



The Effectiveness of Core Stability Exercise to Improve Functional Ability in A Lumbar Herniated Nucleus Pulposus Patient: A Case Study

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ABSTRACT

Background: Hernia Nucleus Pulposus (HNP) is a condition in which the nucleus pulposus has bulged from the intervertebral disc, consequently damages the walls of the annulus fibrosus and compresses the nerves. Clinical problems such as radiating pain, sensory disturbances according to dermatomes, muscle weakness, restricted range of motion, especially during flexion, and decreased functional ability. Core stability exercise is one of the physiotherapy treatments to reduce pain and improve the patient's functional ability with lumbar HNP. The purpose of this study is to determine the effectiveness of core stability exercise on increasing functional ability in cases of lumbar HNP with Modified Oswestry Low Back Pain Disability Questionnaire as a parameter.

Methods: A single case study provided a physiotherapy intervention to a 56-year-old female patient for four weeks with

four evaluations. The dose of exercise given was three times a week, three sets, five repetitions, 6-9 minutes of each type of exercise, and hold time 5-10 seconds. The improvement of functional ability is measured by using the Modified Oswestry Low Back Pain Disability Questionnaire.

Results: There was an improvement in functional ability as measured by Modified Oswestry Low Back Pain Disability Questionnaire. At pre-intervention, the Modified Oswestry score was 52% meaning the patient had severe disability. On the 4th week evaluation, the patient's Modified Oswestry score decreased to 26%, indicating moderate disability.

Conclusion: This study showed that core stability exercise effectively improved functional ability in a patient with lumbar HNP.

Keywords: core stability exercise, lumbar herniated nucleus pulposus, Modified Oswestry Low Back Pain Disability Questionnaire

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INTRODUCTION

The burden of non-infectious diseases is increasing, although the infectious diseases infectious diseases have not been fully resolved. Based on the National and Subnational Disease Burden Analysis 2017, several degenerative diseases have an increase of between 15-25%, one of which is Low Back Pain or LBP in Indonesia.¹ One of the most common causes is Herniated Nucleus Pulposus (HNP).

HNP is a condition where the nucleus pulposus bulges from the intervertebral disc, damaging the annulus fibrosus wall and compressing the nerves.² The incidence rate of HNP globally is 5 to 20 cases per 1000 adults per year.³ A study presented 4456 people (25% of the total visits) suffered from pain, and 819 people (18.37%) of them were pain due to HNP in the 14 teaching hospitals in May 2002.⁴ HNP most often occurs in the third to fifth decades of life and most frequent (90%) occurred in the L4-L5, L5-S1 segments.^{3,5} Clinical symptoms are radiating pain, sensory disturbances, muscle weakness, restricted range of motion, and some

activities that provoke radiating pain, such as coughing and sneezing.²

Core stability exercise is a physiotherapy intervention with isometric contractions to increase muscle strength and central/trunk stability by activating stabilising muscles.⁶ The evaluation parameter used is the Modified Oswestry Low Back Pain Disability Questionnaire (MOLBPDQ). MOLBPDQ consists of 10 domains with five answer choices describing the patient's disability. Each answer has a different value, starting with a score of 0, which means there is no disability, up to 5 for the most severe disability.^{7,8} MOLBPDQ has an excellent intraclass correlation coefficient.⁷

This case study aims to determine the effectiveness of core stability exercises on increasing functional ability in a lumbar HNP patient. While the benefits of writing from this case study are as a learning material and reference for all people who want to increase knowledge, increase understanding related to lumbar HNP and core stability exercise, and be able to apply core stability exercise at home, hospital, or clinic.

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CASE STUDY

Before the intervention, the patient was given informed consent as subject to this case study, agreed to report her data, and received physiotherapy intervention to improve her impairments.

A 56-year-old woman diagnosed with LBP + HNP complained of radiating pain from the lower back to the left heel and stiffness in both legs. In

July 2019, the patient felt a painful sensation in both legs. In December 2020, the patient complained of radiating pain to the left heel, especially when walking and bending over, making it difficult to pray. On December 26th, 2020, the patient went to a general practitioner and conducted laboratory examinations to determine uric acid, cholesterol, blood sugar levels. The results were normal. On January 13rd, 2021, the patient went to the orthopaedic then advised her to take an X-ray. On January 14th, 2021, X-ray results came out with the conclusion of Lumbar Spondylosis with Osteoporosis. On January 27th, 2021, the patient took MRI, and the result was low back pain with hernia nucleus pulposus (**Figure 1**). On January 28th, 2021, the patient came to physiotherapy for the first time. Until March 21st, 2021, the patient had undergone ten sessions of physiotherapy. The patient's current condition is radiating pain in the lower back to the left heel and stiffness in both legs when bending over; the patient cannot walk far for a maximum of 10 minutes and sitting for 30 minutes. The patient also had difficulty performing household activities such as sweeping, mopping, washing clothes, and cooking.

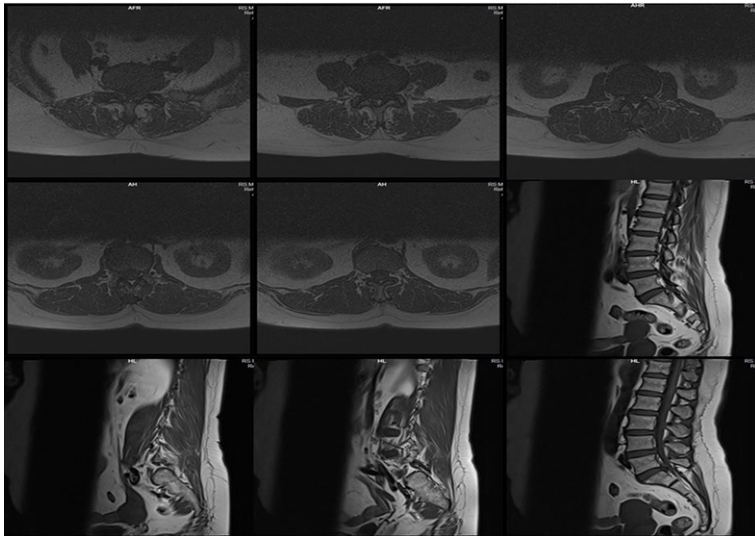


Figure 1. Magnetic resonance imaging (MRI) of the patient

EXAMINATION AND CLINICAL PROBLEM

The patient underwent several examinations to determine the diagnosis, including the range of motion (ROM), muscle strength, pain level, anthropometric, sensory, reflexes, specific tests, and the MOLBPDQ. With the following examination results:

1. ROM

ROM is the amount of movement that occurs in a joint. The active and passive ROMs were measured with a goniometer in several positions, such as supine lying, prone lying, and sitting⁹ **Table 1**. There were limited ROMs in trunk flexion, extension, bilateral lateral flexion, bilateral rotation.

2. Muscle strength and pain scale

The measurement of muscle strength used manual muscle testing (MMT) presents in **Table 2**. In the MMT examination, the physiotherapist positions patients' joints in a neutral position. The MMT scoring system starts from 1 to 5.¹⁰ Meanwhile, the visual analogue scale (VAS) was used to measure the pain level of the patient. VAS is a simple method to measure pain intensity sensitive, inexpensive, and easy to use. Physiotherapists need to educate and explain the pain about VAS on each scale, then ask the patients' pain scale.¹¹

Table 1. Range of Motion Examination Result

Joint	Movement	Normal ROM	Active ROM		Passive ROM	
			Right	Left	Right	Left
Trunk	S	30°-0°-90°	25°-0°-60°		30°-0°-80°	
	F	30°-0°-30°	10°-0°-20°		20°-0°-25°	
	T	60°-0°-60°	40°-0°-45°		60°-0°-60°	
Hip	S	15°-0°-120°	15°-0°-80°	15°-0°-75°	15°-0°-85°	15°-0°-85°
	F	45°-0°-30°	45°-0°-30°	45°-0°-30°	45°-0°-30°	45°-0°-30°
	T	35°-0°-45°	35°-0°-45°	35°-0°-45°	35°-0°-45°	35°-0°-45°

F, frontal plane; S, sagittal plane; T, transverse plane.

Table 2. Muscle Strength and Pain Scale Examination Result

Joint	Muscle Group	MMT		VAS		
		Right	Left	Right	Left	
Trunk	Fleksor	3		4		
	Ekstensor	4		3		
	Lateral fleksor	5	4	0	3	
	Rotator	4	4	0	3	
Myotome	Movement	MMT		VAS		
		Right	Left	Right	Left	
	L2	Hip flexion	4	4	2	3
	L3	Knee extension	5	5	0	0
	L4	Ankle dorsal flexion	5	5	0	0
	L5	Great toe extension	5	5	0	0
	S1	Ankle plantar flexion	5	5	0	0

The decrease of muscle strength of flexor trunk, extensor trunk, lateral flexor trunk, bilateral rotator trunk, and bilateral L2 myotome muscles was found in the patient. The patient felt the pain during trunk flexion, extension, left lateral flexion and left rotation. Also, the pain arises during hip flexion on both legs.

3. Anthropometric examination

The anthropometric examination measured height, weight, body circumference, fat composition, and muscle atrophy. In this case, an anthropometric was performed to determine the presence of muscle atrophy in

Table 3. Anthropometric Examination Result

Description	Right	Left	Difference
20 cm from SIAS	54 cm	54 cm	0
10 cm from tuberosities tibia	40 cm	40 cm	0

Table 4. Sensory Examination Result

Methods	Dermatome	Dextra	Sinistra
Sharp-dull	L2	100%	100%
	L3	100%	100%
	L4	100%	100%
	L5	100%	100%
	S1	100%	100%
Soft touch	L2	100%	100%
	L3	100%	100%
	L4	100%	100%
	L5	100%	100%
	S1	100%	100%

Table 5. Physiological Reflexes Examination Result

Physiological reflex	Dextra	Sinistra
Patellar tendon	+1	+1
Achilles' tendon	+2	+2

Table 6. Specific Tests Used for Lumbar HNP

No.	Specific test	Hasil	Description
1.	Straight Leg Raise (SLR) Test	Negative	The patient felt radiating pain from lower back to heel
2.	Bragard's Test	Positive	The patient felt radiating pain from lower back to heel
3.	Neri Sign	Positive	The patient felt radiating pain from lower back to heel

leg muscles using elastic tape marked in 1-cm increments that measured 20 cm below the spina iliaca anterior superior for thigh muscles and 10 cm below the tuberosities tibia for the calf muscles¹² as presents in **Table 3**. There is no muscle atrophy on both legs.

4. Sensory examination

The sensory examination was carried out to determine sensory disturbances, which are present in **Table 4**. Other sensory functions innervate different skin areas of the lower extremity for each spinal nerve segment, called dermatomes. This examination was performed by scratching the skin and dull stimulus and a soft touch on the dermatome area.¹³ There is no decrease in sensibility along the L2-S1 dermatome area.

5. Physiological reflexes

The physiological reflex examination confirms upper motor neuron or lower motor neuron disorders. This examination was performed by tapping the Patellar and Achilles' tendon with reflex hammer,¹⁴ as presents in **Table 5**. There was hyporeflexia in the bilateral tendon patellar reflex.

6. Specific tests

The straight Leg Raise (SLR) test is the most common passive examination in lower extremity cases. The procedure of this test, the physiotherapist, started with the patient lies in supine, hip slightly internally rotated, knee extended. Then physiotherapist slowly flexed the hip until the patient complained of radiating pain. The patient felt the pain at 70° during hip flexion; but pain after 70° was usually caused by joint facet. Braggard's test was carried out with ankle dorsiflexion after pain appears during SLR. Meanwhile, the physiotherapist performed the Neri test by instructing the patient to flex her neck after pain occurs during Braggard's test,¹⁵ as present in **Table 6**.

7. MOLBPDQ

The physiotherapist also collected the patient's ability using the MOLBPDQ. The total score of MOLBPDQ of the patient was 52%, represents a moderate disability.

Based on these assessments, the physiotherapy goals for the patient was to improve functional ability by core stability exercise with the types of pelvic tilting exercise, bridging exercise, four-point kneeling exercise with the arm lift, four-point kneeling exercise with leg lift, and cat-camel exercise (**Figure 2**). The core stability exercise was given three sets three times a week for four weeks, from March 22, 2021, to April 18, 2021.

INTERVENTIONS

Core stability exercise aims to activate the deep stability muscles that are generally inactive in patients with lumbar pathologies, such as lumbar HNP.^{16,17} In this study, several types of core stability were used, including pelvic tilting exercise, bridging exercise, four-point kneeling exercise with an arm lift and leg lift, and cat-camel exercise.

Pelvic tilting exercise is an exercise that use to reduce symptoms in LBP patients. Anterior pelvic tilt can increase the strength of lumbar lordosis muscles. In contrast, posterior pelvic tilt can correct the alignment of the lumbar spine in LBP patients.¹⁸ Bridging exercise is a closed kinetic chain exercise

aim to increase core muscles. Bridging exercise is easy, comfortable, and can reduce symptoms in LBP patients.¹⁹ Four-point kneeling exercise aims to improve stability and core muscle strength and reduce pain.²⁰ Meanwhile, cat-camel exercise is a closed kinetic chain exercise that aims to increase thoracic and lumbar muscles, reduce pain, reduce intradiscal pressure, and stretch muscles around thoracic and lumbar vertebrae.²¹ **Table 7** describes the muscles that were activated during each type of core stability exercise.

EVALUATION

Figure 3 presents that core stability exercise affect pain intensity based on the MOLBPDQ parameter. On the examination, the pain intensity was 4, which represented very severe pain. On the 1st week of evaluation, the pain intensity decreased to 2 means that the pain felt mild. However, on the 2nd-week evaluation, the pain increased to 3, which showed severe pain because the patient performed more lifting activities than the last week. Thus, the patient was given a home program to minimise and modify the lifting and bending down activities. On the 3rd and 4th week evaluation, the pain intensity decreased to 2, which showed mild pain.

Figure 4 presents the effectiveness of core stability exercise in improving functional ability measured with MOLBPDQ. The MOLBPDQ score was 52% on the examination, which means the patient had a severe disability. On the 1st week of evaluation, the MOLBPDQ score decreased to 44%. On the 2nd and 3rd evaluations, the patient had more significant improvement than the previous week with a MOLBPDQ score of 44% and 30%, respectively. A better functional ability in the house working, walking, and sitting had experienced by the patient. Thus, on the 4th evaluation, the MOLBPDQ score was decreased to 26%, representing a moderate disability.



Figure 2. A. Pelvic tilting exercise; B. Bridging exercise; C. Kneeling with arm lift; D. Kneeling with leg lift; E&F.Cat-camel exercise

Table 7. Activated Muscles During Core Stability Exercise

Type of Core Stability Exercise	Activated Muscles during Exercise
Pelvic tilting exercise	m. erector spine, m. multifidus, m. transversus abdominus, m. rectus abdominis, m. external oblique, m. internal oblique. ¹⁸
Bridging exercise	m. internal oblique, m. rectus abdominis, m. erector spine, m. quadratus lumborum, m. multifidus. ¹⁹
Four-point kneeling exercise	m. transversus abdominus, m. multifidus, m. internal oblique, m. external oblique, m. rectus abdominus. ²⁰
Cat-camel exercise	m. erector spine, m. rectus abdominis, m. internal oblique, m. external oblique, m. serratus anterior, and m. triceps. ²¹

DISCUSSION

Mechanism of Core Stability Exercise in Reducing Pain Intensity

Core stability exercise is an exercise that activates local (trunk muscles) and global stability (trunk, upper- and lower-extremities muscles) by preventing lumbopelvic joint tension and correcting posture. There is a neutral zone in the lumbar vertebrae for the synergistic interaction between the active stability systems (including the muscles, tendons, and nerves) and passive stability systems (including the discs, ligaments, and bones) that control the movement of the intervertebral disc. In an HNP pathology, the neutral zone will be

disrupted due to a working imbalance of the active stability system, one of which is a decrease in the capacity of stabilising the passive stability systems, which results in pain. Core stability exercises can reduce pain intensity by improving coordination and activation of stabilising muscles that reducing the load on the intervertebral discs, which enhance the quality of movement in the trunk.¹⁷

The previous study found that the cat-camel exercise contributes to the improvement of the patient's functional abilities by activating lumbar stability muscles and reducing pain sensation that reduces the excessive movement of the intervertebral disc.²¹ Core stability exercise activates the lumbar stabilising muscle fibres such as multifidus, transversus abdominis, erector spine, consequently increasing neuromuscular control, muscle strength, and muscle endurance.¹⁶ In addition, the core stability exercise might stimulate the brain to release β -endorphin (BE), an endogenous opioid that causes analgesic effects. BE is a peptide released by an adrenocorticotrophic hormone from the anterior lobe of the pituitary gland due to increased metabolism and body heat during exercise. BE acts on endogenous opioid receptors that modulate pain sensation at the spinal cord level. Thus, performing the core stability exercise affects circulating PB levels in the blood vessels, resulting in an analgesic effect or pain reduction.²²

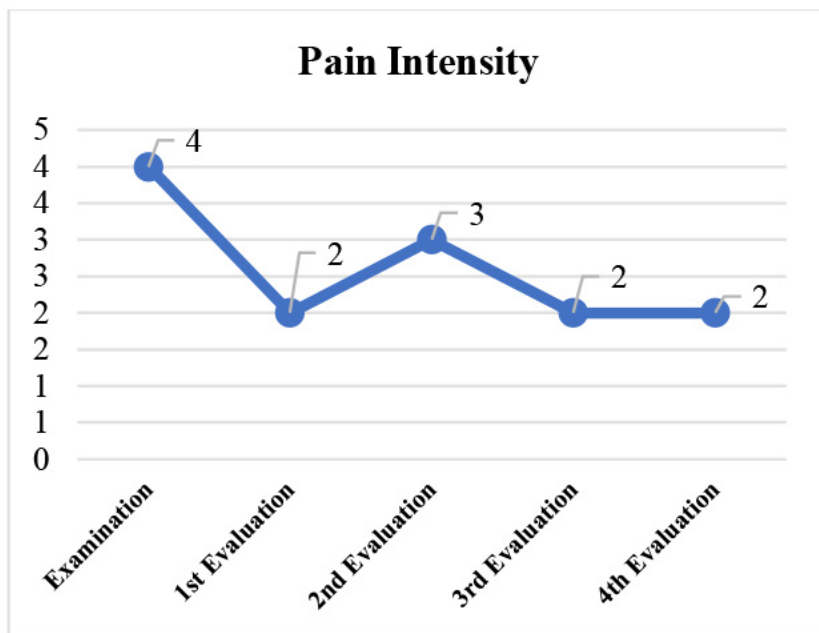


Figure 3. Pain intensity evaluation result of the patient

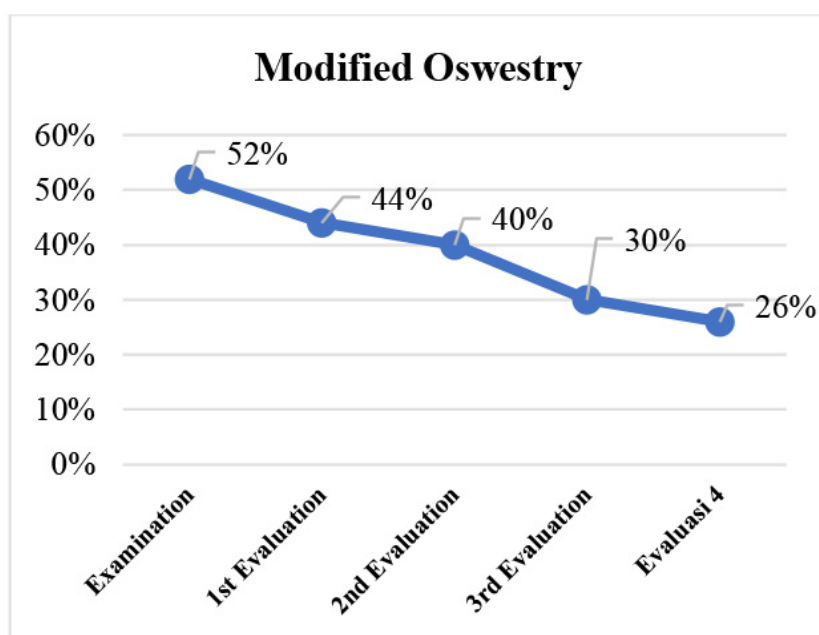


Figure 4. Functional ability evaluation result of the patient

Mechanism of Core Stability Exercise to Improve Functional Ability

LBP patients generally experience the fear-avoidance model (FAM), a phenomenon in which patients fear performing body movements, daily routines or sports activities because of pain and patients tend to avoid related activities.¹⁷ However, the FAM could decrease physical activity, increase stiffness in the lower back, which worsens quality of life, permanent functional disability, and sensation of pain.¹⁷ Core stability exercises might overcome the FAM by reducing the sensation of pain and enhance trunk ROM and neuromuscular control that enhance daily activities of HNP patients.¹⁷ Moreover, when the core stability exercise uses drawing-in manoeuvres, this would help activate vertebral column stability muscles such as m. transversus abdominis, m. multifidus, which enhancing the endurance in lumbar stability muscles.²³

CONCLUSION

This case study concludes that core stability exercises effectively improve pain level and functional ability measured by the VAS and MOLBPQ parameters on the patient with lumbar HNP.

CONFLICT OF INTEREST

There is no conflict of interest.

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N/A

AUTHOR CONTRIBUTIONS

ADP conceived and designed the study. MES collected the patient information, did the examinations and exercises for the patient. All authors drafted the manuscript, contributed to manuscript revisions.

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