

Functional Rehabilitation of Disc Herniation Treated with Combined Therapy

Ramona Delia Arsani, Marius Stoica, Carmen Gherghel

National University of Physical Education and Sports, Bucharest, Romania

Email: delia.arsani@yahoo.com

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Abstract

Current researches reveal that the number of cases diagnosed with operated lumbar disc herniation is growing rapidly, which should draw an increased attention to the treatment used. The objective of this study is to perform a comparative analysis between the application of a classical physical-kinetic program and the application of a combined kinetic program. This research will be conducted on 20 subjects with ages, between 40 - 50 years old, in INEMRCM Bucharest, for 14 days - 1 hour a day. Each subject underwent an invasive surgery for lumbar disc herniation on the L5-S1 vertebrae. During the research, the 2 patients will be given a physical-kinetic program, adapted to the pathology of the operated lumbar disc herniation. The purpose of this research is to check the efficiency of each kinetic program. Furthermore, through the muscular and articular evaluation made in the initial phase and the final phase, it will be possible to discuss the comparative evolution of the established kinetic program and the functional gain obtained. In conclusion, the research shows that mechanized therapy results in faster functional rehabilitation and physical exercise substantially improves quality of life.

Keywords

Lumbar Disc Herniation, Rehabilitation, Physical Therapy

1. Introduction

The evolution of human being in ontogenesis was a concern for the researchers for long time; in order to determine the development of an individual we need motor skills that are in connection with the psychic factor form psychomotor skills.

Psychomotricity is the psychic function that encompasses a set of mental regulations regarding motor activity, in the sense of “activity programming” [1].

The term of psychomotricity has the role of defining and representing motor weakness and was then related to the brain areas that controlled motor life and was initiated by E. Dupre in 1892 [2].

At the same time, psychomotor skills contribute to maintaining the relationships between people and keeping the spiritual, emotional, thinking, affection, compassion and coexistence in society. Coordinated movements, organized in physical exercise for therapeutic purposes, can contribute to the functional recovery of lumbar disc herniation.

In the past few years, the lumbar disc herniation has known an increased number on the adult population around the globe. The causes of this phenomenon are multiple, including the lack of awareness of postures, movements, overload, poor gait, unbalanced lifestyle, daily activities and very often, lack of information on the consequences of the favorable factors of lumbar disc herniation.

According to a study from 2014, which reports the incidence of disc herniation at adults, it is mentioned that lumbar disc herniation is the most common cause of radiculopathy in adults, with an estimated annual incidence from 1.6% in the general population until 43% for certain occupations [3].

It has been shown that another way of producing a lumbar disc herniation can be degenerative, can result from trauma and aging and can start as ring tears. Eventually, this fact leads to the loss of the pulposus nucleus, so that the vertebrae above and below approach each other [4]. Therefore, the most common cause is of a compressive nature, the difference being made by the field of activity, in which the subjects are active. Another factor of disc herniation is obesity. Overweight and patients with a high pain threshold remain important factors underlying delayed diagnosis [5].

The researchers found that the surgery provided significantly better outcomes in all primary and secondary outcome measures compared to non-obese individuals, except for return to work at obese patients [6]. The muscular strength of the lower limbs in plantar flexion and dorsiflexion in patients with lumbar disc herniation decreases by 46 - 50 percent compared to healthy patients [7].

Lumbar disc herniation surgery, attracts changes in the paraspinal muscles and, according to some authors, even genetic changes. In conclusion, it exists a correlated significantly in patients with lumbar disc herniation with multifidus asymmetry [8].

Medical indications need the right to intervene only in extreme cases such as

- Persistent pain for several days, in compliance with the rules of kinetoprophyllaxis and without response to drug treatment and imaging indications, leads to surgical indications;
- Functional deficit progresses to neurological deficit similar to weakness, loss of control or motor reflexes;
- Sphincter disorders.

Failure to follow the basic rules and delaying surgery, as demonstrated by Heikelius, can make the defense can be irreversible [9].

After lumbar disc herniation surgery, quality of life is significantly affected, according to a study in Belgium. This study analyzes the impact of surgery on the recovery of work capacity due to deficiencies installed later, a factor that has serious consequences on several levels such as social, financial or economic. The result of the study reveals that depending on the age of the subject, he can return to work after 4 months, 6 months, 1 year and over 1 year [10].

Work ability is defined as the ability to experience, understanding and learning to perform tasks/occupations in order to have expected personal satisfaction. In choosing the right occupations, each person must value their skills and qualities and use both of them for personal motivational purposes and for the future collaboration [11].

It is well known that patients who needs surgery has difficulties with their emotional state and with the refusal of working due to subsequent medical recovery. For this reason, a study was conducted to determine the rate of emotional prevention, anxiety or even depression, so it was concluded that mental evaluation before surgery, should be a priority and patients needs mental support both before and after surgery [12].

All the elements mentioned above, contribute to the emotional impairment of the subjects because of pain, exercise capacity and low performance. Unfortunately, all of them contribute negatively to the emotional state, so it can occur depression, pronounced negativity and limitation in daily activities. A current research shows that people with low back pain has sleep disorders, even insomnia, which are associated with depression. For this reason, the branch of medical recovery aims to limit or may even eliminate these conditions, so that subjects with this pathology can quickly integrate into social life [13].

All these studies underlie the theory that this subject has an immense resonance among the population from different fields of activity and from all age categories and for this reason, kinetoprophylaxis has an important role because is following the basic rules, we prevent the reoperation of the herniated disc as it happens in 44% of cases in the first two years and 69% in the first 5 years [14].

2. Materials and Methods

2.1. The Objective of the Study

The purpose of this research is to illustrate the importance of the exercise in the functional rehabilitation of patients with operated lumbar disc herniation.

2.2. The Aim of the Study

The adoption of innovative treatment measures through mechanized therapy aims to:

- Increasing the quality of medical care regarding medical rehabilitation for patients with operated lumbar disc herniation;
- Emphasizing the importance of secondary kinetoprophylaxis in the case of this pathology;

- Decreasing the rate of complications in patients who underwent laminectomy or lumbar discectomy;
- Increasing functional independence and quality of life;
- Lowering the invalidation rate in the case of post-laminectomy or lumbar discectomy patients.

2.3. The Hypothesis

Evaluation of the patient with operated lumbar disc herniation, according to the bio-psycho-social model and the inclusion of mechanized therapy in the medical rehabilitation protocol,

- Ensures functional independence;
- Reduces the bio-psycho-social impact determined by pain, in patients with operated lumbar disc herniation.

2.4. Study Tasks

- The initial evaluation of the study groups according to the proposed tests;
- Application of the therapeutic protocol specific to each study group;
- Monitoring the treatment progress;
- Final testing of subjects;
- Analysis and interpretation of results;
- Drawing up the conclusions.

2.5. Research Methods

This study was a randomized controlled trial and was based on the following research methods:

- The method of scientific documentation—included the study of specialized literature;
- Observation method—where we have participatory observation of the subjects;
- Survey method—for the anamnesis of each subject;
- The experimental method—represents the actual research;
- Statistical-mathematical method—in which the data were processed from a mathematical and statistical point of view;
- Case study method—to find out how disc herniation occurs;
- The graphical representation method—for displaying the results and highlighting the differences obtained.

2.6. Subjects

Regarding the sample used in the physical medicine and balneology recovery laboratory, 25 patients with operated disc herniation were registered during 2 weeks. According to the online statistical calculator, out of the 25 patients, we chose 21 subjects for this study, but the 21st subject did not fit the inclusion criteria.

The research will be conducted on a sample of 20 subjects, divided into 2 groups:

- The experimental group (10 subjects, 5 women and 5 men)—performs exercises with mechanized therapy;
- The control group (10 subjects, 5 women and 5 men) performs exercises with classical therapy.

Both groups followed the established therapeutic protocol and performed physical exercises specific to each group, during 14 days, 1 hour/day, in INEMRCM, where the subjects were hospitalized for the medical rehabilitation. The reason for the selection was based on the fact that, in specialized medical recovery centers, only basic gymnastics is used as a recovery method.

The selection criteria were the following:

- **Inclusion criteria:**

- Age between 40 and 50 years;
- Normal weight;
- Main determining factor of the condition: overwork;
- Surgical intervention performed by the conventional method, at least 3 months before;
- The subacute stage of the disease;
- Paresthesias in remission.

- **Exclusion criteria:**

- Hypertension in treatment;
- Obesity;
- Diabetes;
- Cervico-dorso-lumbar surgical treatment in the antecedents;
- Osteosynthesis materials;
- Postoperative complications.

2.7. Treatment Protocol

The proposed common gymnastics program:

- All the subjects will perform 15 repetitions of the exercises indicated below on the kinetic table. Supine position with the upper and lower limbs stretched, the patient performs warm-up movements of the ankle joint by plantar flexion, dorsiflexion and rotations in one direction and the other, for 3 minutes;
- The subject in supine position, on a work table, bent knees and feet on the ground, the therapist in front, together with the patient, performs the bringing of a bent knee towards the chest, alternatively, and then returns. The same exercise but with both knees, bent towards the chest;
- With the bent knees and close to each other, feet on the ground, the subject performs the extension of the right knee with plantar and dorsiflexion of the foot and returns. Same exercise, but with the other lower limb;
- From the same starting posture, bring the bent knees to the side, return, so that the shoulder blades remains in contact with the ground. In the supine

position, with the bent knees, the subject performs the lifting of the pelvis upwards, while the thoracic spine remains in permanent contact with the ground and return; throughout the exercise, the abdominal muscles remains tense;

- In the supine position, with the bent knees, the subject performs the bringing of a knee to the chest, pulled with both hands, simultaneously with the bringing of the forehead to the knees and lifting of the bent torso from the table and returns. The same exercise but with both knees pulled to the chest with his hands and returns;
- In the supine position, with one bent knee, the other leg simulates cycling 10 times forward and back, with the other leg and returns back. The same exercise, but in the opposite direction, is performed with both legs, alternately;
- In the side position, with the head resting on the lower hand, the upper limb remains stretched, the lower knee bent, the upper knee extended, the upper leg performs abduction movements simultaneously with dorsiflexion and return. The same posture, the subject performs bringing the bent knee to the chest and return/ $\times 10$ repetitions. Keep the same side position, both knees bent, the subject performs the above knee lift and returns;
- The same exercises are performed on the opposite side, the trunk remaining stretched and the upper leg is in continuation of the trunk.

Mechanized therapy—Experimental group

The subject will perform the following exercises using mechanized therapy:

- The chair with weights, perform extensions of the knees kept under the metal bar/40 repetitions;
- On the quadriceps chair, from sitting with the knees bent at 90 degrees and the right knee extends where the left one kept under the metal bar, the knee is flexed/30 repetitions; after that, the knee extension with the leg held on the metal bar/30 repetitions;
- On the stepper, with elastic and handles, the subject performs the lifting of the hands forward and upwards simultaneously with the execution of the steps for 4 minutes;
- On the El-track, which is a device with applied weights that is used from a standing distance with the torso held in contraction, for performing the flexion of the arms upwards and returns/30 repetitions.

Classical therapy—Control group

With Bobath ball:

- From the sitting position, with the upper part of the body kept in tension, the arms supported on the edge of the table, the subject with the knee bent and the sole on a Bobath ball, performs pressures on the ball with holding for 6 seconds and returns/15 repetitions; the same exercise is performed with the other leg;
- From the sitting position, legs apart, carry out the hands face down by bending the torso;

- From the quadruped position, with support on the ball, the right leg is extended up to the torso line, simultaneously with the left arm up and returns/15 repetitions;
- Same exercise executed with the other leg/15 repetitions.

Exercises with weights applied on the lower limbs:

- In orthostatism, facing the trellis, hands supported by the slat at the shoulders, the subject performs lifting movements on the tips and heels for 3 minutes;
- The same position, with weights of 1 kg applied on each limb, the subject performs abductions/ $\times 15$ repetitions with the left foot and the same with the right foot;
- Also in orthostatism, the subject performs a vertical float simultaneously with the bringing of one knee bent towards the chest, returns; after that with the other knee and returns/ $\times 15$ repetitions alternatively;
- With the back to the trellis, the arms supported on the bar at the thighs, the back completely glued to the trellis, the legs slightly apart from the trellis and between them, the subject performs the bringing of a bent knee to the chest, returns/15 repetitions each alternately.

Exercises using the elastic belt:

- Sitting on the chair with the back glued to the back of the chair, the knees bent at 90 degrees and fastened with an elastic belt, abductions are performed with the resistance of the band/ $\times 15$ repetitions;
- In orthostatism, with the elastic belt fastened to a slat and with the ends held in the hands, retractions are performed with the trench held in isometry/25 repetitions.

Exercises using the wheel with handles:

- In orthostatism, soles in permanent contact with the ground, walk with the wheel held with both hands on the wall, keeping at the maximum point, return to shoulder level/25 repetitions.

Exercises using the balance board:

- Standing between the parallel bars with support on the hands, the legs placed parallel on the balance plate, the subject performs plantar flexion and dorsiflexion/50 repetitions;
- The same exercise but with the balance plate turned to the side, alternating body weight from one leg to another.

Exercises using the reflexogen tube:

- Sitting on a chair with backrest, the back in permanent contact with the backrest, the right foot on the reflex tube, it is performed with the soles of the tube forward with the toes raised upwards and backwards with the heel raised upwards.

Exercises with Roche cage:

- In the supine position, with the hands held by the horizontal bar attached to the slat, the torso is lifting upwards simultaneously with the leading of the hands to the side and returns/40 repetitions.

2.8. Evaluation Methods

Until now, it is known that Havakeshian & Mannion, 2013 [15], did a study aimed at the psycho-emotional impact of the pathology of operated lumbar disc herniation, but there are no known studies that address operated lumbar disc herniation, from the broad perspective of the bio-psycho-social model. This model includes all the functionality of the body. It includes biological, psychological and social function. The study tools use reflects these aspects.

1) Bio-functional assessment

a) The lumbar Schober-test:

Testing position: standing

A sign is placed on the skin over the 5th spinal process, which is at the level of the superior iliac spines and another sign is placed 10 cm above, in the midline where the subject performs the flexion of the trunk without bending knees. At healthy patients, the distance between the two signs increases by more than 5 cm, while an increase of less than 4 cm suggests a decrease in lumbar spine mobility.

b) Tomayer test:

From orthostatism, the flexed torso, with the legs close together and the arms outstretched, the distance between the index finger and the ground is measured.

c) Lateral tilt of the torso:

Starting position:

In orthostatism position, with the hands next to the body, the subject performs the lateral tilt of the torso, so that the hand approaches the lateral epicondyle of the femur.

Determination: in the frontal plane.

AM (axis of movement)—is fixed parallel to the lumbar spine.

FA (fixed arm) parallel to sacral spine.

MA (mobile arm) parallel to the spine.

The amplitude of movement is between 0 - 35 degrees [16].

Joint balance—using the goniometer—is an objective evaluation method used to measure from a biomechanical point of view, the range of motion of the joint of interest, on the possible anatomical directions, in the corresponding with **Table 1**.

d) Analog visual scale (AVS):

Instructions: mark on a scale from 0 to 10 the intensity of the pain.

Considering the fact that, in the traditional intervention of lumbar disc herniation the paravertebral muscles are affected, in terms of subsequent damage,

Table 1. Normal values measuring movements.

| The motion | Degrees of movement | | |
|----------------------|---------------------|--------|---------|
| | Torso flexion | 0 - 90 | Subhead |
| Left/right side tilt | 0 - 35 | | |

they consist of limitations of movements in the frontal, sagittal and transverse planes.

2) Psycho-emotional assessment

PHQ-9 Patient Depression Questionnaire—evaluates the degree of damage of the subjects in relation to the pathology of operated lumbar disc herniation.

3) Socio-professional assessment

Fear-Avoidance Beliefs Questionnaire (FABQ)—to assess the events that patients try to avoid due to fear of pain. Some items are proposed in order to evaluate the intensity of pain and to determine the extent to which activities such as bending, lifting, walking, or driving influence may influence back pain.

3. Results

Tests were applied to reflect the bio-psycho-social impact of lumbar disc hernia surgery on the subjects.

Physical kinetic therapy—Results

Column 1 is represented by the number of subjects. Columns 2 and 4 are represented by the average of the tests applied to the initial testing and column 3 and 5 are the results of the average of the values at the final testing (**Table 2**).

Table 3 shows the average obtained between the initial and final values of the two study groups.

Figure 1 describes a graphic representation of the way, in which the two study groups, have evolved statistically, in relation to the initial and the final evaluation.

The t-Test was applied to demonstrate whether the two variables are statistically significant. After the initial and final values of the 20 subjects were entered, a difference was made between the two results, for each group separately. The difference in the results calculated with the t-Test showed that $P \leq 0.05$, which means that the data are statistically significant.

Table 2. Comparison of results according to physical therapy—initial and final score.

| Subject | Mecanized therapy | | Classical therapy | |
|---------|-------------------|-------------|-------------------|-------------|
| | Initial score | Final score | Initial score | Final score |
| 1 | 21.71428571 | 24.5714286 | 21.85714286 | 23.4285714 |
| 2 | 21.14285714 | 21.8571429 | 20.71428571 | 20.8571429 |
| 3 | 17 | 18 | 18 | 18.2857143 |
| 4 | 22.28571429 | 22.5714286 | 20.42857143 | 20.7142857 |
| 5 | 21 | 21.5714286 | 18.71428571 | 19.5714286 |
| 6 | 23.42857143 | 24.1428571 | 22.14285714 | 22.8571429 |
| 7 | 21 | 22.8571429 | 22 | 22.2857143 |
| 8 | 23.14285714 | 24.1428571 | 16.57142857 | 16.7142857 |
| 9 | 23.42857143 | 24.2857143 | 16.28571429 | 16.5714286 |
| 10 | 20.71428571 | 21.7142857 | 20.57142857 | 21 |

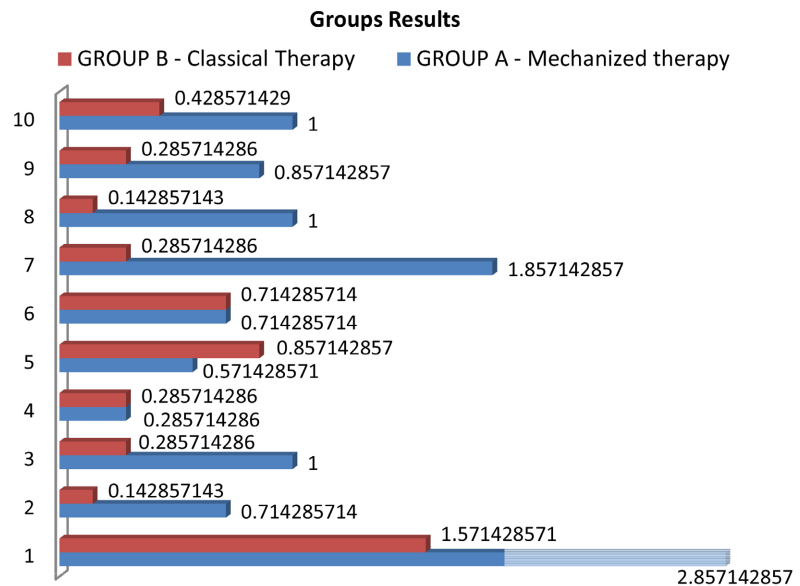


Figure 1. Groups analyses.

Table 3. Comparison of results according to physical therapy groups results.

| Subject | Mechanized therapy | Usual Therapy |
|---------|--------------------|---------------|
| 1 | 2.857142857 | 1.571428571 |
| 2 | 0.714285714 | 0.142857143 |
| 3 | 1 | 0.285714286 |
| 4 | 0.285714286 | 0.285714286 |
| 5 | 0.571428571 | 0.857142857 |
| 6 | 0.714285714 | 0.714285714 |
| 7 | 1.857142857 | 0.285714286 |
| 8 | 1 | 0.142857143 |
| 9 | 0.857142857 | 0.285714286 |
| 10 | 1 | 0.428571429 |

Bio-functional evaluation results

For the bio-functional evaluation, the impact of physical exercise on it, was visible in the differences in the values of the tests that reflect joint mobility. **Figure 2** and **Figure 3** reflects the differences between the initial evaluation and the final value for the groups. For the experimental group, was obtained an average of 2.72 was obtained, while for the control group, was obtained an average of 1.5.

An additional attention for patients with operated lumbar disc herniation, appears in the case of the other psycho-emotional evaluation, respectively the socio-professional evaluation. Regarding the impact of physical exercise on these factors, the PHQ and FABQ tests were used (**Table 4**). Below are the mean values for the initial and final results.

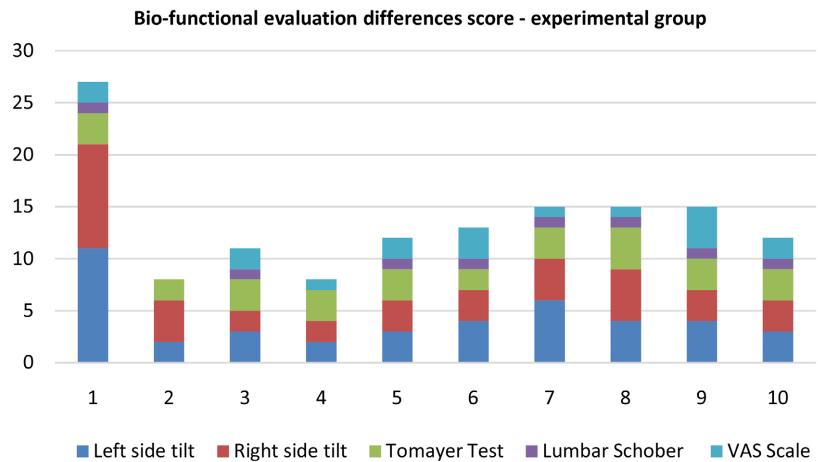


Figure 2. Bio-functional evaluation differences score—experimental group.

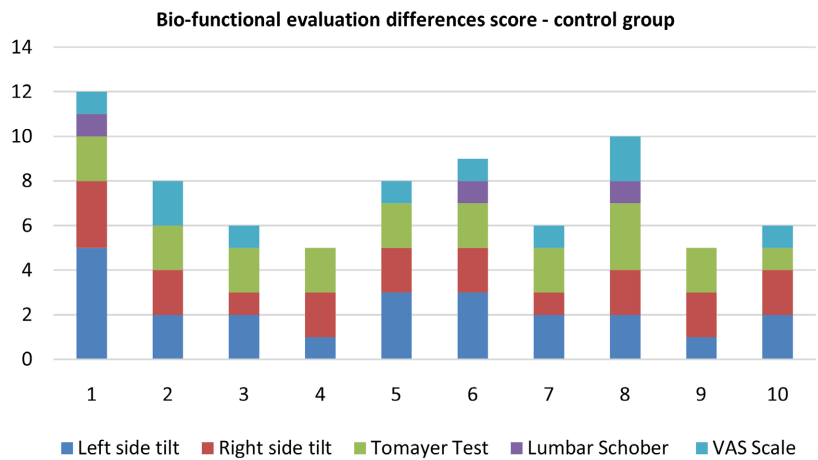


Figure 3. Bio-functional evaluation differences score—control group.

Table 4. Comparison of results according to physical therapy PHQ and FABQ.

| Subject | PHQ | | F-A B Q | |
|---------------------|---------------|-------------|---------------|-------------|
| | Initial score | Final score | Initial score | Final score |
| Differences—Average | 13.95 | 10.1 | 60.4 | 55.1 |

In order to be able to evaluate, if the differences between the initial and final values of the subjects are statistically significant, the t-Test was applied. A value of $P \leq 0.01$ was found, so less than the value of 0.05, which represents the fact that the difference between the initial and final values is statistically significant. From here, we conclude that the impact of physical exercise adapted to lumbar disc herniation through the application of mechanized therapy, has a result to be taken into account for future treatment protocols.

Figure 4 shows the graphic representation of the initial score and the final score obtained in the PHQ and FABQ tests.

Figure 5 displays a graphic representation of the last two tests. The lower result represents the defeat of fear in front of the activities.

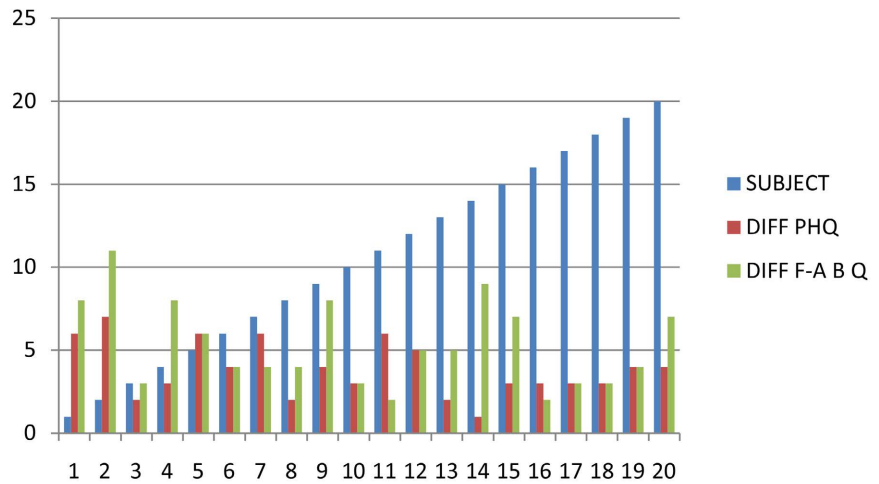


Figure 4. Groups differences analyses.

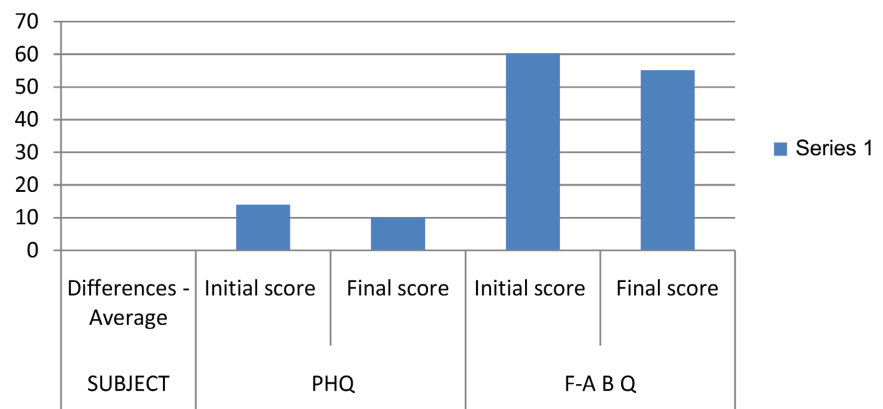


Figure 5. Groups analyses initial and final score.

Data presentation, processing and interpretation

To analyze statistically, we performed T test for pair variables, which shows that it is relevant, P is <0.05 (one-tail, 2-tails) which means that H1 is accepted > there are significant differences between the means of the 2 samples and the values and average is lower in the final score. We conclude that due to the results obtained, we can extrapolate the hypothesis to the entire population.

4. Discussions

The spine, like any load-bearing structure, supports a large static and dynamic load and wears out over time. At a young age, the stable state of the spine is maintained due to an increased regenerative capacity, but it is gradually exhausted. Early changes in age in the case of the spine, are often reported in optimal time, which helps to maintain it.

Most authors believe that aging processes begin in the third decade of life, although the involution may begin earlier under certain conditions (high physical load sports, work and non-compliance with kinetoprophylaxis during work, an asthenic constitution with underdeveloped muscles, spinal malformations etc.).

There are opinions that the aging of the nucleus pulposus can only begin at the age of 35, but in recent years this age has decreased.

Changes in age in the spine have been studied in detail by Vassilev, who deduced that spinal disorders are known to be polyethiological and multifactorial. The whole body is pathologically involved in the degeneration process.

According to the literature, the speed of nerve conductivity, decreases with vertebral degeneration even in the early stages of this disease and as the disease progresses, there is a sharp decrease in the rate of activation along the sensory fibers and, subsequently, increased latency of decreasing the speed of propagation along the motor fibers and decreasing the amplitude of the motor response.

Intervertebral disc herniation results mostly from severe manifestations and are of a compressive nature. Compression of a nerve root causes a disorder of nerve conductivity, associated with demyelination of nerve fibers, under direct or indirect action by anoxic-ischemic mechanism.

Some authors observe a close association of lumbar joint degeneration in the process with age, which leads to an increase in the number of traumas and/or surgeries and, subsequently, to the need for recovery treatment. For example, some authors have found that age correlates with ligament flavum enlargement to a greater extent and also correlates with disc degeneration and facet osteoarthritis to a lesser extent. The authors also, deduced that age influences the intensity of the inflammatory response and implicitly, the nerve root injury and movement disorders caused by herniation of the intervertebral disc. According to needle electromyography data, many patients with lumbar disc herniation and root compression experience root demyelination, axonal damage and even conduction blockage, in severe cases. Disruption of the conduction along the spinal root or loss of axons reduces the muscular strength of the extremities.

5. Limitations

This study primarily, has some potential limitations such as the relatively small sample size. The number of subjects was based on data analysis in relation to the percentage of dynamic activities. All activity monitors outcome measures showed significant differences between the two group. Therefore, there were significant differences found both between response data after the two weeks, in which medical physical gymnastics was affected by applying the 2 types of programs, and the data obtained to collect information on improving the quality of life after exercise. Future studies could increase the number of patients.

A second limitation may or the relatively short data collection period of 14 days. For a possible reporting to a larger number of subjects, the observation spectrum can be extended up to 21 days of treatment. A third limitation would be the search for a technological measurement method for a greater accuracy of the obtained data but also to shorten the response time of the information.

6. Conclusions

The incidence rate of operated lumbar disc herniation is on the rise, which re-

quires the rapid development of post-operative assessment and treatment methods.

Following the postoperative lumbar disc herniation, difficulties appear that reduce mobility, walking, the possibility of self-care but also a decrease in the quality of sleep, which translates into a generation of disabilities that have repercussions on the functionality, the performance of daily activities and on the recovery of work capacity from the reason for limitations due to physical health.

Allocation of investments within the global rehabilitation system can attract, improve the quality of treatment, shorten the recovery time, increase the quality of life and socio-professional reintegration of individuals with operated lumbar disc herniation.

Adopting an appropriate recovery method, based on the study of classical methods and modern methods, increases the quality of life and actively contributes to the recovery of work capacity.

This research proves that the initial hypotheses proved to be real and are valid. The use of T-tests showed that the final results were statistically significant. The result obtained for the first hypothesis states that mechanized therapy makes a greater contribution to the medical recovery of patients with operated lumbar disc herniation, from a bio-psycho-social point of view.

The results obtained for the second hypothesis show the beneficial impact of physical exercise on quality of life in relation to mental impairment at patients with operated lumbar disc herniation.

At the end of this research, we admit that this research needs to be done on a larger sample, because of the substantial contribution on the human body.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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