.001	

Table 4.2- Mean and standard deviation of H-reflex peak-to-peak Amplitude in millivolts of involved and non-involved side before and after RBEE.

Leg	before RBEE X±SD	After RBEE X±SD	P-value
Involved	4.51±2.6	4.47±2.9	0.81
Non-involved	7.77±3.2	7.60±3.2	0.14
P-value	0.001	0.001	

Table 4.3- Mean and standard deviation of pain intensity before and after RBEE.

	Before RBEE X±SD	After RBEE X±SD	p-value
Pain intensity	6.6±2.4	6.5±2.4	0.82

Table 4.4- The correlation coefficient between involved side H-reflex latency and pain.

	Person Correlation	Sig.(2 tailed)
Involved side latency vs pain	0.04	0.85

Table 4.5- Mean and standard deviation of sit-to-stand test score in seconds before and after RBEE.

	Before RBEE X±SD	After RBEE X±SD	p-value
Sit-to-stand test score	15.3±13.0	15.9±15.4	0.43

Table – 4.6 The correlation coefficient between sit-to-stand test and pain intensity .

	Pearson Correlation	Sig.(2 tailed)
Sit-to-stand test vs pain intensity	0.02	0.10

Table – 4.7 The correlation coefficient between Non-involved side H-reflex latency before RBEE and age and height.

	Pearson Correlation	Sig.(2 tailed)
Non-involved side latency vs Age	0.49	0.006
Non-involved side latency vs Height	0.60	0.001

Chapter 5

Discussion

Discussion

5.1 Discussion

This study showed that RBEE had no positive neurophysiological effect on the compromised S1 spinal root, pain intensity or functional ability of patients with chronic LSR. This could indicate that the compromised large fibers of the spinal root have either not been sufficiently decompressed after RBEE or have been severely demylinated and/or degenerated to a degree unable to recover within short period of time.

The H-reflex latency and amplitude recorded from the non-invoved leg before RBEE were within the published normal range.[73, 75] The H-reflex latency and peak-to-peak amplitude of the non-involved leg were significantly shorter and bigger, respectively, than what were recorded from the involved side. Such a difference is consistent with previous studies.[65,76] The H-reflex latency difference between the involved and non-involved leg was two ms. This difference indicates a true pathological delay in conveying impulses through the involved S1 nerve root. These differences between the H-reflex latency and amplitude of involved and non-involved legs indicated the presence of nerve root compression, demyelination or both, in the involved leg. [65,76] It has been reported that both spinal root compression and demyelination increase H-reflex latency and decreases amplitude. [60,61,77] It has been documented that demylination interrupts the passage of impulses and to prevents salutatory conduction.[89] Muscle weakness and diminished tendon reflex of the patients in the present study confirm extensive damage in the compromised nerve root causing increase H-reflex latency and decrease H-reflex amplitude.

A side-to-side latency difference of more than 1 millisecond is said to be abnormal.[75] Some electrophysiologists considered 1.2-2.0 ms side-to-side difference is the minimum for a definite sign of radiculopathy.[75,88] The prolongation in H-reflex latency in patients with S1 radiculopathy have been documented in several studies.[74,78,80,82-84,86] The delay is said to occur in 41% to 100% of radiculopathy patients[87] and found to be equally useful in acute or chronic S1 radiculopathy.[73]

The H-reflex latency after RBEE did not change. This could attribute to the fact that remylination or axonal regeneration in patients with chronic LSR is not possible to occur in one session of 30 repetitions of RBEE. It is suggested that recovery from the neurological deficit as a result of radiculopathy ranges from 3 weeks up to one year or not fully recoverable at all.[84,91] No significant recovery of H-reflex latency after RBEE does not mean there was no nerve root decompression or nucleus pulposus movement. Anterior displacement of the nucleus pulposus of the lumbar spine was found to accompany RBEE.[91]

The H-reflex amplitude of the involved side was significantly smaller than non-involved side. The amplitude difference ratio between involved and non-involved side was 42% represent 3.26 mv side-to-side difference. A difference of less than 40% of peak-to-peak amplitude is said to be normal.[81] Moreover, two-to-four fold amplitude side-to-side difference has been also considered abnormal.[5,81] The decrease in H-reflex amplitude in the involved leg is obvious indicating possible conduction block as a result of axonal damage and demylination.[59-61] The value of using side-to-side amplitude difference in the diagnosis of unilateral S1 radiculopathy is well documented.[74,78,80,82-84,86] Nevertheless, the issue of which parameter latency or amplitude is more indicative and sensitive is a controversy. Some researchers consider the variability of H-reflex amplitude is too broad to be used for the diagnosis purposes and is unreliable electrophysiologic parameter due to the variability under different states of leg muscle activities or joint positions. This most likely resulted from either the variation of excitability and responsiveness of motor neuron pool [90] or the tremendous amount of H-reflex absolute amplitude variability between normal individuals.[81] In contrast, side-to-side amplitude difference measured in relaxed position – as happened in our study- found to be clinically useful as a diagnostic tool. [75] Braddom and Johnson found a high correlation between right and left side H-reflex amplitudes in normal subjects($r = .884$).[81] patients with confirmed unilateral LSR and having normal H-reflex latency in both sides, H-reflex amplitude then is of significant value in identifying the nerve root compression. [81]

H-reflex amplitude is believed to be an appropriate approach to detect the compression/decompression effect on the axonal blockage in patients with LSR.[60] It is also believed that decompression of the blockage axons associated with recover H-reflex amplitude. In contrast, compression causes the opposite. Based on this believed Sabbahi [60] used H-reflex amplitude as an objective measure for detecting improvement in patients with radiculopathy. Sabbahi[60], in his study of optimal spinal position (OSP), mentioned that patient with LSR responded favorable to forward bending. He partially attributed such recovery in H-reflex amplitude to decompression of the blockage axons. In our study H-reflex, amplitude did not recover after RBEE. Perhaps, there was severe damage more than blockage in the large diameter axons of patients in our study.

No previous studies have investigated the effect of back extension of H-reflex for patients with S1 radiculopathy. Nevertheless, Abdulwahab et al [59] studied the changes in the flexor carpi radialis H-reflex after reading, and neck retraction exercises and correlated reflex changes with intensity of radicular pain. He reported a significant decrease in H-reflex amplitude associated with increase in radicular symptoms after reading, and a significant increase in the H-reflex amplitude associated with decrease in pain intensity after repeated neck retraction. No significant changes in H-reflex amplitude were recorded in the healthy group after reading and retraction exercises. Abdulwahab concluded that 20 repetitions of neck retraction appeared to alter H-reflex amplitude to promote cervical root decompression and to reduce radicular pain in patients with C7 radiculopathy. The opposite effects were found with the reading posture.

Although neck retraction and RBEE are the routinely prescribed exercise in the McKenzie method for the treatment of cervical and lumbosacral radiculopathy[89,91], and both reported to cause vertebral extension and to move nucleus pulposus anteriorly. The H-reflex recovered and pain reduced by 20 repetitions of neck retraction but not by 30 repetition of back extension. This could attribute to the degree of demylination and axonal damage in the participants in both studies. It seems that the degree of demylination and axonal damage in the participants of this study were more severe than the other study.[59] It may also be attributed to biomechanics of the spine.

McKenzie back extension exercises were reported to be effective in reducing acute and chronic radicular pain.[91] McKenzie back extension is a progression to lying prone.[31] Lying prone is believed to encourage the nucleus pulposus to move interiorly away from the compromised nerve root as a result of gravity effect [91] and to improve the alignment of the lumber spine at L5-S1. [92] Moreover, back extension from prone lying is assumed to have a greater effect in moving the disc content anteriorly away from spinal nerves pathway.[41-46] This movements is believed to reduce radicular symptoms of patient with derangement.[91] The result of our study did not support such belief; as the H-reflex, pain intensity and functional test did not show a significant change after the RBEE. This controversy may attribute to the pathological differences among groups, affecting the movement of the nucleus pulposus. According to Schnebel [43] patients with chronic radicular symptoms (herniation) are expected to have some degree of disc degeneration. Movement of nuclear material in degenerated disc reported to be less predictable.[43] Patients in our study had chronic discal pathology. Therefore, no significant changes after RBEE may be due to abnormal movement of nuclear materials. Nuclear materials either did not move during RBEE or slightly moved but insufficient to decompress the compromised spinal root, or moved into a direction not decompressing the spinal root. It was reported that 59% of disc protrusion is posterolateral and 28% is central. [91] This may lead us to postulate that RBEE that is purely sagittal movement would not be efficient in reducing a posterolateral disc prolapses.

Moreover, McKenzie[91] believed that patients with chronic constant symptoms of LSR need long time to achieve centralization or reduction in pain intensity. The results of the present study support such believe. Patients with chronic LSR are expected to have demylination of nerve root.[43] The increased H-reflex latency and decreased amplitude in the results of our study confirm such expectation and explain why more time and number of RBEE sessions are required to centralize and reduce pain intensity in this group of patients. Furthermore, this is going to be true only if extension was the direction that improve the symptoms.

Chronic constant symptoms of LSR with no signs of improvement could indicate that the cause is undoubtedly a large irreducible discal hernia, and both bulging annulus displaced disc material is in a state of fixation and incapable of moving by fibrous repair[91] (McKenzie and May). This discal abnormality causes constant entrapment of the nerve root. The calf muscle weakness and reduction in tendon reflex of the patients in our study support such assumption. This could be another explanation for the abnormal H-reflex latency and amplitude reported in the present study.

Kilpikoski et al. [93] documented a study to assess the interexaminar reliability of the McKenzie method for performing clinical tests and classifying patients with low back pain. He found that only 18% of patients responded to extension exercises while 64% responded to lateral forces. This finding indicates the limited effect of extension exercise as reported in our study.

However, even if RBEE was assumed to cause sufficient anterior movement of the nucleus pulposus decompressing the involved spinal root due to demyelination of some of the large diameter nerve fibers of the compromised nerve root, H-reflex had not been recovered because of RBEE.

One session of RBEE was reported to be enough to show improvement or worsening of pain intensity and location.[53] McKenzie technique depends entirely in performing repeated movements to induce or abolish symptoms during initial assessment.

Karas et al[85] found that out of 126 patients with chronic low back pain 73% showed centralization of symptoms during the first or second visit when treated with the directional preference exercises. Moreover, Denelson et al[53] studied the usefulness of centralization phenomenon in evaluating and treating referred pain using mechanical treatment. In the majority of the patients, centralization of pain was noted during the initial visit, whereas the remainder experienced it over the next two days. In the first visit 81% of patients with chronic symptoms experienced centralization while 98% patients with acute symptoms experienced centralization[91] Both studies did not clarify wither patients had intermittent or constant radicular symptoms. Intermittent and constant radicular symptoms behave differently.[91] Both studies did not explain what was the used preferred direction of exercising. Such shortages and lack of duplication had weakened the results of these studies.

H-reflex latency of the involved leg showed poor correlation with pain intensity and functional performance. This may be explained by the fact that pain is multidimensional in nature.[94, 95] The tool that measure one aspect of the pain experience may not reflect any changes in other aspects. While pain intensity scale measures the psychological aspect, sit-to-stand test measures on aspect of functional activities, the H-reflex is being used to measure the neurophysiological aspect of pain.

H-reflex latency of non-involved leg showed significant correlation with age as reported in previous studies.[78,96,98] Such positive correlation could be attributed to the reported slower peripheral motor nerve conduction velocity,[99,100] as a result of age-related axonal demylination.[101] Other possible explanations are reduction in number of fast-conducting corticospinal tract neurons[102] and alterations in motor end plate.[103,104]

The significant correlation between height and H-reflex latency of the non-involved leg is consistence with previous studies.[105-107] This attributes to the length of the extremity. Short extremity is associated with short latency and vise versa.

5.2 Conclusion

Single session of thirty repetition of McKenzie back extension exercise from prone position seems to have no neurophysiological effect on the H-reflex of the compromised S1 nerve root in patients with chronic unilateral LSR. Furthermore, RBEE had no significant positive effect on pain intensity or functional level.

5.3 Clinical significance

1. This study provides the evidence that one session of RBEE is not efficient in the management of chronic LSR.

2. Neurophysiological testing, H-reflex in particular, is a valuable tool to evaluate current physical therapy techniques and modalities.

3. Back Extension Exercise is not the exercise of choice for all patients with chronic LSR.

5.4 Limitation of the study

1. This study is limited to patients with constant chronic LSR whom underwent one session of thirty repetitions of McKenzie Back Extension Exercises.

2. This study did not investigate if RBEE have a different effect on acute or sub acute LSR.

3. The effect of more than one sessions of RBEE has not been investigated.

5.5 Recommendations and future works:

1. Larger sample is recommended to be used.
2. To include patients with acute and sub-acute symptoms.
3. To study the effect of RBEE on H-reflex of patients with constant and intermittent radiculopathy.
4. To investigation the effect of RBEE on H-reflex of patients with acute and sub-acute radiculopathy.
5. To study the efficacy of long term application of RBEE on H-reflex of patients with radiculopathy.
6. To study the effect of a complete McKenzie program on H-reflex in patients with radiculopathies.
7. To evaluate the centralization phenomenon by H-reflex.

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ملخص الرسالة

تأثير تمرين فرد الظهر على منعكسة هوفمان في مرضى اعتلال جذور الأعصاب القطن عجزية

من أهم المشاكل الصحية الشائعة عالميا مرض إعتلال جذور الأعصاب القطن عجزية. ويصيب هذا الاعتلال العصب العجزي الأول الخارج من بين الفقرة القطنية الخامسة والفقرة العجزية الأولى مسببا قصوراً في النشاط اليومي وضغوطاً انفعالية واضطرابا في النوم ناتجاً عن الألم المصاحب لهذا الاعتلال. وغالباً يسبب هذا الاعتلال الانزلاق الغضروفي أو التغيرات الرثوية والاحتكاك في الفقرات القطن عجزية. ويسيطر على أعراض هذا الاعتلال إما بالتدخل الجراحي أو بطرق غير جراحية حسب الحالة, ومن الطرق الغير جراحية المستعملة في السيطرة على أعراض هذا الاعتلال تمرين فرد الظهر بطريقة ماكينزي. وهو من أكثر التمارين التي تستخدم لعلاج مرض اعتلال جذور الأعصاب القطن عجزية عالمياً. .وهذا التمرين هو التمرين الأهم والأكثر فاعلية في طريقة ماكينزي الواسعة الانتشار. كما أن هذا التمرين يعتبر التدرج الثالث في هذه الطريقة لكل من يحس بألم مفاجأ بمنطقة الظهر. يتم عمل التمرين من وضع الاستلقاء على البطن حيث يقوم المريض بتكرار فرد الظهر إلى أقصى حد يستطيعه وذلك بواسطة فرد الذراعيين مع بقاء الحوض ثابتاً قدر الأمكان.

وتشير الدراسات إلى أن فرد الظهر يعمل على تحريك نواة الغضروف بين الفقرات إلى الأمام بعيدا عن جذور الأعصاب مما يساعد على إزالة الضغط عن العصب المصاب وبالتالي تحسن الأعراض.ولقد استدلت على فعالية هذا البرنامج من خلال وجهة نظر المريض نفسه والتصوير الإشعاعي فقط ورغم أن المشكلة تتعلق بالأعصاب الطرفية إلا أنه لم تدرس فعالية البرنامج في أحداث تغير في فسيولوجية جذوع الأعصاب المصابة . من هنا برزت أهمية هذه الدراسة كونها تقوم بدراسة

تأثير تمارين الفرد على جذوع الأعصاب المصابة عن طريق منعكسة هوفمان بالإضافة إلى قياس شدة الألم والمستوى الوظيفي قبل وبعد التمرين لبحث العلاقة بين المتغيرات الثلاثة.حيث لا توجد دراسة موضوعية مشابهة وكل الدراسات السابقة التي تعرضت لقياس الألم عند هذه الفئة اعتمدت على القياس الوصفي فقط.وقد شارك في هذه الدراسة 30 مريضاً,19 من الرجال و11من النساء .معدل أعمارهم(38± 8.4سنة) يشكون من اعتلال مؤكد وحيد الجانب مزمن لجذور الأعصاب القطن عجزية وأعراض مرضية بشكل متواصل. وقد تم فحص منعكسة هوفمان للعضلة الأخمصية للرجل المصابة والرجل السليمة وكذلك قياس شدة الألم والمستوى الوظيفي لهذه العينة قبل وبعد التمرين. وقد بينت النتائج عدم وجود تأثير للتمرين على منعكسة هوفمان وشدة الألم والمستوى الوظيفي مما يشير إلى عدم حدوث إزاحة كافية للضغط عن جذور الأعصاب المذكورة أو أن تأثير الإزاحة يحتاج لوقت أطول للسماح بظهور النتائج وبالتالي عدم فعالية هذا التمرين بالطريقة المذكورة.