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Pathophysiology and Treatment of Discogenic and Radicular Lower Back Pain

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Keywords: Lower back pain; lumbar disc degeneration; lumbar herniated disc; lumbar radiculopathy; Transforaminal epidural injectionLower back pain affects 80% of the population and the incidence is rising [1]. In fact, lower back pain is the third most common reason to see a physician [2]. The cost of caring for lower back pain in United States is over $100 billion [3], which does not include the indirect cost of the time lost from work. In this article, we will provide a fundamental overview of the pathophysiology and treatment of low back pain.

Pathophysiology of Lower Back Pain

Anatomy and function of the vertebral disc

If you would, imagine the vertebral disc as a tire. The function and anatomy of a vertebral disc correlates well with the composition and purpose of a tire. A tire is composed of rubber on the outside and filled with air on the inside. A vertebral disc has an outer membrane composed of fiber (annulus fibrosus) and inside is a jelly-like substance, instead of air, which is called the nucleus pulposus. The function of a tire is rolling and cushioning. The vertebral disc also functions as a cushion between two vertebral bodies and helps facilitate movement, acting as a hinge. The elements of the spinal column include the vertebral body, vertebral discs, paired facets, pedicles, lamina, spinous and transverse processes, all of which are surrounded by ligaments and muscles for support. Of particular importance are the facets, which under normal circumstances, act to prevent the lumbar segment from moving forward excessively.

Pathophysiology of disc degeneration and facet hypertrophy

Human beings reach peak spinal growth by the age of 30. After the age of 30, our tissues, joints, and discs gradually begin to degenerate. Repetitive chronic shearing or twisting forces can accelerate the process of disc degeneration, resulting in increased laxity, shearing, and tearing of the annulus fibrosis. These degenerative changes ultimately result in weakness of the annulus fibrosus. Certain load bearing activities or maneuvers lead to increases in the intra-disc pressure. Under these conditions, the nucleus pulposus will be pushed through the weak and ruptured annulus like toothpaste. Herniation of the nucleus pulposus most commonly occurs in the direction of the lateral posterior longitudinal ligament, typically resulting in what is referred to as a paracentral herniated disc. This form of herniation can induce foraminal stenosis and resultant nerve root compression. In addition, the leaked nucleus pulposus can trigger an inflammatory cascade. This is because the nucleus pulposus is normally isolated within the vertebral disc, with extravasation after rupture the body recognizes it as a foreign entity. The inflammatory reaction can irritate the nerve root and cause lumbar radiculitis. The ruptured annulus fibrosus results in a void in the surrounding disc space. While the body attempts to repairs this void, the nerve endings from the sinus nerve can grow into the disc through the annulus fibrous gap. This regenerated nerve ending usually lacks a nerve sheath and therefore is very sensitive to chemical (e.g. inflammation) and mechanical (e.g. shearing force from disc) irritation. The pain caused by this regenerated nerve ending is referred to as discogenic back pain.

When the annulus fibrosus tears, the normal hinge motion of the spine is altered. This typically manifests as an increase in the anterior and posterior micromotion of the spine, subsequently irritating the surrounding nerve roots or the regenerated nerve endings inducing further pain. Any additional movement of the vertebrae can increase shearing force to the disc segment, which can cause pressure to the facet joint. To prevent excessive disc movement anteriorly (spondylolisthesis), the facet joint gradually compensates through osteoarthritic changes and hypertrophy. Unfortunately, a hypertrophic facet joint may press upon the exiting nerve root and contribute to worsening foraminal stenosis. Ligamentum flavum hypertrophy is another compensatory mechanism for the degeneration of the spine, but it too can also cause foraminal stenosis (and spinal stenosis). Foraminal stenosis is one of the major causes of lumbar radiculopathy and chronic lower back pain. If these compensatory reactions fail to stabilize the spine, the patient may eventually develop spondylolisthesis. This segmental forward movement of the disc and facets stretches the nerve and may cause nerve damage often seen in chronic lumbar radiculopathy. These pathophysiologic changes are progressive with age or the disease itself. Pain induced by this degenerative process can limit a patient's activity or exercise tolerance, which may result in weight gain and additional strain on the spine: a vicious cycle. The goal of treatment is to break this vicious cycle, relieve pain, and to slow this degeneration.

Non-Surgical treatment of discogenic and radicular lower back pain

During the initial period following an episode of acute back pain and lumbar radiculopathy resulting from lumbar degenerative disc disease or herniated nucleus pulposus, the goal of treatment is to alleviate the pain. Based on the previously illustrated pathophysiology, irritation of the nerve root caused by herniated nucleus pulposus or inflammation can be relieved by transforaminal epidural injection. Precise transforaminal epidural injection will directly deliver the local anesthetic and steroid to the inflamed nerve roots to reduce the pain, diminish the inflammation, and minimize the swelling around the nerve. This targeted injection therapy can significantly decrease the duration of pain and give the patient immediate pain relief. Therefore, the patient can reinitiate lumbar core strengthening exercises while in therapy, return to normal daily activities or the workplace. If an epidural injection is contraindicated, one can use oral medications such as NSAID, oral steroids, or opioid medications to provide relief.

Oral medications may also be used in combination with epidural injections.

Lumbar core-strengthening exercises

As we know, the treatment of a broken bone is internal or external fixation by casting or a surgical procedure. This principle can be used for non-operative treatment of lumbar degenerative disc disease. Managing degenerative disc disease with micromotion is similar to managing an unstable fracture. After relieving the acute pain, lumbar core-strengthening exercises are crucial to restoring functional motion. The strengthened core muscles (lumbar muscles and abdominal muscles) can function as a cast (brace) to stabilize the lumbar column and to prevent further degeneration and recurrence of pain and moreover, this may prevent the need for surgical intervention such as lumbar fusion. These lumbar core-strengthening exercises include swimming, which is tolerated well even in the acute phase because underwater the human body is less affected by the forces of gravity and swimming is typically done in the extended position, which helps build paraspinal musculature. In the acute phase, swimming tends to be less painful than other core strengthening modalities. The patient may prefer walking exercises as a mode of core strengthening. As we know, during the heel strikes, the ground reaction can transmit force to the calf, quadriceps, gluteal muscles and back muscles overall enhancing lumbar core musculature. Walking exercises may be better tolerated after an epidural injection has been performed. Once the patient passes the acute phase, he/she should be encouraged to undergo lumbar core-strengthening exercises with bending, extending, and twisting machines under supervision. Other exercises such as yoga can also increase the core musculature.

Weight reduction

It has been well documented that being overweight can increase the pressure to the disc and weakens the lumbar core musculatures. Therefore, weight reduction is also important for preventing back pain in the overweight patient.

Summary

In summary, understanding the pathophysiology of the lumbar segment can guide our treatment of lower back pain and can shorten the length of treatment, effectively cutting medical costs and more importantly, decrease the patient's suffering therefore improving the patient's quality of life.

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