

## **PATHOLOGY OF INTERVERTEBRAL DISC AND REHABILITATION**

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### **Abstract**

Back pain is a common problem and a recent systematic review concludes that the number of patients with the back pain is increasing and it leads to increasing number of people being on sick leave because of the chronic back pain. The pathology of intervertebral disc is a common problem which leads to back pain. The fundamental role in the back pain therapy are the following: prevention, regularly exercises, and rehabilitation. We are able to say, that the chronic back pain has negative impact on the health and psychic of patients, as well as it has substantial social and economic effects on them.

**Keywords:** Intervertebral disc. Disc protrusion. Prolapsed disc. Back pain. Rehabilitation

### **1 Introduction**

Most of the population suffers from a back pain during their lives. The initial problem is the lack of the physical activity among people and the lack of knowledge about how to protect our back or about the principals of back school. There is a lack of time in general. People are under mental and physical pressure every day and they do not pay attention to the very first signs of pain and suppress it with analgesics. They do not seek for help until the last moment. Unfortunately, this approach of theirs only prolongs the treating process. Patients with back problems in general still increases and the intervention of specialists and the physiotherapists will be needed more. The vertebral column with muscles, ligaments, nerves and intervertebral discs allows the extensive spinal movements. If a segment will get impaired it influences the whole body. The cause of arising back pain is typically linked to muscle or ligament strain which happens during lifting a heavy object, twisting the spine or a sudden movement which might lead to a specific spine condition – an impairment of intervertebral discs which is followed by a pain. The symptoms as numbness, tingling, weakness and radiating pain can appear but it depends on the place and extent of the disc impairment. If conservative way of treatment does not help, the surgery is indicated.

### **2 Intervertebral Disc**

Intervertebral discs link the bodies of each vertebrae and make natural shock-absorber. The greatest weight of the body is in the lumbar region, thus the disc is the firmest there [1]. The thickness of all discs is equal to one quarter up to one fifth of total spinal height [2]. It increases craniocaudally, therefore in the lumbar region there are the thickest discs. The ratio of thickness of the disc to the vertebral body height tells us about the mobility in a given segment. In other words, the larger the ratio is, the more mobile is the segment. The lumbar spine has a ratio of one third. In comparison, the least moveable region is the thoracic spine with its ratio of one fifth [3]. From a very moment as a person gets up in the morning, the discs are exposed to the pressure of the load of a human body, and spine movements. The muscle tension is primarily caused during the movements of the spine [4].

*Anatomy:* The intervertebral disc is an extraordinary part of the spinal column due to its location between vertebrae as well as the structure. It consists of fibrocartilage which continuously transfers to fibrous tissue on its circumference. The vertebral body and the disc itself are fused by the end plate, the hyaline cartilage. There is an inner gelatinous substance in the core of the disc called nucleus pulposus which is a remnant of the notochord with round or discoidal shape. The position of the nucleus pulposus is in the middle of the disc except the one in the lumbar region. The lumbar discs direct slightly posteriorly. During the spinal movement, the nucleus pulposus is being pushed toward the opposite side than the motion happens. Incompressible core is surrounded and supported by an outer fibrous ring denominated annulus fibrosus. The fibres of annulus fibrosus are in a criss-cross composition. The nucleus pulposus is therefore able to absorb shocks, is resistant to deep bending and torsional pressure [4].

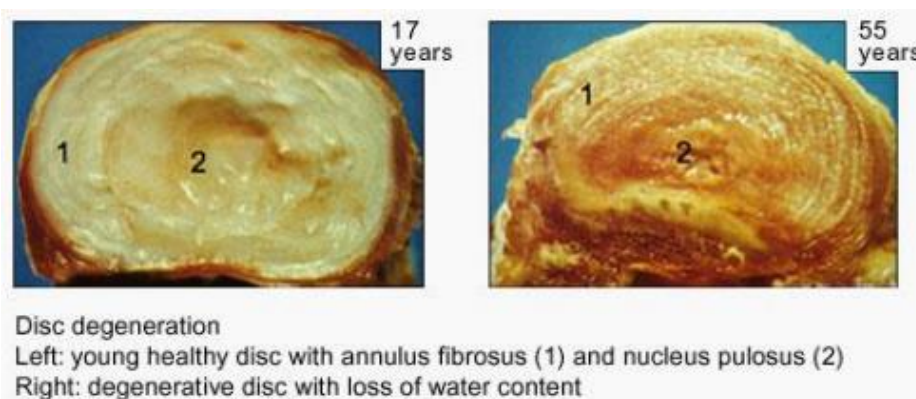
*Physiology:* In an adult body, the nucleus pulposus is located closer to the dorsal margin. The polysaccharides contained in the core can take in fluids in a volume nine times bigger than their own. The volume of the water in the disc is from 70 to 90 per cent and it only decreases after the birth. The lowering of the water causes the decrease of intradiscal pressure. The annulus fibrosus consists of 15 to 25 concentric lamellae. The disc is large and avascular and the number of cells depends on the margins of blood vessels to supply nutrients and remove metabolic waste. In an adult healthy human body, the cartilaginous end plates are completely avascular and aneural. The longitudinal ligaments are supplied with blood vessels. The single disc contains a few blood vessels however, the nerves are present and they mainly terminate in proprioceptors [5]. During the day in standing position of a person, there is an axial pressure caused by the gravity and the muscle tension. The water contained in the pores of the gelatinous nucleus pulposus is squeezed into the vertebral body during the day and this makes the disc narrower in the evening than in the morning (approximately 2 cm). The opposite happens at night when a body

rests in a horizontal position where there is no axial gravity effect on the spine. There is present only the muscle tension which is decreased when a person is unconscious. During the time when a patient is sleeping, the nucleus pulposus has the opportunity to regain the water from vertebral bodies again [3]. Under the load the nucleus pulposus constricts its height but widens to the sides, against the collagen fibres of the annulus fibrosus. The annulus fibrosus extends itself, lowers the pressure, and makes a space for the nucleus pulposus. If forty kilograms are put on a healthy disc, it expands one millimetre vertically and a half millimetre radially [6].

### 3 Pathology Of The Intervertebral Disc

*“One of the primary causes of disc degeneration is thought to be failure of the nutrient supply to the disc cells. Like all cell types, the cells of the disc require nutrients such as glucose and oxygen to remain alive and active. A fall in nutrient supply that leads to a lowering of oxygen tension or of pH could thus affect the ability of disc cells to synthesize and maintain the disc's extracellular matrix and could ultimately lead to disc degeneration”* [5].

The degeneration commonly begins in the midlife. There are the signs of lowering the water content. The posterior part of the annulus fibrosus might show more signs of overuse than the anterior one. If the disc is extremely damaged, it is not clear to differentiate between the border of the annulus fibrosus and nucleus pulposus due to the loss of gelatinous structure and the decrease of hydration in the nucleus pulposus (Fig. 1) [4].



*Figure 1* Comparison of healthy and degenerated disc [7]

There is a limitation of the regeneration of articular cartilage. The irreversible damage can be caused by an irrational and incorrect overload. The following elements might be the potential reasons of a damage as it has been hypothesized: the stress intensity, the number of traumas on the cartilage, structure changes of the collagen and the tissue changes of its mechanical properties. Another crucial aspect is a weight decomposition on the articular surface. Particularly, the joint surface incongruity causes that the connected areas are smaller. This results to an increasing pressure on the surfaces. The stimulation of the loss of collagen structure appears to be a primary factor as well as a loss of cartilage rigidity and permeability increase [4].

### 4 Prolapsed Disc

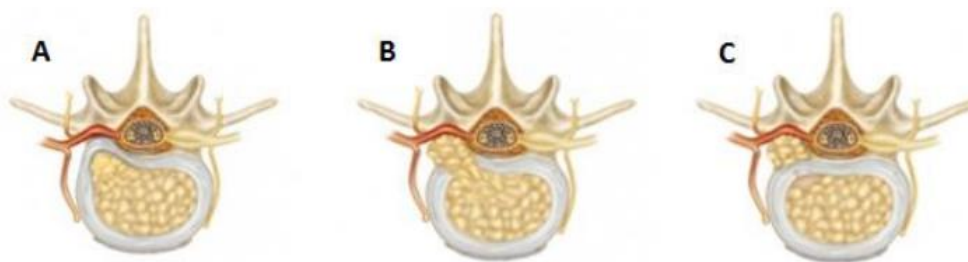
This condition mainly happens when the trunk is flexed and weight is lifted. It only occurs after the degeneration of annulus fibres which starts around the age of 25 or after multiple disc microtraumas. There are three stages of intervertebral disc prolapse formation:

1. The first stage occurs when the trunk is flexed, the discs are flattened on the anterior side, and the posterior margins of the vertebral bodies move away from each other.
2. In the second stage, there the weight is being lifted. Thus, the force of an axial compression increases enormously, the nucleus pulposus is pushed posteriorly until it is pressed in the posterior longitudinal ligament.
3. During the third stage, the acute pain or lumbago appears. When the spine is almost straight, the space created by the nucleus pulposus is closed because of the pressure of the vertebral bodies. The hernia is stuck under the posterior longitudinal ligament.

The pain will disappear by itself or with a medical care, despite that the hernia grows larger with the repetition of traumas until it reaches a nerve root. A common direction of the herniated nucleus pulposus is posterolateral since it is the weakest spot of the posterior longitudinal ligament [3]. If the nucleus pulposus gets through the fibres of the annulus fibrosus, it causes the herniation of disc. Of all the reported cases of disc herniation there are only 3 % in children (as a result of other vertebral illness) and from 30 to 60 % in adults with male domination [8].

*Types of disc prolapse:* The prolapsed (herniated) disc occurs when the annulus fibrosus fails to hold the nucleus pulposus in its place and allows the portion of the annulus pulposus to bulge out or rupture. The

posterolateral direction is more frequent than an anterior. Disc generation precedes the herniation and together with an overload of the back and wrong movement of the spine, the prolapse takes place. There are three types: protrusion, extrusion and sequestration (Fig. 2). The protrusion occurs when the annulus fibrosus holds the nucleus pulposus in a centre of the disc but the vertebral plateaus are dislodged from their staid position under the higher axial pressure and wrong spinal movement. The extrusion happens when the annulus ruptures and allows the nucleus to squeeze out posteriorly until it reaches the posterior longitudinal ligament. The sequestration occurs when the annulus and the posterior longitudinal ligament rupture, the squeezed part of the nucleus separates from the rest of the nucleus and it can get into the spinal canal which often causes nerve irritation. This inhibits a recovery back to normal and the surgery is needed. The subligamental prolapse is caused when the slipped disc reaches the deep surface of the posterior longitudinal ligament and slips either superiorly or inferiorly [3].



Legend: A – protrusion; B – extrusion; C – sequestration

Figure 2 Stages of prolapsed disc [9]

*Symptoms of prolapsed intervertebral disc:* The typical symptoms are a backache and a pain caused along the lower extremity if the nerve root is impaired. A muscle spasm along the spine can be developed. The pain aggravates in a sitting position, and during standing and walking, and it declines in a supine position with bent lower extremities. If there is a damage in an outer fibrous ring, the sudden prolapsed disc is caused by coughing or sneezing. We use a term sciatica if the sciatic nerve is affected. The pain runs down to a thigh, knee, calf and toes [10].

In the report of the journal *Physiotherapy Theory and Practice*, there was a case study of the 49-year old male patient whose MRI showed the disc protrusion between L5/S1 vertebrae with a compression of the L5 nerve root. The patient was complaining about the pain in the lumbosacral region and in the left buttock but he also sensed a numbness and tingling which spread into the left side down to the toes [11].

The spinal stenosis is defined as a narrowed vertebral canal by surrounding tissues and due to a compression of nerve structures it often leads to neurological difficulties. The anatomical changes such as hypertrophy of facet joints, spondylolisthesis or narrowing of the spinal canal can lead to prolapsed disc [12].

## 5 Rehabilitation of disc protrusion

In an acute condition, we firstly approach the conservative therapy which means the prescription of bed rest, correct positioning – lower limbs flexed up to 90 degrees as we want to relax and straighten lumbar spine, to use thermotherapy, soft tissue therapy and a classical massage for reflex muscle spasm relief. Patients also get the medication for analgesia, non-steroid antiflogistics and muscle relaxants. An assistance of a physical therapist is needed so as to teach the patient suitable exercises for strengthening of the axial skeletal muscles. If there, in conservative therapy, is no improvement, the surgical approach is necessary [13].

Another option of therapy is a traction. The easiest way is with a patient lying in a prone position on the bed, we take a firm grip around the patient's ankles. Very important is the intermittent manual traction, the effect of which is localized in a correct area – in this case in a lumbar region. We need to find the appropriate rhythm of pulling back and forth so that the pelvis moves but the lumbar spine stays still. There is no need to use a strong pull.

A patient in an acute condition is not able to lay on his/her stomach. For that reason, a patient lays in a supine position with his/her lower limbs flexed, the pelvis is on the edge of the bed. We place patients' calves on our hips, hold them with our hands and stand close so as our thighs are touching. By erecting our trunk, the patient's pelvis should lift a little. The patient needs to be relaxed, we do that by gentle swinging to the right and left. After we repeat the same process as in a prone position.

The traction by using a post-isometric relaxation is considered a very efficient therapy. The patient lays on his/her stomach, we stand by his/her head and our hands are laid on a patient's backside. We make a resistance

against his/her backside as it moves cranially during the exhale. The relaxation comes during an inhale while the patient's backside moves caudally [14].

*Back school:* The prevention of functional disorders was formed in the second half of the 20<sup>th</sup> century and became worldwide known as "back school". The main conceptions were the medical treatment of back pain and practical advices in everyday life, for example how to stand from a bed, sit correctly, dress up, do domestic chores, stand by the sink, clean or vacuum the floor, mow the grass and others. It is easier to teach correct habits a patient who has back pain than to talk about the prevention with a person who currently does not have any pain. However, he/she is predestined to end up with spine difficulties by their way of life. A patient who suffers from a pain is willing to listen and honestly follow our instructions in order to get better. In other words, our target group is population divided into two groups, the people who suffer from acute or chronic pain and the people who never had backache [15].

The low back pain can begin from raising the intradiscal pressure by compression or lifting heavy objects. Although the disc needs intermittent axial pressure to function properly. The aim of back school is to inform and to teach the population how to avoid the critical motions which increase the intradiscal pressure [16].

## 6 Conclusion

Today, back pain is a common problem and a recent systematic review concludes that the number of patients with the back pain is increasing and it leads to increasing number of people being on sick leave because of the chronic back pain. There is also increasing usage of anti-inflammatory medications all the same. We are able to say, that the chronic back pain has negative influence on the patient's health and psychic, as well as it has substantial social and economic consequences. The fundamental role in the back pain therapy is prevention at all levels - primary, secondary and tertiary. There are many physiotherapeutical concepts dedicated to treat spinal disorders. The concepts include Brunkow exercises method, Mc Kenzie, Klapp method, Schrott method, SM system, Yoga, Pilates and many others.

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