Introduction

One of the most useful definitions of Lumbar canal stenosis since its description, is being "a disproportion in the spinal canal between the size of the neural elements and the space available." Compression of the thecal sac and its neural contents can cause pain and neural symptoms **(Lohman et al, 2006).**

Degenerative Spinal stenosis is part of the aging process, and predicting who will be affected is not possible. No clear correlation is noted between the symptoms of stenosis and race, occupation, sex, or body type. The degenerative process can be managed, but it cannot be prevented by diet, exercise, or lifestyle **(Kalichman et al, 2009).**

Lumbar stenosis is the result of lumbar spine degeneration and loss of disc elasticity as well as disc herniation, facet hypertrophy, spur formation, spondylosis, thickening of yellow ligament and spondylolisthesis, all impinging on the spinal canal and intervertebral foramen. It can be categorized according to the anatomic area of the spine affected into central or lateral stenosis **(Domagoj et al, 1997).**

The surgical aim of treatment for symptomatic lumbar canal stenosis is relief of symptoms by adequate neural decompression while preserving much of the anatomy and the biomechanical function of the lumbar spine**.**

The concept of classic open decompressive lumbar laminectomy for the treatment of spinal stenosis dates back to 1893 when the procedure was performed by Lane. It is one of the most commonly performed procedures which can be done alone or along with a variety of other procedures such as foraminotomies for affected roots and partial or complete facetectomies. The extent of decompression should be determined according to each affected anatomical site **(Palmer et al, 2002).**

Despite affording a wide decompression, laminectomy or “unroofing” of the spinal canal, Open decompression can cause destruction or impairment, insufficiency of the pars interarticularis or facet joints, resulting in segmental instability and paravertebral muscle atrophy **(Watanabe et al, 2005).**

In particular, spinal instability has been implicated as a cause of surgical failures, because wide decompression significantly alters spinal anatomy and biomechanics, thus prompting many surgeons to perform fusion procedures as an adjuvant treatment for lumbar stenosis. The frequency of fusion surgery has been steadily increasing in the treatment of degenerative lumbar stenosis despite numerous concerns **(Korovessis et al, 2004)**.

In recent years limited opening in the spinal canal has increased in popularity. Single level or multilevel bilateral fenestration procedures constitute the major alternative to decompressive laminectomy for the treatment of multilevel lumbar spinal stenosis **(Young et al, 1988).** In 1991 McCulloch modified microsurgical fenestration as described by Young et al, and devised Microscopic Bilateral Decompression through a unilateral approach as a less invasive technique **(McCulloch et al, 1991).**

Implantation with a minimally invasive interspinous spacer is an alternative treatment option for patients with mild to moderate neurogenic intermittent claudication secondary to Lumbar Spinal Stenosis. Although use of interspinous spacers dates back to the

1950s, frequent dislodgements caused these devices to largely fall out of favor until the last decade (**Sobottke et al, 2009).**

Microdecompression techniques may effectively reduce unnecessary tissue damage, and therefore, decrease the incidence of the complications. Fenestration with minimal soft tissue dissection and limited bone removal instead of extensive laminectomy to prevent subsequent lumbar instability has become widely accepted for the treatment of spinal stenosis. **(Guiot et al, 2002).**

Aim of the work

This study aims at reviewing the different modalities in Surgical Management of Lumbar Canal Stenosis by comparison of Microdecompression and Decompressive Laminectomy via prospective study in patients who suffer from lumbar canal stenosis with back pain and/or claudication pain or sciatica after failure of medical treatment.

Anatomy of the Lumbar Spine

The anatomy of the lumbar spine consists of a remarkable combination of five moveable strong vertebrae, with multiple bony elements linked by joint capsules, and flexible ligaments, large muscles, and highly sensitive nerves. It has also a complicated vascular and nerve supply. The lumbar vertebrae, numbered L1 to L5, have a vertical height that is less than their horizontal diameter. They are composed of three functional parts: the vertebral body, the vertebral arch, and the bony processes (spinous and transverse) **(Drake et al., 2009).**

Bony structures:

The lumbar vertebral bodies can be distinguished from the thoracic bodies by being larger and by lacking the rib facets. The lumbar vertebrae are connected together by the intervertebral discs. The size of the vertebral body increases from L1 to L5, which indicate the increasing loads that each lumbar vertebra absorbs while descending lower. L5 vertebra has the heaviest body, smallest spinous process, and thickest transverse process **(Moore et al., 2006).**

The surface of the intervertebral disc of an adult vertebra contains a ring of cortical bone peripherally named the epiphyseal ring which acts as a growth zone in the young while attaching the annular fibers in adults. A hyaline cartilage plate lies within the limits of this epiphyseal ring **(Devereaux, 2007).**

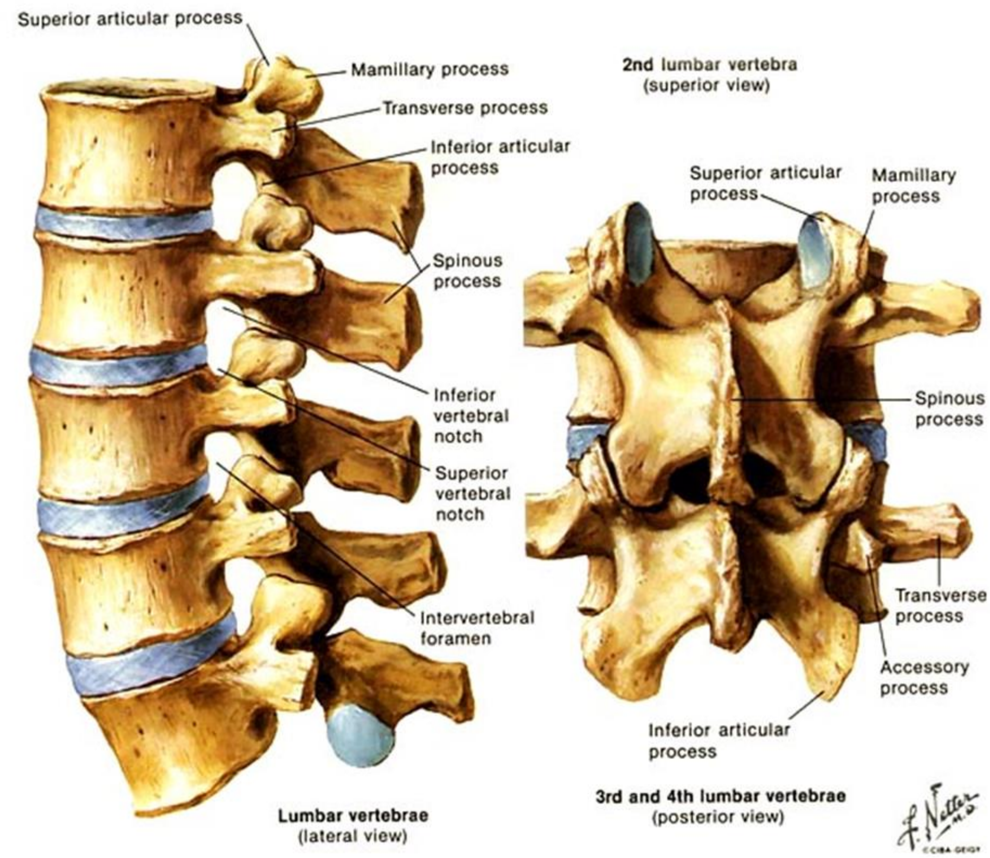

Figure (1): The lumbar vertebrae from lateral and posterior views **(Netter, 2014).**

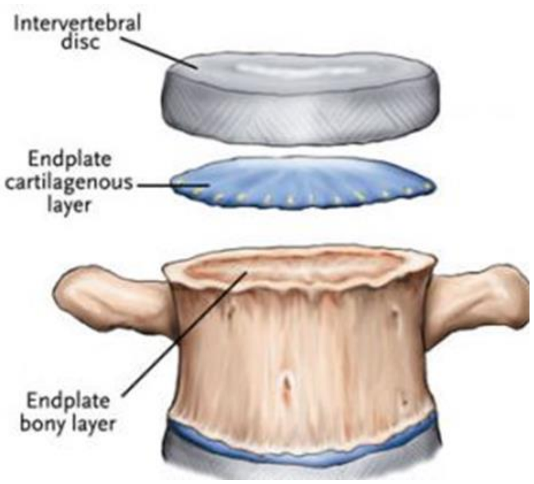

Figure (2): The junction of the vertebral endplate with the intervertebral disc **(Devereaux, 2007).**

The vertebral arch is composed of 2 pedicles, 2 laminae, and 7 different bony processes (1 spinous, 4 articular, 2 transverse), connected together by ligaments and facet joints. The pedicle is a strong bony structure that directed posteriorly, joins the arch to the posterolateral body. It is attached to the cephalad portion of the body and act as a protective cover for the cauda equina contents. The concavities in both the cranial and caudal surfaces of the pedicle represent the vertebral notches. The broad and strong laminae are the plates that extend postero-medially from the pedicle. The spinous processes are directed posteriorly from the union of the laminae **(Drake et al., 2009).**

The two superior (directed posteromedially) and inferior (directed anterolaterally) articular processes, termed Superior Articular Process and Inferior Articular Process, respectively, extend cranially and caudally from the point where the pedicles and laminae join. Between the superior and inferior articular processes, two long, slender, and strong transverse processes are projected laterally. They have an upper tubercle at the junction with the superior articular process (mammillary process) and an inferior tubercle at the base of the process (accessory process). These bony protuberances are the sites for attachment of deep muscles of the back. The lumbar spine has an anterior, middle, and posterior columns that are susceptible for fractures **(Moore et al., 2006).**

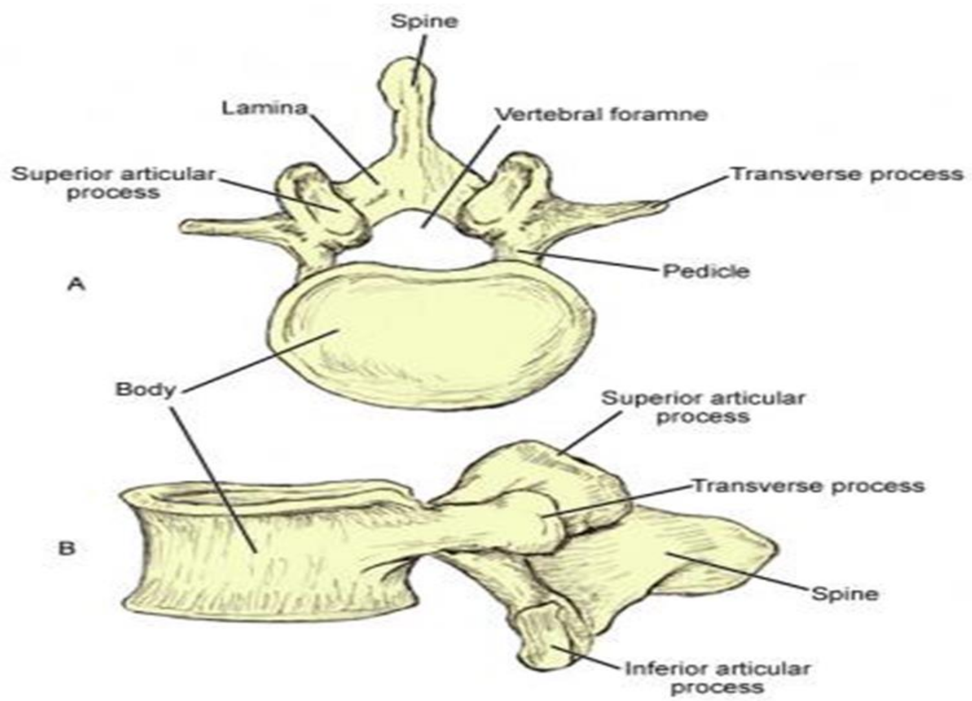

Figure (3): The vertebral arch with its components merged with the vertebral body **(Drake et al., 2009).**

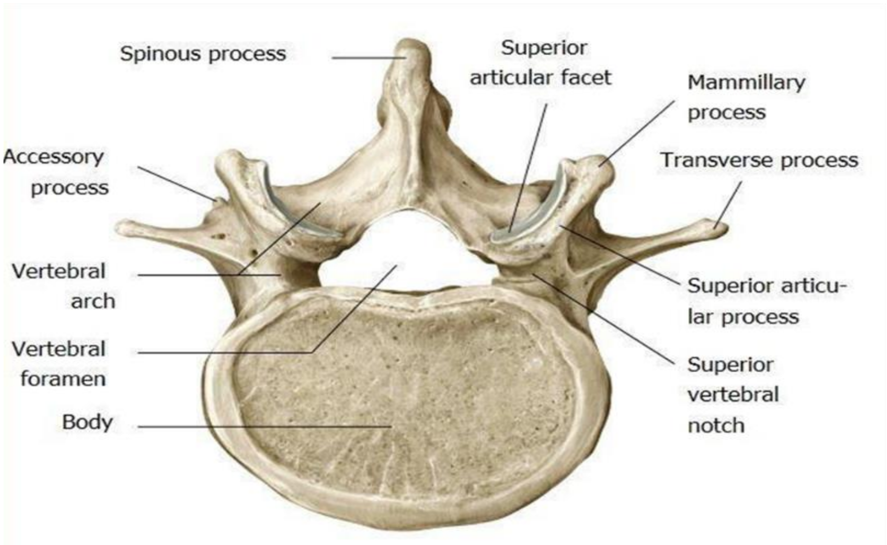

Figure (4): Lumbar vertebrae from above, showing the superior articular process, Mammillary and Accessory processes **(Moore et al., 2006).**

Lumbar vertebral joints

The vertebral column mobility is provided by the symphyseal joints between the vertebral bodies which is formed by a layer of hyaline cartilage on each vertebral body and an intervertebral disc between the layers. The synovial joints between the superior and inferior articular processes on adjacent vertebrae are named the facet joints (also known as zygapophyseal joints or Z -joints) which allow simple gliding movements. The movement of the lumbar spine is largely confined to flexion and extension with a minimal degree of rotation. The pars interarticularis is the region between the superior articular process and the lamina. The facet or zygapophyseal joints are in a parasagittal plane. When viewed in an oblique projection, the outline of the facets and the pars interarticularis appear like the neck of a Scottie dog **(Drake et al., 2009).**

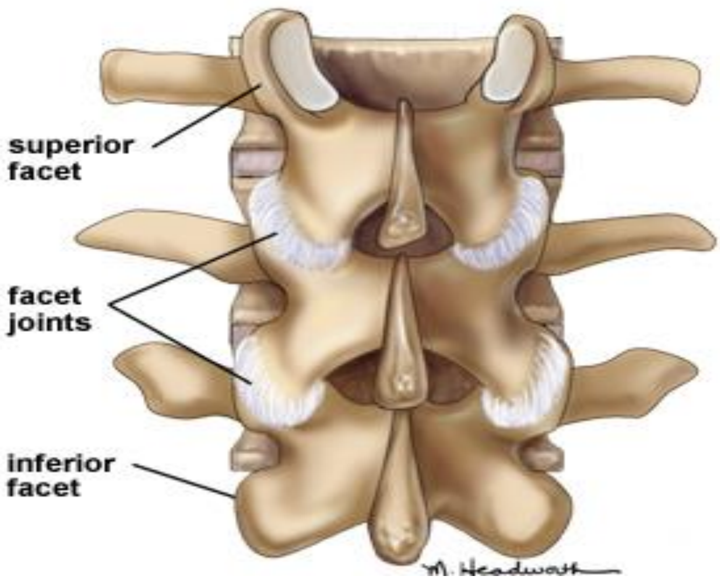

Figure (5): The superior and inferior facets connect each vertebrae together. There are four facet joints associated with each vertebrae **(Hines, 2013).**

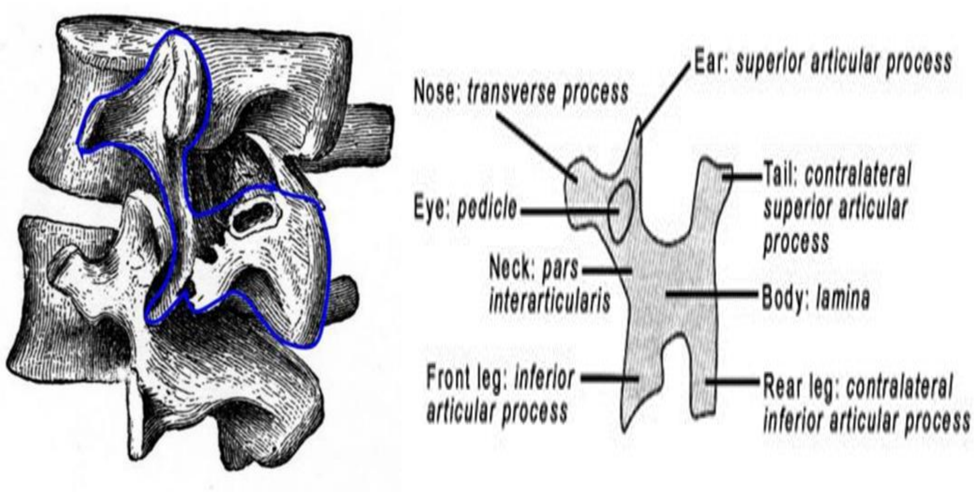

Figure (6): (Left) Oblique view of the facet joints showing the Scottie dog appearance. **(Right)** Diagram defines the parts forming the Scottie dog **(Kirkaldy-Willis et al., 1999).**

Lumbar intervertebral discs

The intervertebral discs are the main connection between the vertebrae. During axial compression, the discs bear loading, and they also allow movement between the vertebrae. Their size varies according to the adjacent vertebrae size and comprises approximately one quarter the length of the vertebral column. Each disc consists of a central but slightly posterior mucoid substance termed the nucleus pulposus, embedded with reticular and collagenous fibers, and surrounded by the annulus fibrosus, which is a fibrocartilaginous lamina **(Drake et al., 2009).**

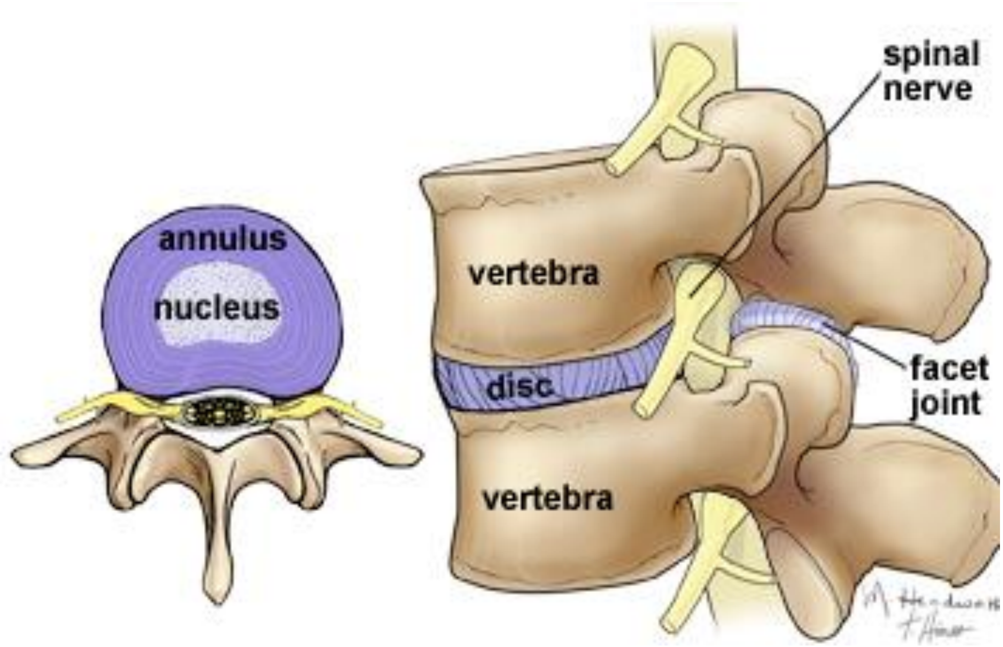

Figure (7): The intervertebral disc consists of inner nucleus pulposus and outer annulus fibrosus **(Hines, 2013).**

The annulus fibrosus is divided into 3 parts: the outermost, middle, and innermost fibers. The anterior fibers are strengthened by the strong anterior longitudinal ligament (ALL). The posterior longitudinal ligament (PLL) is a narrow structure attached to the annulus that affords just a weak midline reinforcement, especially at L4-5 and L5-S1 levels. The anterior and middle fibers of the annulus are most numerous anteriorly and laterally but deficient posteriorly. The annular fibers are firmly attached to the vertebral bodies and are arranged in lamellae. This arrangement helps in limiting the vertebral movements, and this is reinforced by the surrounding ligaments **(Drake et al., 2009).**

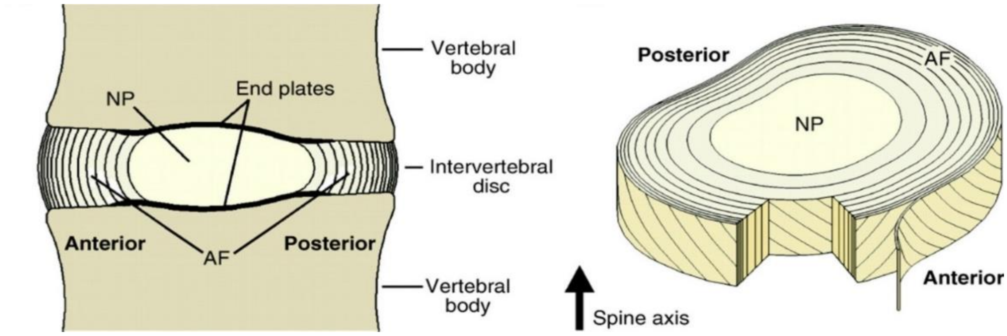

Figure (8): Lamellae of the intervertebral disc **(Lachlan et al., 2011)**

The disc is avascular structure that receives most of its nutrition by diffusion that is facilitated by spinal motion, and mostly supplied via the capillary beds of the cartilaginous end plate that receive blood supply from the distal branches of the interosseous arteries supplying the vertebral bodies. The area around the disc space is innervated by a meningeal branch of the spinal nerve, known as the recurrent sinuvertebral nerve **(Martin et al., 2002).** Degenerated lumbar discs have been shown to be more vascular and contain more nerve tissue than normal discs **(Coppes et al., 1997).**

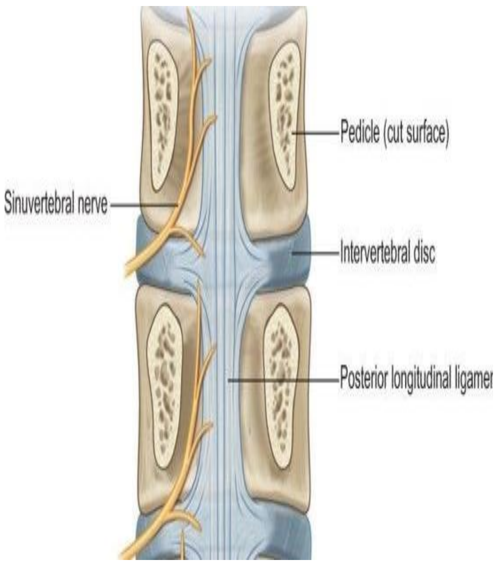

Figure (9): The course and skeletal distribution of the lumbar sinuvertebral nerves. Each nerve supplies the intervertebral disc at its level of entry into the vertebral canal, the disc above, and the intervening posterior longitudinal ligament. In about one-third of cases, the nerve at a particular level may be represented by more than one filament (**Lachlan et al., 2011).**

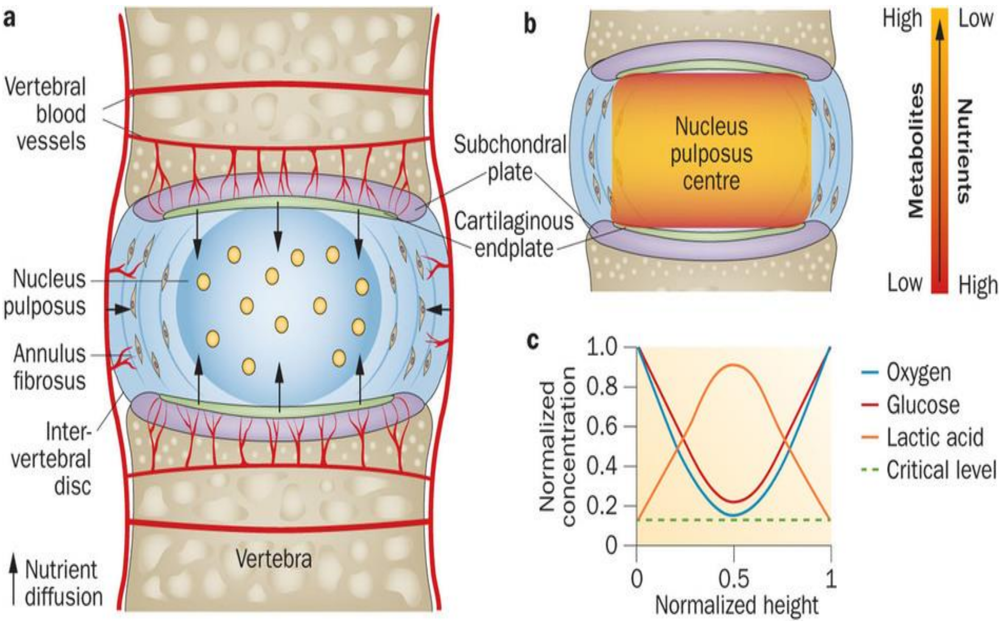

Figure (10): a | Cells of the nucleus pulposus and inner annulus fibrosus are supplied by vertebral blood vessels. Capillaries penetrate the subchondral plate through marrow spaces and terminate in loops at the junction of the subchondral plate and cartilaginous endplate. Nutrients (e.g. oxygen and glucose) diffuse from the capillary bed through the cartilaginous endplate under gradients arising from metabolic demands of disc cells, while metabolic wastes (e.g. lactic acid) diffuse in the reverse direction. Cells of the outer annulus fibrosus are supplied by capillaries from blood vessels in the surrounding soft tissues that penetrate a few millimetres into the disc. **b** | The center of the disc has the lowest levels of nutrients and highest concentration of metabolites. **c** | Schematic showing normalized concentration gradients of glucose, oxygen and lactic acid across the nucleus, endplate–endplate. Nutrient concentrations should be maintained above the critical levels to keep cell viability and activity **(Yong-Can et al., 2014).**

Lumbar vertebral ligaments

1-**The Anterior Longitudinal Ligament (ALL)** covers the ventral surfaces of lumbar vertebral bodies and the intervertebral discs. It is firmly attached to the anterior annular disc fibers and widens as it descends the vertebral column. The ALL preserves the stability of the joints and limits extension.

2- **The Posterior Longitudinal Ligament (PLL)** is located within the vertebral canal covering the posterior surface of the vertebral bodies and intervertebral discs. It functions to limit flexion of the vertebral column, except at the lower lumbar spine, where it becomes narrow and weak.

3- **The Supraspinous Ligament** joins the tips of the spinous processes of adjacent vertebrae from L1 to L3.

4- **The Interspinous Ligament** interconnects the spinous processes, from root to apex of adjacent processes. Sometimes described together as the interspinous/supraspinous ligament complex, they resist spinal separation and flexion within limits.

5- **The Ligamentum Flavum (LF)** covers the interlaminar interval, attaching to the interspinous ligament medially and the facet capsule laterally, forming the posterior wall of the vertebral canal. It has a broad attachment to the undersurface of superior lamina and inserts into the upper edge of the inferior lamina. Normally, the ligament is tight, stretching for flexion and contracting its elastin fibers in neutral position or in extension. It preserves constant disc tension.

6- **The Intertransverse Ligament** joins the transverse processes of adjacent vertebrae and resists lateral bending of the trunk.

7- **The Iliolumbar Ligament** arises from the tip of the L5 transverse process and connects to the posterior part of the inner lip of the iliac crest. It helps the lateral lumbosacral ligament and the other mentioned ligaments to stabilize the lumbosacral joint. **(Drake et al., 2009).**

Figure (11): Diagram showing the lumber vertebral ligaments **(Drake et al., 2009).**

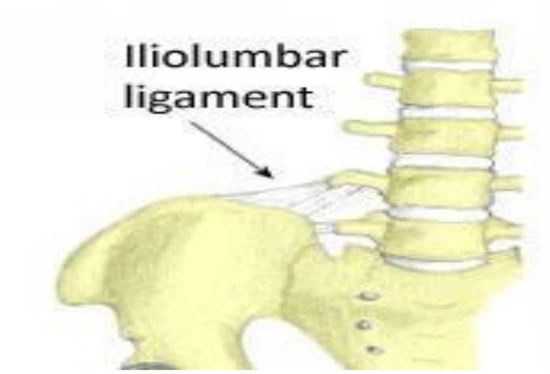

Figure (12): The iliolumbar ligament arises from L5 transverse process to the iliac crest **(Drake et al., 2009).**