بسم الله الرحمن الرحيم

Sudan University For Science and Technology

College of Graduate Studies

Characterization of Lumbar Degenerative Disc Disease in Patients with Lower Back Pain using Magnetic Resonance Imaging

توصيف مرض تآكل الأقراص القطنية في مرضى آلآم أسفل الظهر باستخدام التصوير بالرنين المغنطيسي

A Thesis Submitted for Partial Fulfilment of M.SC Degree in Diagnostic Radiologic Imaging

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الآية

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﴿ (الرَّحْمَنُ (1) عَلَّمَ الْقُرْآنَ (2) خَلَقَ الإِنْسَانَ (3)
عَلَّمَهُ الْبَيَانَ (4))

(صدق الله العظيم)

(سورة الرحمن 1-4)

Dedication

To my family and friends.

Acknowledgment

Firstly I thank Allah for helping me to complete this research, the thank also to my superviser, the families of Antalya & Alnilein medical centers , Dr. Sami ahmed abdalgadir consultant radiologist in Aliaa specialized hospital and to all who support me to accompolish this research.

Abstract

The purpose of this study was to characterize the lumbar degenerative disc disease in patients with lower back pain by using MRI depending on pfirrmann's grading system. The data collected from Antalya medical diagnostic centre in Khartoum state from march 2016 to august 2016. The MRI machine used in this study was general electric (GE) 1.5 tesla and the protocol used was sagittal T2. The number of patients in this study were 35 (22 females & 13 males) and the mean age was 46.2

After tabulating and analizing the collected data we found that the females are more affected with lumbar degenerative disc disease (62.9%) than males (37.1%), and the most affected ages were the persons at the ranges of (40 – 49) and (50 – 59) . The most affected persons were the housekeepers (37.1%), employees (11.4%) then teachers and farmers (8.6%) for both. The smoking percentage was 5.7%. According to analization of 175 lumbar discs for 35 patients depending on pfirrmann's grading system the results were: grade I has 6 disc (3.4%), grade II has 85 discs (48.6%), grade III has 56 discs (32%), grade IV has 22 discs (12.6%), grade V has 6 discs (3.4%). The degeneration of disc being considered starting from the 3rd degree including the 4th, and 5th degrees; and accordingly the study prove that most discs (56 disc from 175) is affected by 3rd degree representing 32%. We prove that the most affected lumbar discs with degeneration disease were the fourth and fifth (68.6% and 74.3%) of patients respectively.

الخلاصة

الغرض من هذه الدراسة هو وصف مرض تآكل الأقراص القطنية في المرضى الذين يعانون من آلام أسفل الظهر بواسطة إستخدام الرنين المغنطسي وبالإعتماد على نظام فيرمان في وصف تدرج تآكل الأقراص. تم جمع البيانات من مركز أنطاليا للتشخيص الطبي بولاية الخرطوم وذلك في الفترة من مارس 2016م حتى أغسطس 2016م. جهاز الرنين المغنطيسي المستخدم في الدراسة هو جهاز جنرال الكتريك وقوته المغنطيسية 1.5 تسلا والبروتوكول المستخدم هو زمن الإسترخاء العرضي. عدد المرضي في هذه الدراسة 35 مريضا (22 أنثى و 13 ذكر) ومتوسط العمر هو 46.2

بعد جدولة البيانات وتحليلها وجد أن الإناث أكثر تأثرا من الرجال بمرض تآكل الأقراص القطنية بنسبة 62.9% للإناث و 37.1% للذكور، وأكثر الأعمار تاثرا هم الأشخاص في الفئتين العمريتين (40 – 49) و (50 – 59). وأكثر الأشخاص تاثرا هن ربات البيوت بنسبة 37.1% يليهم الموظفين بنسبة 11.4% ثم المعلمين والمزارعين بنسبة 8.6% لكل منهما. نسبة التدخين كانت 5.7%. وفقا لتحليل 175 قرص قطني وذلك بالإعتماد على نظام فيرمان لوصف تدرج تآكل الأقراص كانت النتائج كالآتي: الدرجة الأولى تحوي 6 أقراص (3.4%)، الدرجة الثانية تحوي 85 قرص (48.6%)، الدرجة الثالثة تحوي 56 قرص (32%)، الدرجة الرابعة تحوي 22 قرص (12.6%)، الدرجة الخامسة تحوي 6 أقراص (3.4%). يكون تآكل الاقراص معتبرا إبتداءً من الدرجة الثالثة شاملاً الرابعة والخامسة، وقد أثبتت الدراسة أن الدرجة الثالثة من التاكل بها أكثر الأقراص (56 فقرة من مجموع 175 فقرة) بنسبة 32%. الدراسة أثبتت أن أكثر الأقراص القطنية تاثرا بالتآكل المرضي هما القرصان الخامس بنسبة 68.6% من مجموع المرضى ثم يليه الرابعة بنسبة 74.3 من مجموع المرضى.

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List of abbreviations

AP	Accessory process
C1	First cervical vertebra
C2	Second cervical vertebra
C7	Seventh cervical vertebra
DDD	Degenerative disc disease
GE	General electric
IAF	Inferior articular facet
IAP	Inferior articular process
L	Lamina
LDDD	Lumbar degenerative disc disease
L1	First lumbar vertebra
L5	Fifth lumbar vertebra
MRI	Magnetic resonance imaging
MSEC	Millisecond
MP	Mammillary process
NA	Neural arch
P	Pedicle
S(1-5)	Sacrum from first segment to fifth segment
SAF	Superior articular facet
SAP	Superior articular process
SP	Spinous process
T1	First thoracic vertebra / longitudinal relaxation time
T2	Transversal relaxation time
T12	Twelfth thoracic vertebra
T1W	T1 weighted
T2W	T2 weighted
TP	Transverse process
VF	Vertebral foramen
VB	Vertebral body

Chapter one

Introduction

1.1 Introduction :

The vertebral column is a remarkable structure that supports the weight of the body, helps to maintain posture and protects the delicate spinal cord and nerves. It is made up of 33 vertebrae, which can be separated into cervical, thoracic, lumbar, sacral and coccygeal sections. (Kelley & petersoen.2007).

The vertebral bodies are separated by shock-absorbing cartilaginous intervertebral discs . these discs consist of a central mass of soft semigelatinous material called the nucleus pulposus and a firm outer portion termed the annulus fibrosus.(Kelley & Peterson.2007).

The intervertebral disc is a highly specialized structure working as a fixed cushion that resists loads and allows controlled movement between vertebrae.(pinheiro-franco et al. 2016)

The major signs of degenerative disc disease on radiograph are disc space narrowing , sclerosis of the vertebral end plates and osteophytes. Computed tomography is more accurate in the morphological evaluation of spinal bony structure.(pinheiro-franco et al. 2016)

Magnetic resonance imaging is the modality of choice for the evaluation of the degenerative spine, as it allows an analysis of the disc, bone marrow, and facet changes as well as structures that might be injured secondary to degenerative changes such as nerve roots and muscles. (pinheiro-franco et al. 2016)

On longitudinal relaxation time (T1) - and transversal relaxation time (T2)-weighted magnetic resonance imaging, the signal of the normal intervertebral disc is, respectively, lower and higher than that of the vertebral body; the high signal is related to bounded water by the proteoglycans of the nucleus pulposus. According to pfirrmann et al, five grades can be described for lumbar disk degeneration on T2- weighted magnetic resonance imaging. (pinheiro-franco et al. 2016)

Lumbar degenerative disc disease (DDD), is intimately related to aging and oftentimes may not be symptomatic. Low back pain (LBP) due to degenerative disc disease is often referred in the nomenclature as “non specific low back pain” differentiating it from specific, example., tumoral, infectious, inflammatory, and traumatic, causes of low back pain. (pinheiro-franco et al. 2016).

The literature suggests that discogenic low back pain is worse with sitting, flexion, and rotational forces. Discogenic pain may be alleviated with lying or standing. (pinheiro-franco et al. 2016).

1.2 Problem of the study :

Lumbar Degenerative disc disease is one of the most misunderstood diseases, magnetic resonance imaging MRI can help in diagnosis .

1.3 Objectives of the study:

1.3.1 General objective :

To characterize lumbar degenerative disc disease LDDD in patients with lower back pain by pfirrmann’s grading system using magnetic resonance imaging MRI .

1.3.2 Specific objectives :

1- highlighting the role of MRI in diagnosing lumbar degenerative disc disease.

2- correlation the lumbar degenerative disc disease to gender.

3- correlation the lumbar degenerative disc disease to age.

4- correlation the lumbar degenerative disc disease to occupation.

5- correlation the lumbar degenerative disc disease to smoking.

1.4 Overview of the study :

The study is divided into five chapters :

Chapter one : general introduction and proposal .

Chapter two : theoretical background and literature review .

Chapter three: methods and materials .

Chapter four: results .

Chapter five: discussion, conclusion, recommendations, references and appendices.

Chapter tow

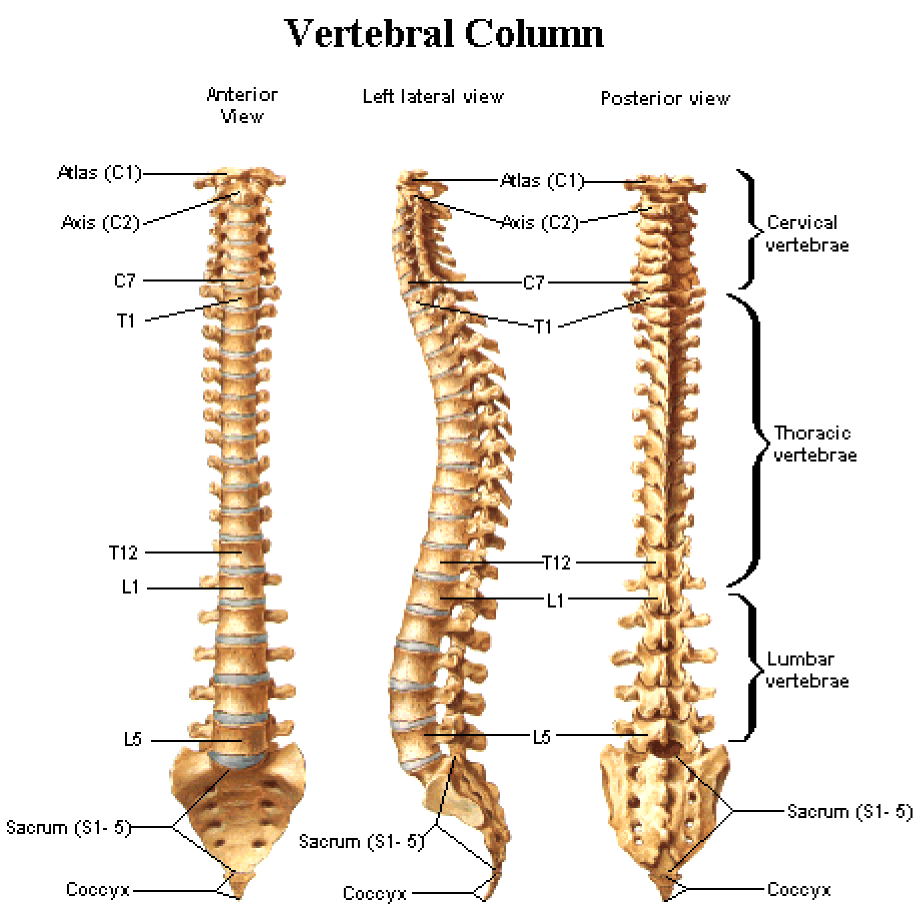
Literature Review

Literature review

2.1:Theoretical background:

2.1.1: Anatomy:

The lumbar vertebral column consists of five separate vertebrae, which are named according to their location in the intact column (figure 2.1). From above downwards they are named as the first, second, third, fourth and fifth lumbar vertebrae.(Bogduk, 2005)



www.matabkadeh.com. {accessed at 8-11-2018}

Figure 2.1: vertebral column

2.1.1.1: A typical lumbar vertebra:

The lumbar vertebrae are irregular bones consisting of various named parts (Fig. .2.2). The anterior part of each vertebra is a large block of bone called the vertebral body. The vertebral body is more or less box shaped, with essentially flat top and bottom surfaces, and Viewed from above or below the vertebral body has a curved perimeter that is more or less kidney shaped. The posterior surface of the body is essentially flat but is obscured from thorough inspection by the posterior elements of the vertebra. (Bogduk, 2005)

Projecting from the back of the vertebral body are two stout pillars of bone. Each of these is called a pedicle. It can be seen that attached to the back of the vertebral body is an arch of bone, the neural arch, so called because it surrounds the neural elements that pass through the vertebral column. (Bogduk, 2005)

. Projecting from each pedicle towards the midline is a sheet of bone called the lamina. . The two laminae meet and fuse with one another in the midline.

The inferolateral corner and inferior border of each lamina are extended and enlarged into a specialised mass of bone called the inferior articular process. A similar mass of bone extends upwards from the junction of the lamina with the pedicle, to form the superior articular process. (Bogduk, 2005)

Each vertebra thus presents four articular processes: a right and left inferior articular process; and a right and left superior articular process. On the medial surface of each superior articular process and on the lateral surface of each inferior articular process there is a smooth area of bone which in the intact spine is covered by articular cartilage. This area is known as the articular facet of each articular process. (Bogduk, 2005)

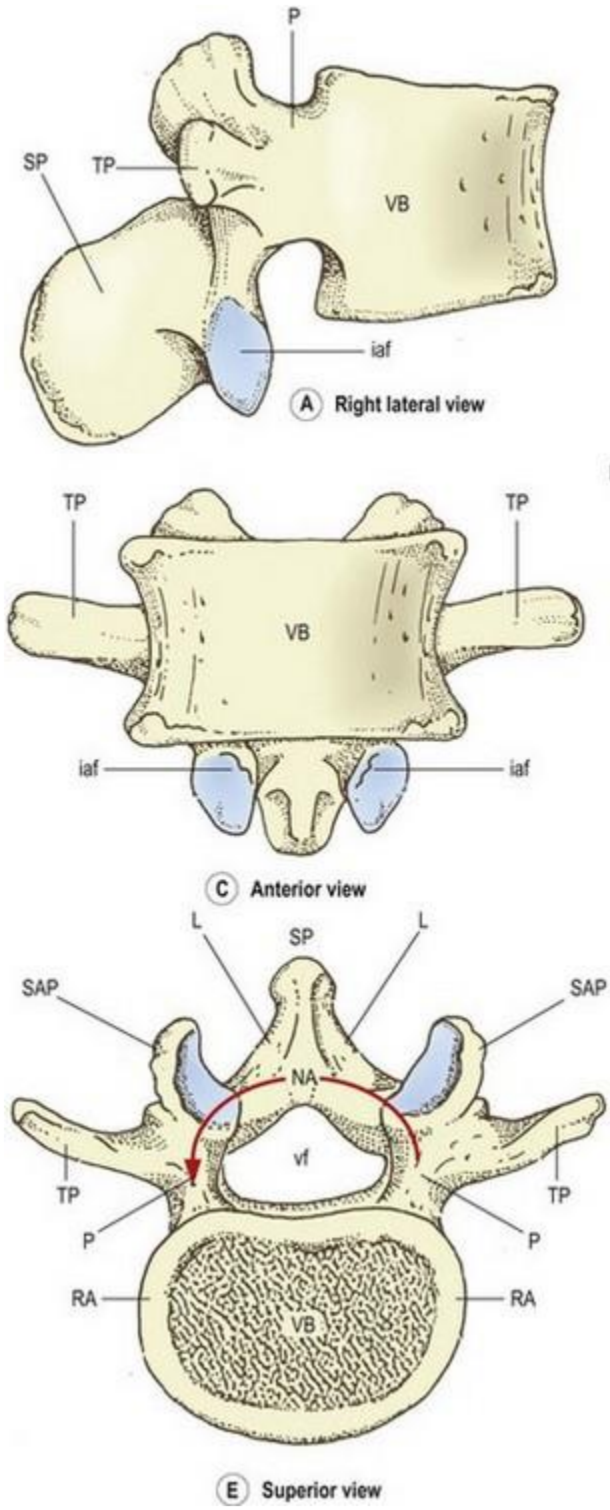


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Figure 2.2:The parts of a typical lumbar vertebra: AP, accessory process; iaf, inferior articular facet; IAP, inferior articular process; L, lamina; MP, mamillary process; NA, neural arch; P,

pedicle; RA, ring apophysis; saf, superior articular facet; SAP, superior articular process; SP, spinous process; TP, transverse process; VB, vertebral body; vf, vertebral foramen.

Projecting posteriorly from the junction of the two laminae is a narrow blade of bone which in a side view resembles the blade of an axe. This is the spinous Process. (Bogduk, 2005)

Extending laterally from the junction of the pedicle and the lamina, on each Side, is a flat, rectangular bar of bone called the transverse process. Near its attachment to the pedicle, each transverse process bears on its posterior surface a small, irregular bony prominence called the accessory process. Accessory processes vary in form and size from a simple bump on the back of the transverse process to a more pronounced mass of bone, or a definitive pointed projection of variable length It is most evident if the vertebra is viewed from behind and from below (Fig. 2.2D, F). (Bogduk, 2005)

Close inspection of the posterior edge of each of the superior articular processes reveals another small bump, distinguishable from its surroundings by its smoothness, called the mamillary process. it Lies just above and slightly medial to the accessory process, and the two processes are separated by a notch, of variable depth, that may be referred to as the mamilla-accessory notch. (Bogduk, 2005)

The other named features of the lumbar vertebrae are not bony parts but spaces and notches. Viewing a vertebra from above, it can be seen that the neural arch and the back of the vertebral body surround a space. This space is the vertebral foramen, which amongst other things transmits the nervous structures enclosed by the vertebral column. (Bogduk, 2005)

In a side view, two notches can be recognised above and below each pedicle. The superior notch is small , The inferior notch is deeper and more pronounced. when consecutive lumbar vertebrae are articulated the superior and inferior notches face one another and form most of what is known as the intervertebral foramen. (Bogduk, 2005)

2.1.1.2 The intervertebral joints:

When any two consecutive lumbar vertebrae are articulated, they form three joints. One is formed between the two vertebral bodies. The other two are formed by the articulation of the superior articular process of one vertebra with the inferior articular processes of the vertebra above . (Bogduk, 2005)

The joints between the articular processes have an 'official' name. Each is known as a zygapophysial joint ' Individual zygapophysial joints can be specified by using the adjectives 'left' or 'right' and the numbers of the vertebrae involved in the formation of the joint. For example, the left L3-4 zygapophysial joint refers to the joint on the left, formed between the third and fourth lumbar vertebrae.

Other names used for the zygapophysial joints are 'apophysial' joints and 'facet' joints. (Bogduk, 2005)

A joint could be formed simply by resting two consecutive vertebral bodies on top of one another. An alternative modification, and the one that occurs in humans and most mammals, is to interpose between the vertebral bodies a layer of strong but deformable soft tissue. This soft tissue is provided in the form of the intervertebral disc. The foremost effect of an intervertebral disc is to separate two vertebral bodies. (Bogduk, 2005)

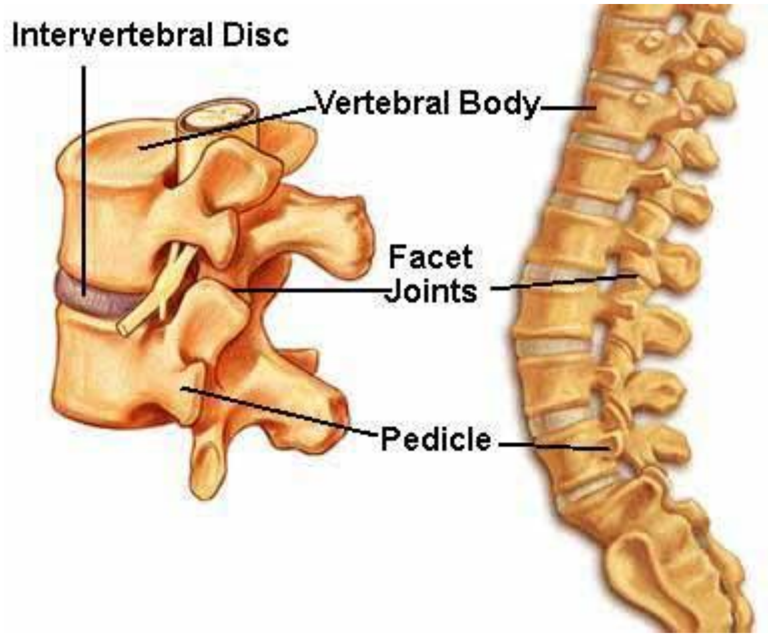

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Figure 2.3: the joints between two lumbar vertebrae

2.1.1.3: Structure of the intervertebral disc:

Each intervertebral disc consists of two basic components: a central nucleus pulposus surrounded by a peripheral anulus fibrosus. Although the nucleus pulposus is quite distinct in the centre of the disc, and the anulus fibrosus is distinct at its periphery, there is no clear boundary between the nucleus and the annulus within the disc, Rather, the peripheral parts of the nucleus pulposus merge with the deeper parts of the anulus fibrosus. A third component of the intervertebral disc comprises two layers of cartilage which cover the top and bottom aspects of each disc. Each is called a vertebral endplate. (Bogduk, 2005)

The vertebral endplales separate the disc from the adjacent vertebral bodies, and it is debatable whether the endplates are strictly components of the disc or whether they actually belong to the respective vertebral bodies. (Bogduk, 2005)

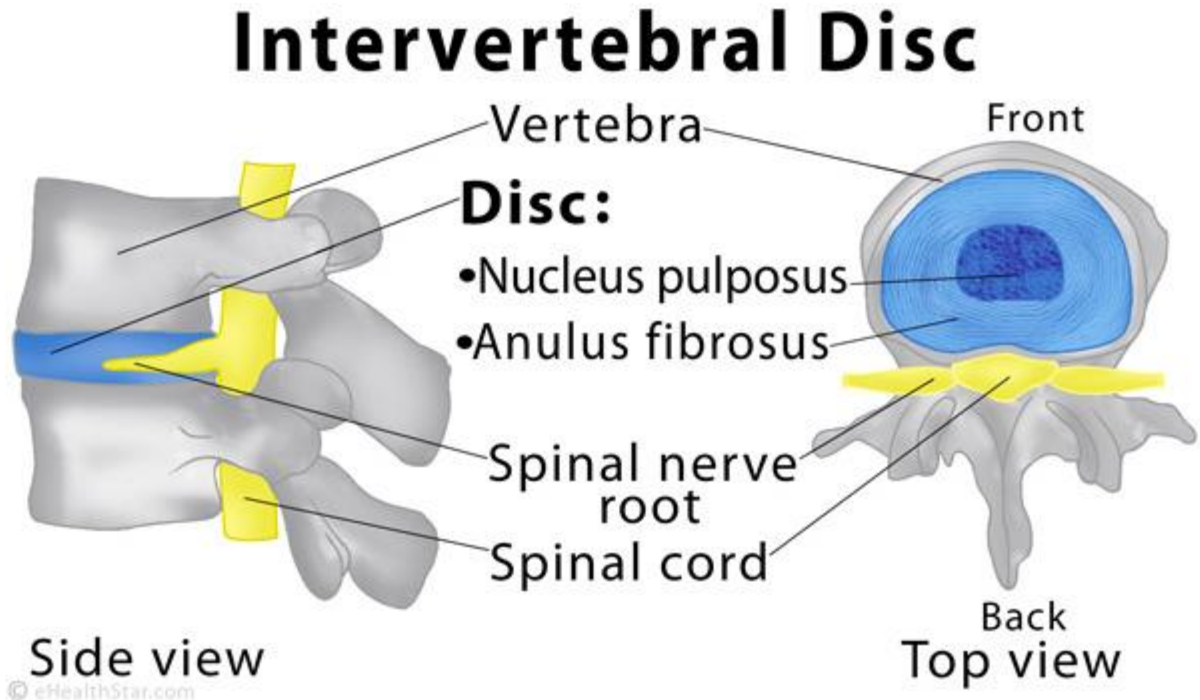

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Figure 2.4: intervertebral disc

2.1.1.3.1 Nucleus pulposus:

In typical, healthy, intervertebral discs of young adults, the nucleus pulposus is a semifluid mass of mucoid material (with the consistency, more or less, of toothpaste). (Bogduk, 2005)

Histologically, it consists of a few cartilage cells and some irregularly arranged collagen fibres, dispersed in a medium of semifluid ground substance. Biomechanically, the fluid nature of the nucleus pulposus allows it to be deformed under pressure, but as a fluid its volume cannot be compressed. if subjected to pressure from any direction, the nucleus will attempt to deform and will thereby transmit the applied pressure in all directions. A suitable analogy is a balloon filled with water. Compression of the balloon deforms it; pressu in the balloon rises and stretches the walls of the balloon in all directions. (Bogduk, 2005)1

2.1.1.3.2 Anulus fibrosus:

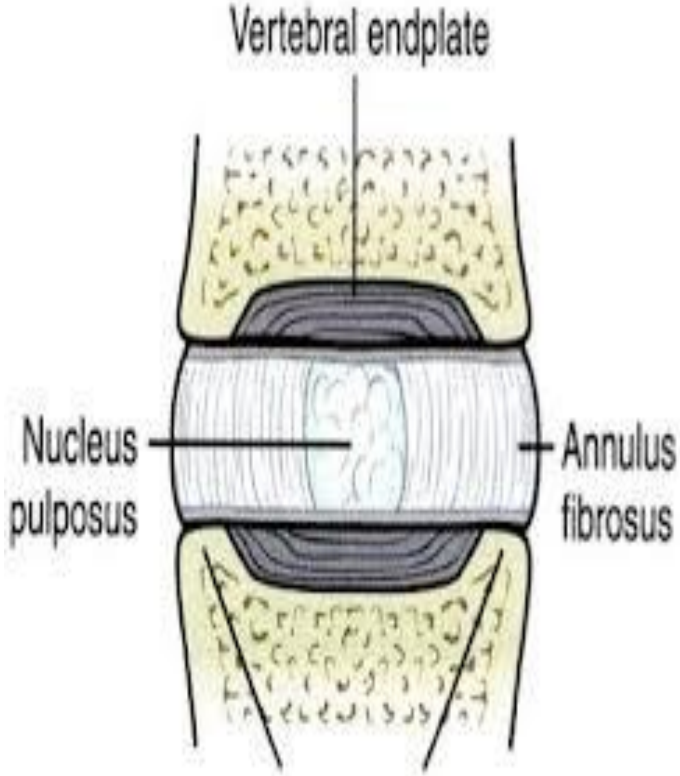
The anulus fibrosus consists of collagen fibres arranged in a highly ordered pattern. Foremost, the collagen fibres are arranged in between 10 and 20 Sheets called lamellae (from the Latin lamella meaning little leaf). The lamellae are arranged in concentric rings which surround the nucleus pulposus. (Bogduk, 2005)

The lamellae are thicker towards the centre of the disc; they are thick in the anterior and lateral portions of the anulus but posteriorly they are finer and more tightly packed. Consequently the posterior portion of the anulus fibrosus is thinner than the rest of the anulus. Within each lamella, the collagen fibres lie parallel to one another, passing from the vertebra above to the vertebra below. (Bogduk, 2005)

2.1.1.3.3 Vertebral endplates :

Each vertebral end plate is a layer of cartilage about 0.6-1 mm thick that covers the area on the vertebral body encircled by the ring apophysis. The two end plates of each disc, therefore, cover the nucleus pulposus in its entirety, but peripherally they fail to cover the entire extent of the anulus fibrosus . Histologically, the end plate consists of both hyaline cartilage and fibrocartilage. Hyaline cartilage occurs towards the vertebral body and is most evident in neonatal and young discs .

Fibrocartilage occurs towards the nucleus pulposus; in older discs the end plates are virtually entirely fibrocartilage . (Bogduk, 2005)

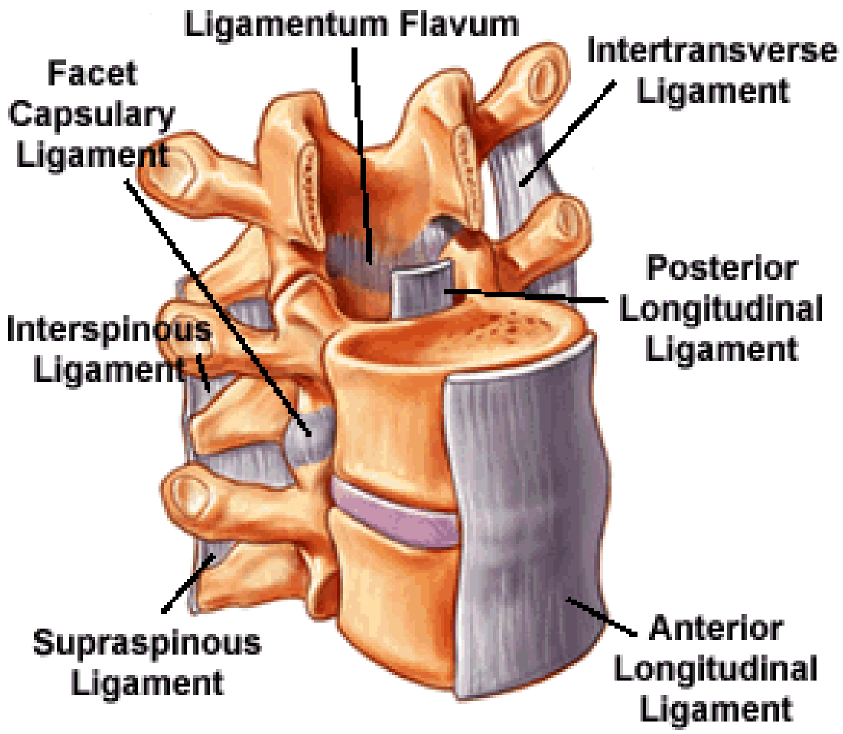


www.bodiempowerment.com {accessed at 8-11-2018}
Figure 2.5: vertebral endplate

2.1.1.4 ligaments of the lumbar spine :

2.1.1.4.1 The broad, thick anterior longitudinal ligament (Fig. 2.4) originates from the anterior and basilar aspect of the occiput and ends at the upper and anterior part of the sacrum. (Ombregt, 2013)

2.1.1.4.2 The posterior longitudinal ligament (Fig. 2.4) is smaller and thinner than its anterior counterpart: 1.4 cm wide (versus 2 cm in the anterior ligament) and 1.3 mm thick (versus 2 mm) .(Ombregt, 2013)



www.coloradospineinstitute.com {accessed at 8-11-2018}

Figure 2.6: the ligaments of the lumbar spine

2.1.1.4.3 The ligamentum flavum (Fig. 2.4) connects two consecutive laminae and has a very elastic structure with an elastin content of more than 80%. The lateral extensions form the anterior capsule of the facet joints and run further laterally to connect the posterior and inferior borders of the pedicle above with the posterior and superior borders of the pedicle below. (Ombregt, 2013)

2.1.1.4.4 The interspinous ligament (Fig. 2.4) lies deeply between two consecutive spinal processes. Unlike the longitudinal ligaments, it is not a continuous fibrous band but consists of loose tissue, with the fibres running obliquely from posterosuperior to anteroinferior. This particular direction may give the ligament a function over a larger range of intervertebral motion than if the fibres were vertical. The ligament is also bifid, which allows the fibres to buckle laterally to both sides when the spinous processes approach each other during extension. (Ombregt, 2013)

2.1.1.4.5 The supraspinous ligament is broad, thick and cord-like. It joins the tips of two adjacent spinous processes. (Ombregt, 2013)

2.1.1.4.6 The intertransverse ligaments are thin membraneous structures joining two adjacent transverse processes. They are intimately connected to the deep musculature of the back. (Ombregt, 2013)

2.1.1.4.7 The iliolumbar ligaments consist of an anterior and a posterior part.

The iliolumbar ligaments play an important role in the stability of the lumbosacral junction. (Ombregt, 2013)

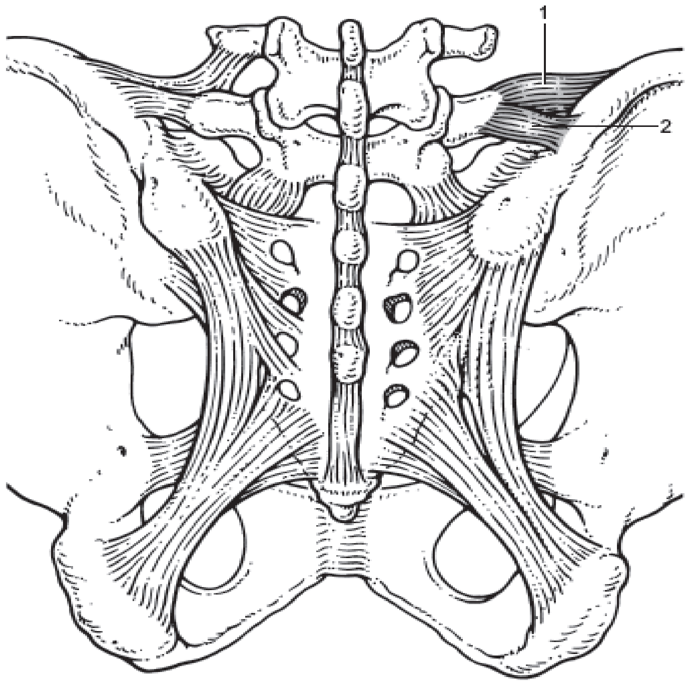


Figure 2.7 : Iliolumbar ligaments: 1, anterior band; 2, posterior band.

[Ombregt, L. 2013]

2.1.1.5 Muscles and fasciae of the lumbar spine:

The spine is unstable without the support of the muscles that power the trunk and position the spinal segments. Back muscles can be divided in four functional groups: flexors, extensors, lateral flexors and rotators (Fig. 31.18). (Ombregt, 2013)

2.1.1.5.1 The extensors are arranged in three layers: the most superficial is the strong erector spinae or sacrospinalis muscle. Its origin is in the erector spinae aponeurosis, a broad sheet of tendinous fibres attached to the iliac crest, the median and lateral sacral crests and the spinous processes of the sacrum and lumbar spine. The middle layer is the multifidus. The fibres of the multifidus are centred on each of the lumbar spinous processes. From each spinal process, fibres radiate inferiorly to insert on the lamina, one, two or three levels below. The arrangement of the fibres is such that it pulls downwards on each spinal process, thereby causing the vertebra of origin to extend. (Ombregt, 2013)

The third layer is made up of small muscles arranged from level to level, which not only have an extension function but are also rotators and lateral flexors. (Ombregt, 2013)

The extensor muscles are enveloped by the *thoracolumbar fascia* (Fig. 31.18b), which in turn consists of three layers. The anterior layer is quite thin and covers the anterior surface of the quadratus lumborum. Medially, it is attached to the anterior surfaces of the lumbar transverse processes, and in the intertransverse space it merges with the intertransverse ligaments. The middle layer lies behind the quadratus lumborum muscle. Medially, it also continues into the intertransverse ligament to attach to the lateral border of the lamina. The posterior layer covers the back muscles. It arises from the lumbar spinous processes and from the supraspinous ligaments to envelop the back muscles and blend with the other layers of the thoracolumbar fascia along the lateral border of the iliocostalis lumborum. The union of the fasciae is quite dense and forms a strong raphe (the lateral raphe) which fuses with the fibres of transversus abdominis, internal oblique and latissimus dorsi muscles. The lateral raphe further inserts at the posterior segment of the iliac crest and the posterior superior iliac spine. (Ombregt, 2013)

2.1.1.5.2 The flexors of the lumbar spine consist of an intrinsic (psoas and iliacus) and an extrinsic group (abdominal wall muscles). (Ombregt, 2013)

2.1.1.5.3 Lateral flexors and rotators are the internal and external oblique, the intertransverse and quadratus lumborum muscles. (Ombregt, 2013)

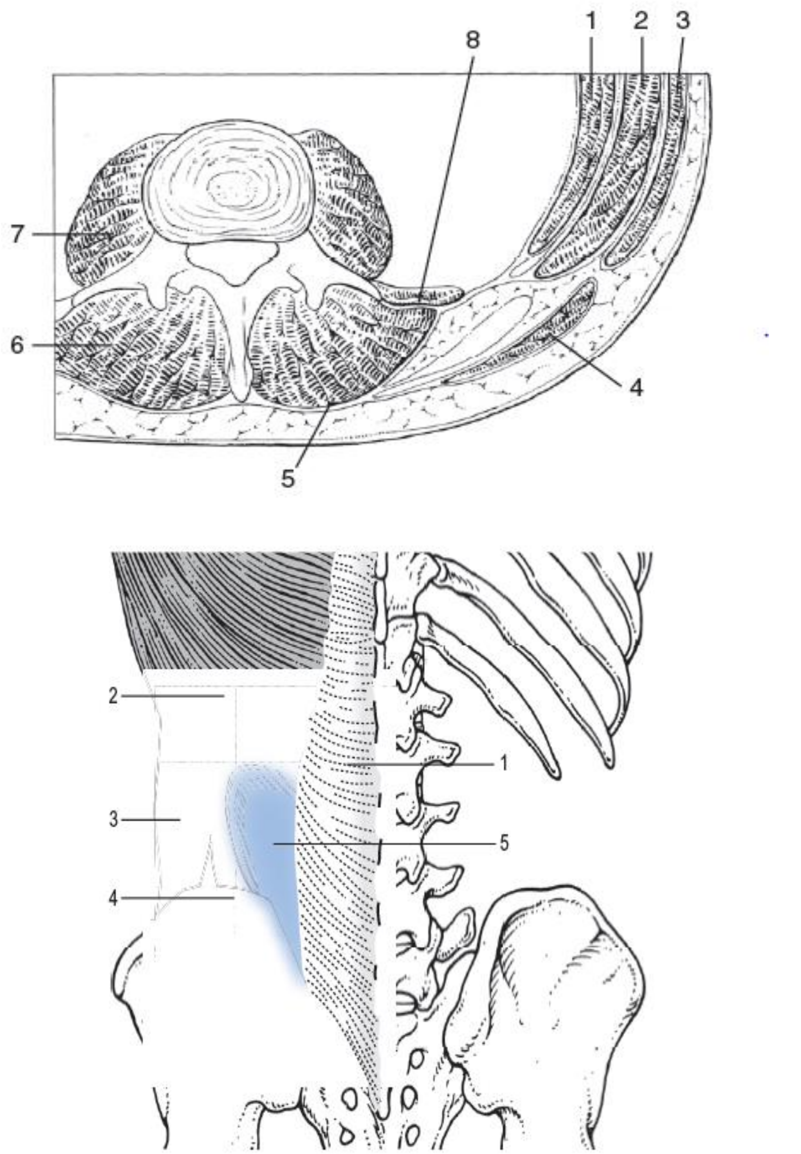


Figure 2.8 : (a) Muscles of the lumbar spine: 1, transversus abdominis; 2, internal oblique; 3, external oblique; 4, latissimus dorsi; 5, lumbar fascia; 6, erector spinae; 7, psoas; 8, quadratus lumborum. (b) Posterior layer of the thoracolumbar fascia: 1, thoracolumbar fascia; 2, fascia latissimus dorsi; 3, fascia of external oblique; 4, posterior superior iliac spine; 5, lateral raphe. (Ombregt, 2013)

2.1.1.6 Nerves of the lumbar spine :

The lumbar spine is associated with a variety of nerves, the central focus of which are the lumbar spinal nerves. These lie in the intervertebral foramina and are connected to the spinal cord by the spinal nerve roots, which occupy the vertebral canal. Peripherally (i.e. outside the vertebral column), the spinal nerves divide into their branches: the ventral and dorsal rami. Running along the anterolateral aspects of the lumbar vertebral column are the lumbar sympathetic trunks, which communicate with the ventral rami of the lumbar spinal nerves. (Bogduk, 2005)

2.1.1.7 Innervation of the lumbar intervertebral disc:

The lumbar intervertebral discs are supplied by a variety of nerves. The posterior aspects of the discs and the posterior longitudinal ligament are innervated by the sinuvertebral nerves. The posterolateral aspects of the discs receive branches from adjacent ventral primary rami and from the grey rami communicantes near their junction with the ventral primary rami. The lateral aspects of the discs receive other branches from the rami communicantes. Some rami communicantes cross intervertebral discs and are embedded in the connective tissue of the disc deep to the origin of psoas. Such paradiscal rami are likely to be another source of innervation to the discs. The anterior longitudinal ligament is innervated by recurrent branches of rami communicantes. (Bogduk et al 1981)

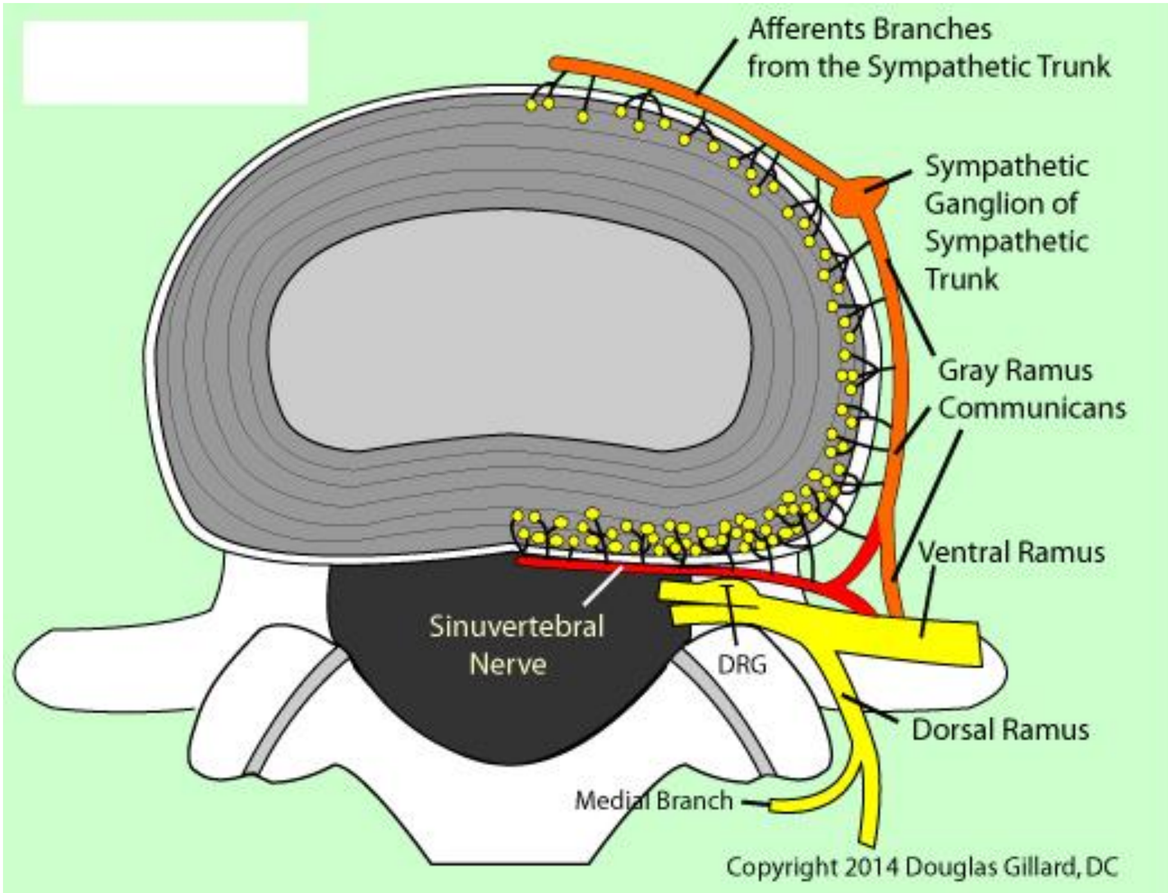


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Figure 2.9 : innervation of the lumbar intervertebral disc

2.1.1.8 Blood supply of the lumbar spine :

The blood supply of the lumbar spine is derived from the lumbar arteries, and its venous drainage is through the lumbar veins. (Bogduk, 2005)

2.1.1.8.1 The lumbar arteries :

A pair of lumbar arteries arises from the back of the aorta in front of each of the upper four lumbar vertebrae. Occasionally, the arteries at a particular level may arise as a single common trunk which rapidly divides into right and left branches. At the L5 level, the fifth lumbar arteries arise from the median sacral artery but otherwise they resemble the other lumbar arteries. [Bogduk, N. (2005)]

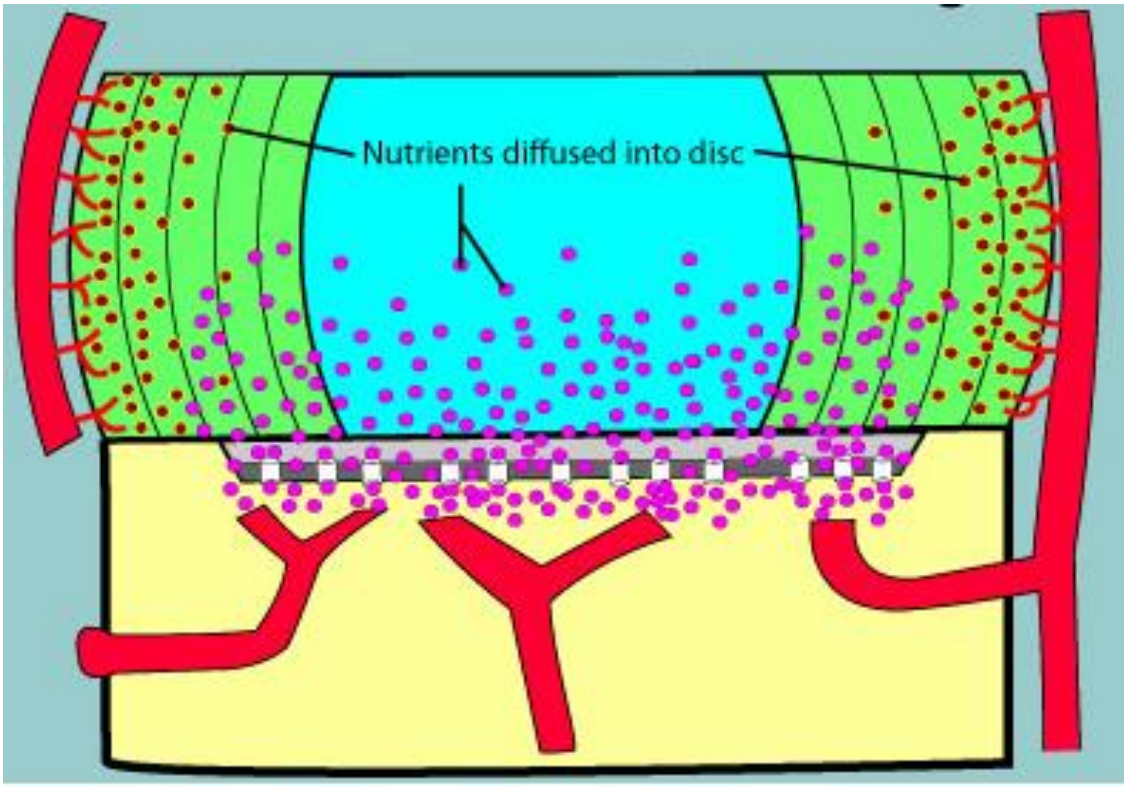
2.1.1.8.2 The lumbar veins :

Several veins surround and drain the lumbar spine. These are the lumbar veins, the ascending lumbar veins and several vertebral venous plexuses. The lumbar veins accompany the lumbar arteries in their course around the vertebral bodies, and drain into the inferior vena cava. (Bogduk, 2005)

2.1.1.9 Nutrition of the intervertebral disc :

The intervertebral disc is not an inert structure. The cartilage cells in the nucleus pulposus and the fibroblasts in the anulus fibrosus are biologically active but this activity is essential for the constant synthesis and replacement of proteoglycans and collagen.To sustain this activity these cells require nutrition However, the intervertebral discs receive no major arterial branches. (Bogduk, 2005)

The only vessels that actually enter the discs are small branches from the metaphysial arteries which anastomose over the outer surface of the annulus fibrosus but these branches are restricted to the very outermost fibres of the anulus. Consequently, for their nutrition, intervertebral discs are dependent on diffusion, and this diffusion takes place from the two closest available systems of vessels: those in the outer anulus, and the capillary plexuses beneath the vertebral end plates. To reach the nucleus pulposus, nutrients like oxygen, sugar and other molecules must diffuse across the matrix of the vertebral endplate or through the anulus fibrosus. Subsequently, nutrients to the nucleus must permeate the proteoglycan matrix of the nucleus. (Bogduk, 2005)



www.chirogeek.com. {accessed at 8-11-2018}

Figure 2.10: Nutrition of the lumbar intervertebral disc.

2.1.2 PHYSIOLOGY :

2.1.2.1 Functions of the spine :

The spine is a segmented structure consisting of a precisely aligned column of vertebrae and their intervertebral articulations. Its primary functions are (1) to provide support for the trunk and head; (2) to provide a protective covering for the spinal cord; and yet, (3) to permit enough flexibility to allow movement.(Byrne et al, 2000)

2.1.2.2 Functions of the disc :

The primary function of the disc is to join the vertebrae and allow movement between them. The other functions are typical of the erect spine: a shock absorber; a load distributor; and a separator of the posterior facets to maintain the size of the intervertebral foramen. (Ombregt, 2013)

2.1.3 Pathology

2.1.3.1 Some disorders of the spine:

2.1.3.1.1 Low back pain

Low back pain is by far the most common spinal complaint among adults in the United States. It affects the back anywhere below the ribs and above the legs. Causes include overuse, strain, injury, compression fracture, aging, and diseases such as arthritis and osteoporosis. (Inova spine institute, 2018)

2.1.3.1.2 Sciatica

Sciatica is pain, tingling or numbness caused by irritation of the sciatic nerve in the lower back. It can result from a herniated disc pressing against the nerve roots, spinal stenosis, arthritis or an injury-induced pinched nerve. (Inova spine institute, 2018)

2.1.3.1.3 Radiculopathy

Radiculopathy is a disease of the spinal nerve roots and spinal nerves. Cervical radiculopathy affects the nerve roots near the neck and radiates through the arms and hands. Lumbar radiculopathy causes nerve irritation in the lower back that radiates through the legs and feet. Wear and tear, degeneration, herniated discs and traumatic injury are the primary causes. (Inova spine institute, 2018)

2.1.3.1.4 Spinal stenosis

Spinal stenosis is a condition in which the spinal canal narrows and pinches the nerves, resulting in back and leg pain. Spinal stenosis often occurs in older adults, although younger people who are born with a small spinal canal may also develop symptoms. (Inova spine institute, 2018)

2.1.3.1.5 Spondylolisthesis

Spondylolisthesis is a forward slip of one vertebra in the spinal column and usually occurs in the lumbar region. Some people are born with a defective vertebra; in others, trauma, a stress fracture, infection or disease may cause the problem. The condition is on the rise among children and adolescents who are active in athletics. (Inova spine institute, 2018)

2.1.3.1.6 Myelopathy

Myelopathy is the gradual loss of nerve function caused by disorders of the spine. The condition commonly results from spinal injury or spinal stenosis, a progressive narrowing of the spinal canal. (Inova spine institute, 2018)

2.1.3.1.7 Scoliosis

Scoliosis is a condition that causes the spine to curve sideways. It can develop during childhood or adolescence and can range from mild to severe. (Inova spine institute, 2018)

2.1.3.1.8 Kyphosis

Kyphosis is a progressive disorder that causes curvature of the thoracic spine in children and adults. It is most often the result of developmental problems, trauma, degenerative diseases (such as arthritis) or osteoporosis with compression fractures. (Inova spine institute, 2018)

2.1.3.1.9 Ankylosing spondylitis

Ankylosing spondylitis is a form of arthritis that primarily affects the ligaments and joints of the spine, especially the lower back. As the disease progresses, it can lead to a stooped posture. (Inova spine institute, 2018)

2.1.4 Magnetic resonance imaging :

MRI utilizes the phenomenon of nuclear magnetic resonance to provide contrast between normal tissues and disease. When protons are placed in a very strong magnetic field, they oscillate at a frequency proportionate to the field strength and absorb electromagnetic energy in the form of radio waves, which are at the same frequency of oscillation. They return to a state of equilibrium, releasing radio wave energy that is detected to create the images. (Clarke et al, 2010)

The restoration of equilibrium can be measured in the longitudinal plane in T1-weighted (T1W) and the transverse plane in T2-weighted (T2W) sequences. Tissues differ in the rate at which they achieve. equilibrium, providing excellent contrast between normal soft tissues and disease processes. Water appears dark on T1W and bright on T2W images. Normal fat appears bright on most sequences so that many examinations utilize 'fat-suppressed' sequences to make pathology more conspicuous. (Clarke et al, 2010)

Safety concerns with MRI scanning are related to the very strong magnetic field generated by the superconducting electromagnet, so that there are contraindications in a small proportion of patients. (Clarke et al, 2010)

2.1.4.1 Contraindications to MRI :

Cardiac pacemakers

Cochlear implants

Some prosthetic heart valves

Some intracerebral aneurysm clips

Nerve stimulators

Ocular metallic foreign bodies

MRI provides excellent demonstration of soft tissues of the spine showing disc dehydration, disc herniation, nerve root compression, disc and paraspinal infection and primary or secondary neoplasms. (Clarke et al, 2010)

Normal bone marrow signal, with its high fat content in adults, provides excellent contrast to diseases such as vertebral tumours, osteomyelitis and degenerative vertebral end plate changes. (Clarke et al, 2010)

2.1.5 Pfirrmann grading system :

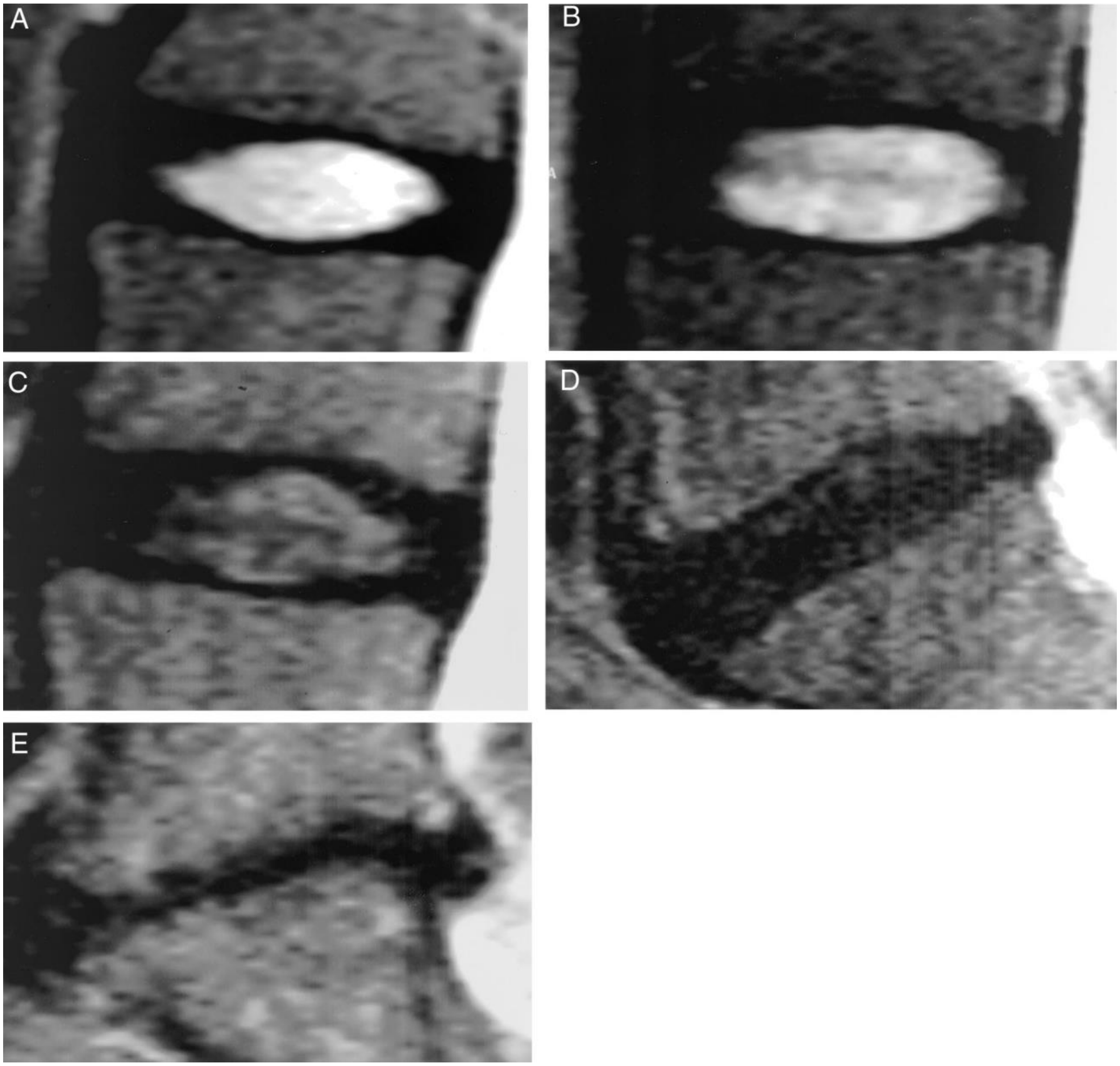


Figure 2.11 : A–E, Pfirrmann Grading system for the assessment of lumbar disc degeneration (pfirmann et al, 2001)

The above Figure show the Grading system for the assessment of lumbar disc degeneration. Grade I: The structure of the disc is homogeneous, with a bright hyperintense white signal intensity and a normal disc height. Grade II: The structure of the disc is inhomogeneous, with a hyperintense white signal. The distinction between nucleus and anulus is clear and the disc height is normal, with or without horizontal gray bands. Grade III: The structure of the disc is inhomogeneous, with an intermediate gray signal intensity. The distinction between nucleus and anulus is unclear and the disc height is normal or slightly decreased. Grade IV: The structure of the disc is inhomogeneous, with an hypointense dark gray signal intensity. The distinction between nucleus and anulus is lost and the disc height is normal or moderately decreased. Grade V: The structure of the disc is inhomogeneous, with a hypointense black signal intensity. The distinction between nucleus and anulus is lost, and the disc space is collapsed. Grading is performed on T2-weighted midsagittal (repetition time 5000 msec/echo time 130 msec) fast spin-echo images. (pfirmann et al, 2001)

2.2 Previous studies:

- Pfirrmann et al (2001) analyzed 300 lumbar discs of 60 individuals (33 men and 27 women) with a mean age of 40 years (range, 10 – 83 years). The consensus reading resulted in 14 Grade I discs (5%), 82 Grade II discs (27%), 72 Grade III discs (24%), 68 Grade IV (23%), and 64 Grade V discs (21%).
- Saleem et al (2013) studied 163 patients diagnosed with lumbar degenerative disc disease in which 95 (58.3%) were male and 68 (41.7%) were females. Patients were between the ages of 20 and 70 years and most were in their fourth decade of life with mean age of 43.92±11.76 years. All included patients had history of low back pain. Most patients 159 (97.5%) had sciatica and 4 (2.5%) had no sciatica complaint

  low back and sciatic pain Aggravate during bending 81 (49.7) . The most common levels of disc degeneration were L4/L5 and L5/S1, seen in 105 (64.4%) and 76 (46.6%) patients respectively. Most cases of disc degeneration were observed in 4th and 5th decade of life in this study.The signal intensity changes of the disc in sagittal sections on T2-weighted images was graded using a scale from 0 to 3 where 0=homogeneous hyper-intense (white), 1=hyper-intense with visible intranuclear cleft (white with a dark band in the equator plane of the disc), 2=intermediate visible nuclear complex). Lumbar disc degeneration was diagnosed if there was a signal intensity change (grade 2 or 3) at one or more lumbar levels. Those with normal signal intensity (grade 0 and 1) were classified as subjects without disc degeneration.
- Jakoi et al (2017) found that the prevalence of patients with disc degenerative disease who were also smokers rose 627.2% from 2007 to 2014

(from 0.40 to 2.88 out of 10.000) compared to just 117.6% (108.12 to 235.25) for the population never dignosed with smoking.

- Luoma et al (1998) studied 53 machine drivers, 51 construction carpenters, and 60 municipal office workers aged 40-45 years. The prevalence of lumbar disc degeneration L2/L3-L5/S1 was determined with MRI. And they found that occupational load affects the risk of disc degeneration of the lumbar spine.

Chapter three

Materials and Methods

Chapter three
Material and Methods

3-1 Material :

3.1.1 Study area and duration :

This is descriptive analytic study that done in Khartoum state in Antalya medical diagnostic center in the department of magnetic resonance imaging from March 2016 to August 2016.

3.1.2 Sample :

3.1.2.1 Sample size :

The sample size was 35 case (22 females and 13 males).

3.1.3 Inclusion :

Patients complain of lower back pain and came with lumbar degenerative disc disease.

3.1.4 Exclusion :

Patients not complain of lower back pain and not patients with lumbar anomalies.

3.1.5 Study equipment :

3.1.5.1 MRI machine :

GE 1.5 tesla

3.1.5.2 Coil : surface coil

3.2 Methods

3.2.1 Patient preparation :

The procedure is explained to the patient. Any metal objects such as keys, coin, jewellery...etc is removed before the examination. The pacemaker, metal plates and screws are contraindicated for the exam. The patient is asked to undress and wear hospital gown.

3.2.2 Technique :

The Patient lies supine with the arm on sides. The lazer beam is centered at the level of L3.

3.2.3 Protocol used :

- Sagittal T1
- Sagittal T2
- Axial T2

3.2.4 Method of evaluatioin :

The master data sheet was divided into : gender, age, occupation, smoking, buttock pain, increasing of pain with bending, decreasing of pain with lying down and leg numbness.

3.2.5 Method of data analysis :

The data analyzed by Microsoft excel 2013.

3.2.6 Ethical considerations:

Written or verbal consent was taken from the patients. No personal information was published.

Chapter four

Results

Chapter four

Results

Table (4 -1) shows age statistics

Mean	46.2
Median	46.50
Std. Deviation	11.166
Minimum	29
Maximum	72

Table (4 - 2) shows gender distribution

Gender	Frequency	Percent
Female	22	62.86
Male	13	37.14

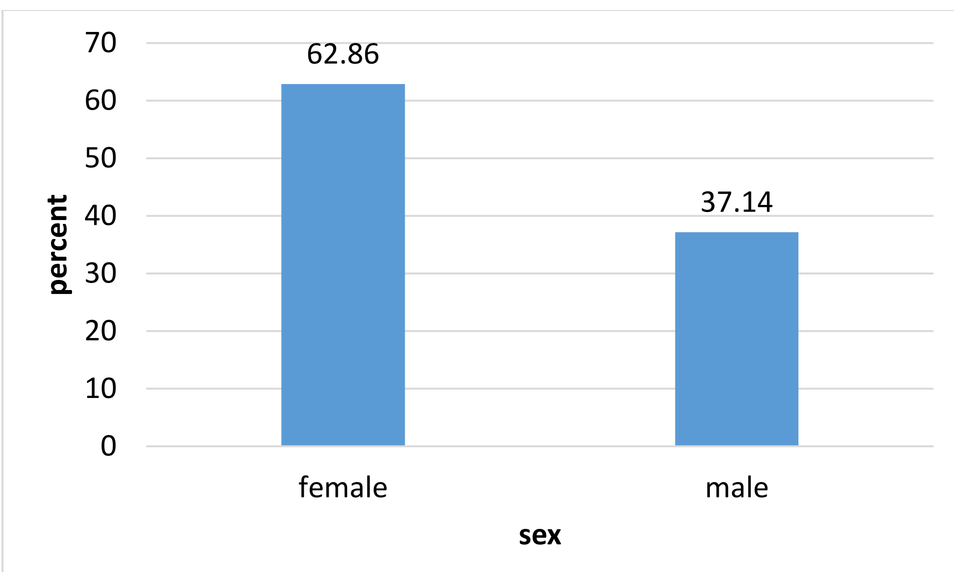


Figure (4- 1) shows gender distribution

Table (4 - 3) shows age groups distribution

Age groups	**Frequency**	**Percent**
20 – 29	1	2.86
30 – 39	9	25.71
40 – 49	10	28.57
50 – 59	10	28.57
60 – 69	4	11.43
70 - 79	1	2.86

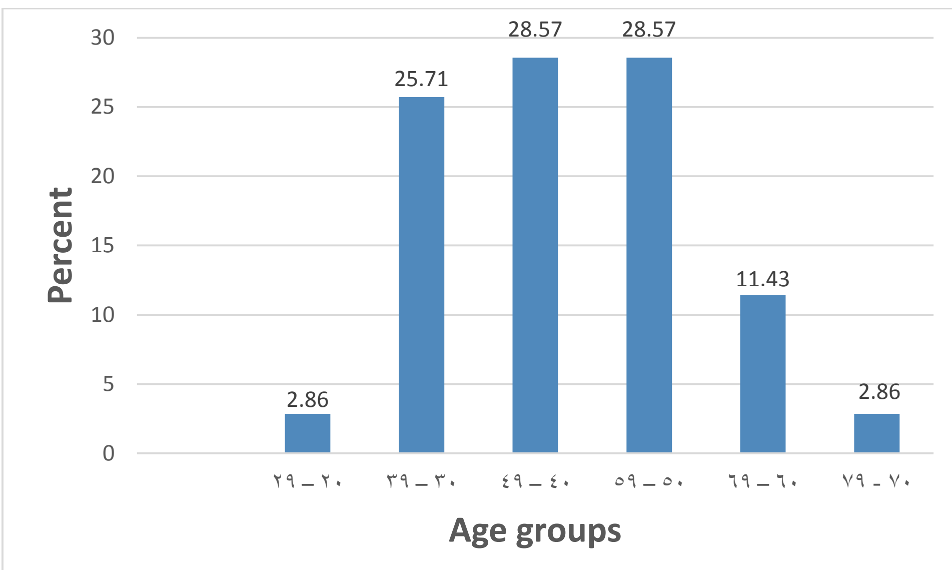


Figure (4 - 2) shows age groups distribution

Table (4 - 4) shows occupation distribution

Occupation	frequency	Percent
Housekeeper	13	37.14
Farmer	3	8.57
Employee	4	11.43
Teacher	3	8.57
Maid	2	5.71
Driver	2	5.71
Worker	2	5.71
Blacksmith	1	2.86
Nurse	1	2.86
Architectural contractor	1	2.86
Carpenter	1	2.86
Sales representative	1	2.86
Merchant	1	2.86

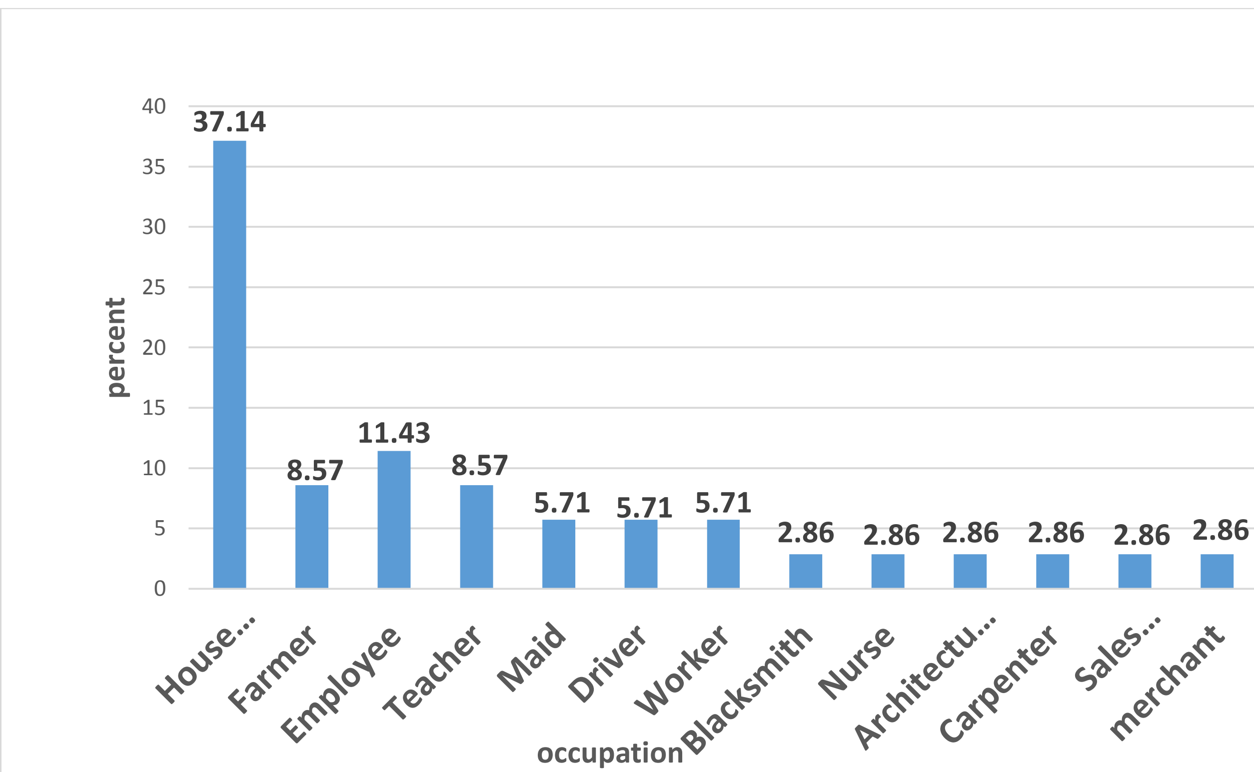


Figure (4 – 3) shows occupation distribution

Table (4 – 5) shows smoking distribution

	Frequency	Percent
Yes	2	5.7%
NO	33	94.3%

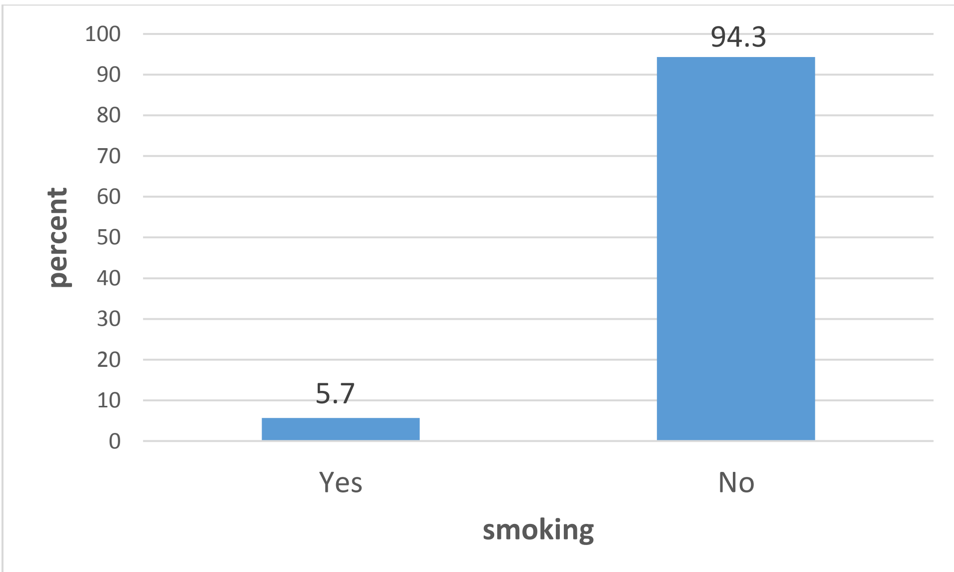


Figure (4 – 4) shows smoking distribution

Table (4 – 6) shows buttocks pain distribution

	Frequency	Percent
Yes	27	77.14
No	8	22.86
Total	35	100.0

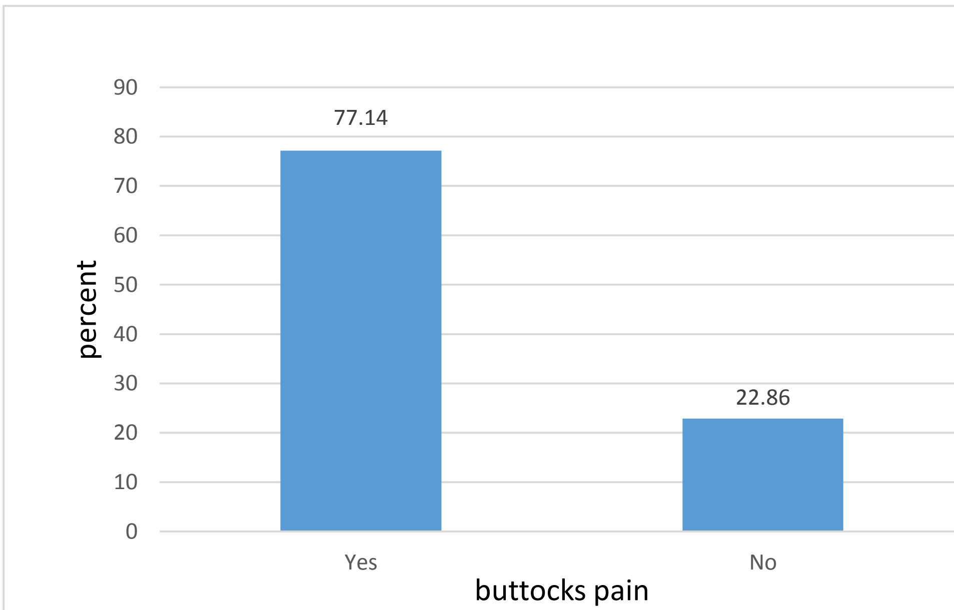


Figure (4 – 5) shows buttocks pain distribution

Table (4 - 7) shows distribution of increasing of low back pain when bending

Yes	30	85.71
NO	5	14.29
Total	35	100.0

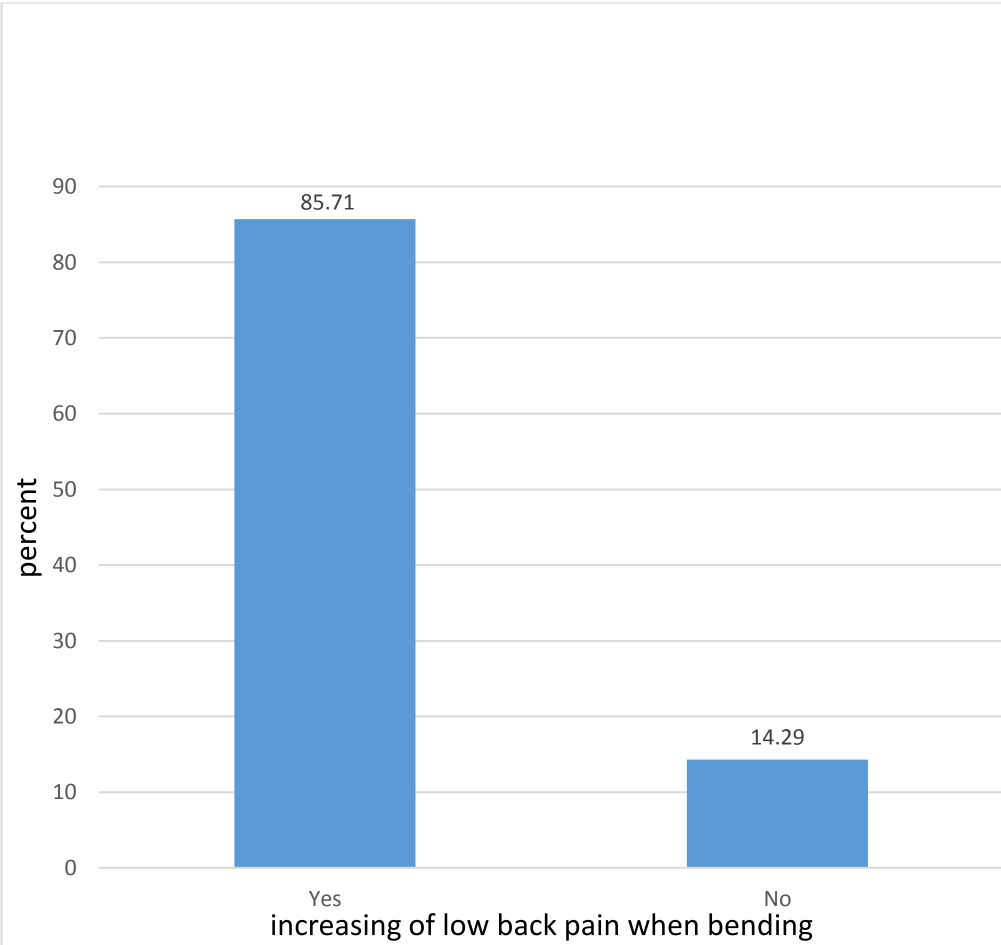


Figure (4 – 6) shows distribution of low back pain increasing when bending

Table (4 – 8) shows distribution of decreasing of low back pain when lying down

	Frequency	Percent
Yes	29	82.86
NO	6	17.14
Total	35	100.0

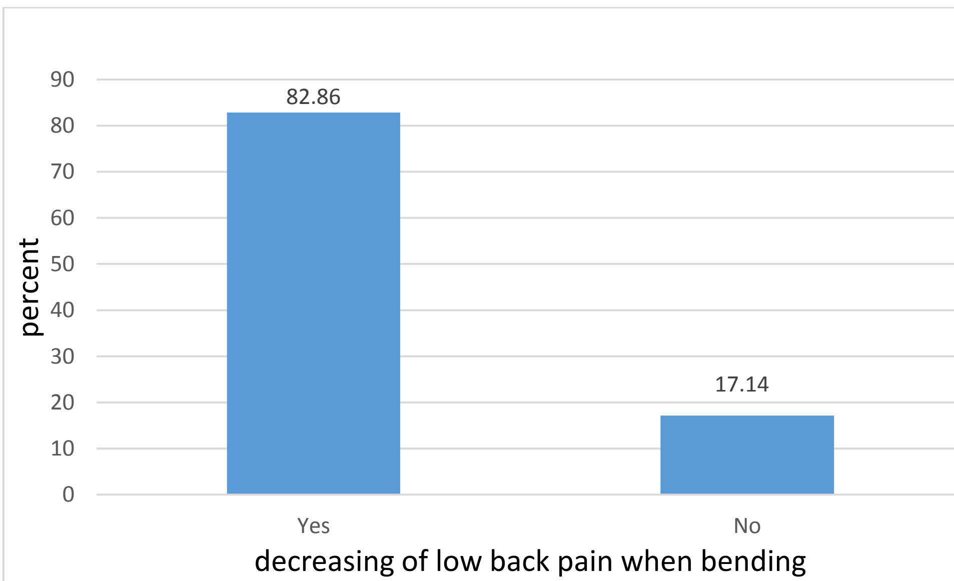


Figure (4 – 7) shows distribution of decreasing of low back pain when lying down

Table (4 – 9) shows leg numbness distribution

	Frequency	**Percent**
Yes	23	65.71
NO	12	34.29
Total	3	100.0

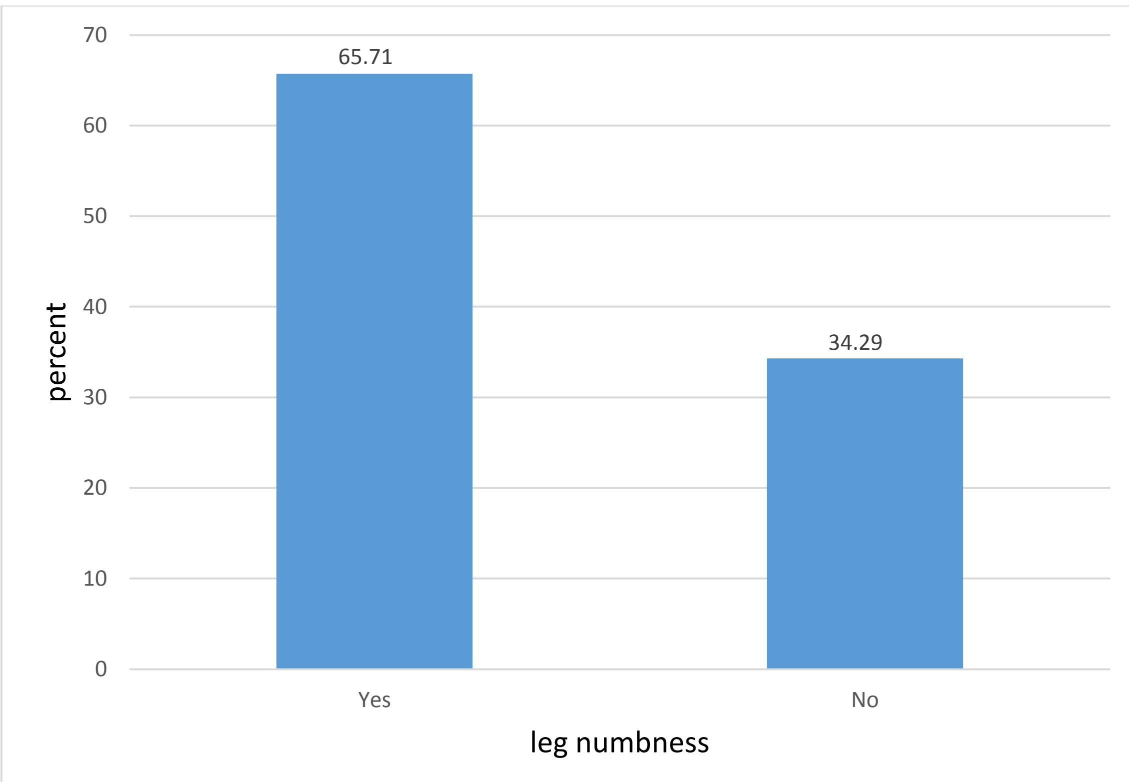


Figure (4 – 8) shows leg numbness distribution

Table (4 – 10) shows distribution of degeneration grades for all discs

Grade	Number of discs
I	6
II	85
III	56
IV	22
V	6

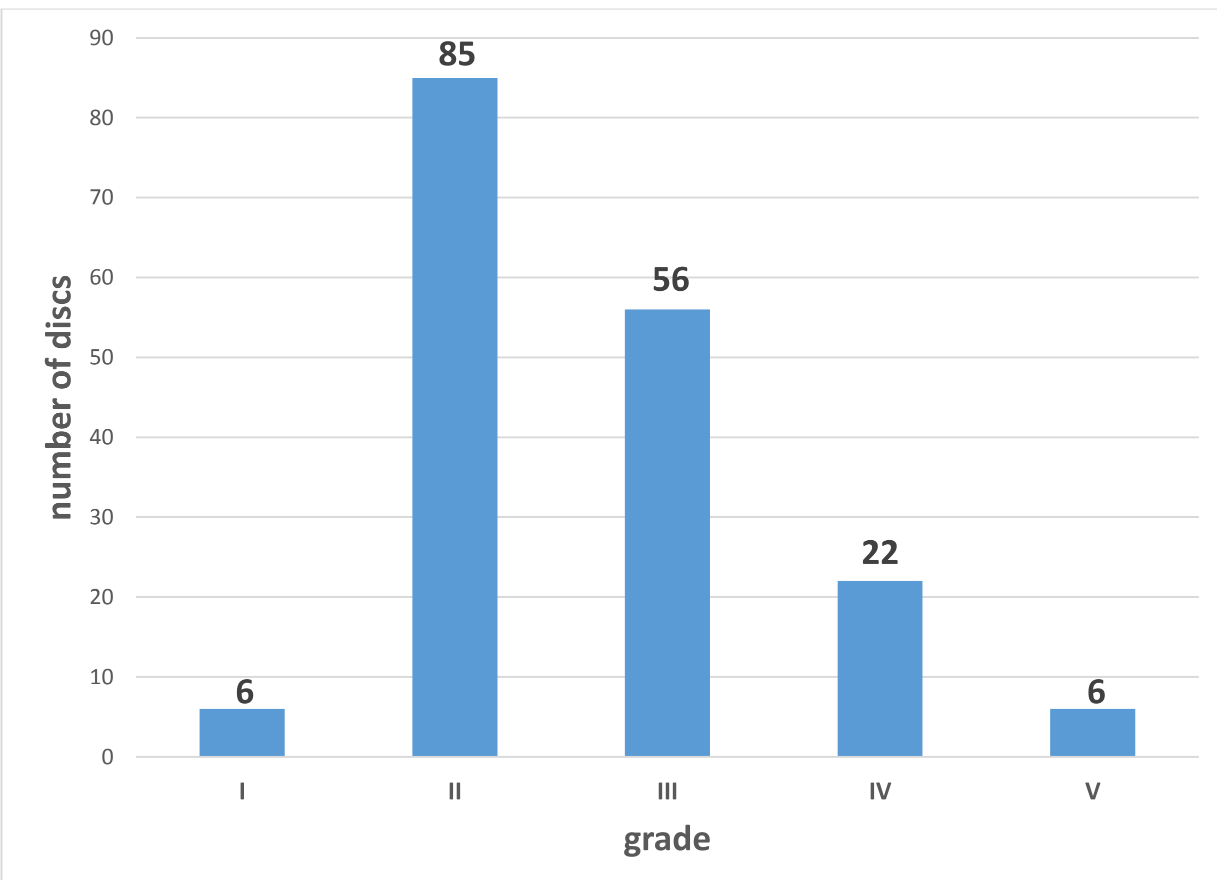


Figure (4 – 9) shows distribution of degeneration grades for all discs

Table (4 – 11) shows distribution of degeneration grades for each disc

	Grade I	Grade II	Grade III	Grade IV	Grade V	Total
Disc 1	1	27	5	2	0	35
Disc 2	2	22	7	3	1	35
Disc 3	1	18	12	4	0	35
Disc 4	1	10	17	6	1	35
Disc 5	1	8	15	7	4	35
Total	6	85	56	22	6	175

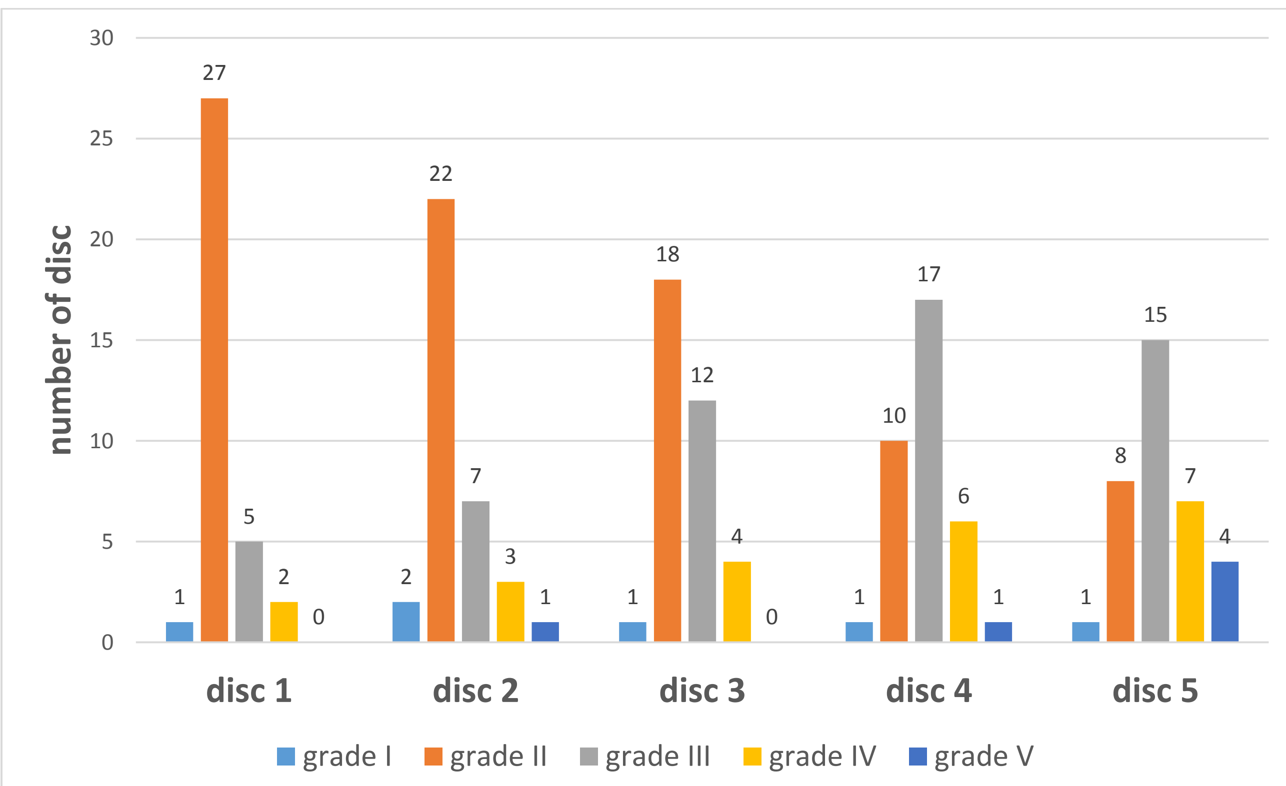


Figure (4 – 10) shows distribution of degeneration grades for each disc

Chapter five

Conclusion, Recommendations, References and Appendices

Chapter five

5-1 Discussion:

The aim of this study was to characterize the lumbar degenerative disc disease in patients with low back pain by using MRI depending on the pfirrmann grading system. Pfirrmann grading system divided the degenerative disc into 5 divisions as demonstrated in figure (2.11).

The patient gender was investigated and the study revealed that the most affected gender was the females with frequency of 62.9% and males was 37.1% , these is not similar as Pfirrmann et al-2001 and Saleem et al-2013.

The mean age of patients was 46.2 years this is something similar to Pfirmann et al-2001 and Saleem et al-2013 (40 and 43.92±11 years respectively).

The most affected age groups of patients are that between (40 – 49) & (50 – 59) representing 28.57% for each group, these is similar to Saleem et al-2013. The most affected persons according to their occupation were housekeepers 37.1%, then employees 11.4% and both farmers & teachers 8.6% for each one, and these is not agree with Luoma et al (1998) who suggest that heavy work is assist in disc degeneration.

The smoking percentage was 5.7%. smoking assist in degeneration as mentioned in Jakoi et al-2017 study. The buttocks pain was found in 77.14%. the low back pain that increase when bending was found in 85.71% (in Saleem et al-2013 study was 49.7%) . the low back pain that decrease when lie down was found in 82.86% . the leg numbness was found in 65.71%.

According to analization of 175 lumbar discs for 35 patients according to Pfirmann grading system there were ; 6 grade I disc (3.4%), 85 grade II discs (48.6%), 56 grade III discs (32%), 22 grade IV discs (12.6%), 6 grade V discs (3.4%) these are something similar to Pfirmann et al-2001 (14 Grade I discs (5%), 82 Grade II discs (27%), 72 Grade III discs (24%), 68 Grade IV (23%), and 64 Grade V discs (21%)).

The degeneration of disc being considered from the 3rd degree including the 4th, and 5th degrees; and accordingly most discs (56 disc from 175) is affected by 3rd degree representing 32%.

The most common levels of disc degeneration were L4/L5 and L5/S1, seen in (68.6%) and (74.3%) patients respectively; these are agree with Saleem et al-2013 but L4/L5 has higher degeneration percentage than L5/S1 (64.4%) and (46.6%) respectively.

The first, second and third lumbar discs affected more with second degree of degeneration. The fourth and fifth lumbar discs affected more with third degree of degeneration. The most affected lumbar disc with fourth degree of degeneration is the fourth and fifth discs. The most affected lumbar disc with fifth degree of degeneration is the fifth disc.

5-2 Conclusion:

The objective of this study was to characterize the lumbar degenerative disc disease in patients with low back pain by using MRI depending on the pfirrmann grading system.

The females are more affected with lumbar degenerative disc disease than males. The most affected age groups of patients are that between (40 – 49) & (50 – 59). For oocupations the most affected are the housekeepers then employee. smoking can assist in degeneration.

Most discs are affected by 3^{rd} degree of degeneration. The most common levels of disc degeneration were L4/L5 and L5/S1.

Study concluded that magnetic resonance imaging is better in evaluation of lumbar degenerative disc and pfirrmann grading system is

5-3 Recommendations:

1- Correlation of lumbar DDD to weight.
2- Further studies with a large samples of patients.

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Data collection sheet :

Sex	Age	occupation	smoking	Buttocks Pain	Pain Increases With Bending	Pain Decreases With Lying down	Leg numbness

MRI images of grades of lumbar degenerative disc disease:

Image A: T2 sagittal image of 31 years old male patient shows that L1 and L2 with second degree of degeneration, L3 with first degree of degeneration.

Image B: T2 sagittal image of 60 years old female patient shows that L1 with second degree of degeneration, L2 and L3 with fourth degree of degeneration ,L4 and L5 with third degree of degeneration.

Image C: T2 sagittal image of 29 years old male patient shows that L1,L2.L3 and L4 with second degree of degeneration, L5 with third degree of degeneration

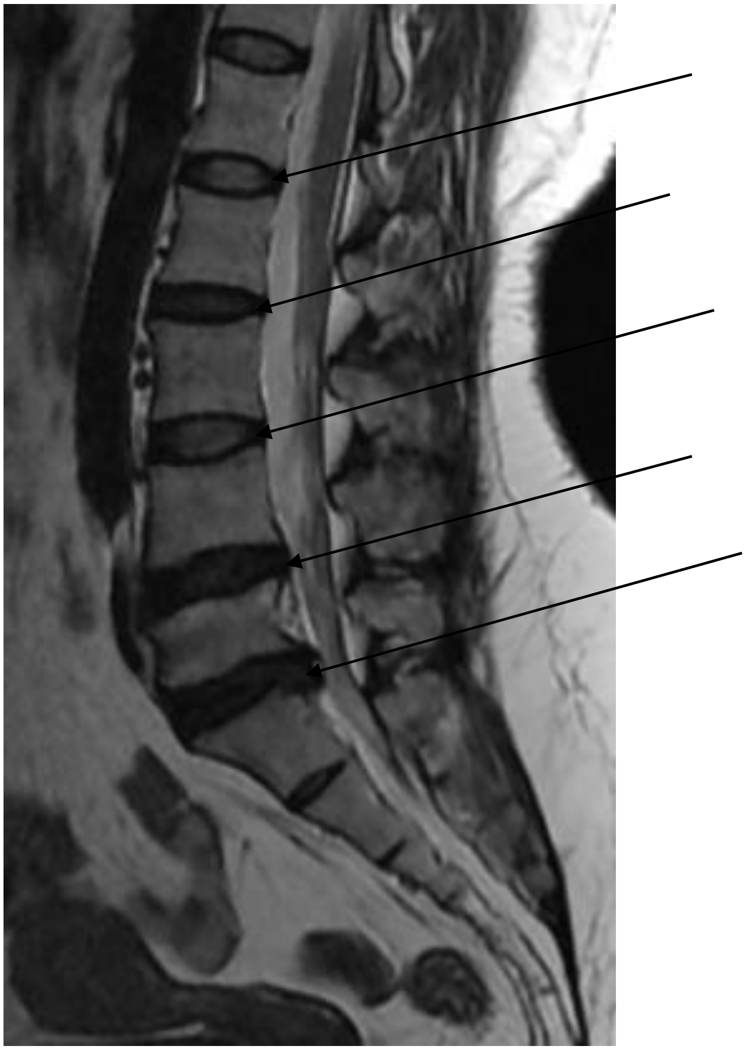

Image D: T2 sagittal image of 30 years old female patient shows that L1 and L3 with second degree of degeneration, L3.L4 and L5 with third degree of degeneration.

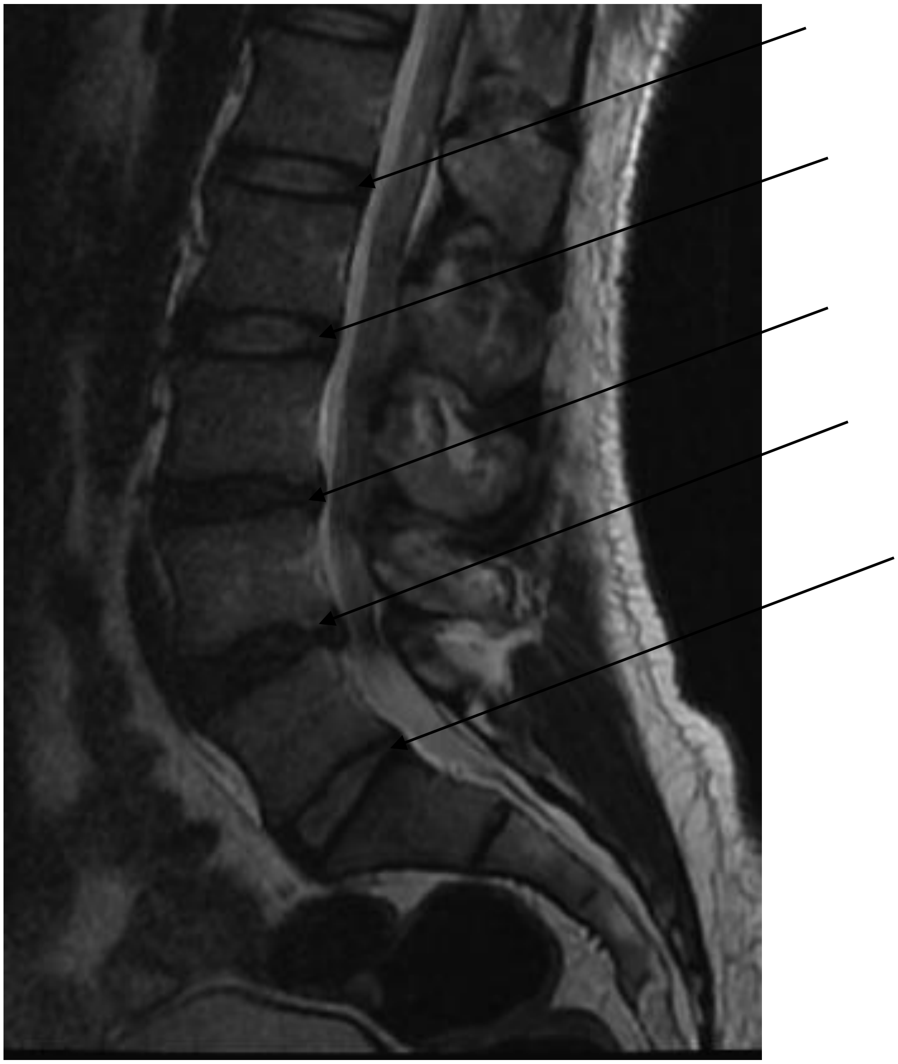

Image E: T2 sagittal image of 33 years old male patient shows that L1, L2 and L5 with second degree of degeneration, L3 and L4 with third degree of degeneration.

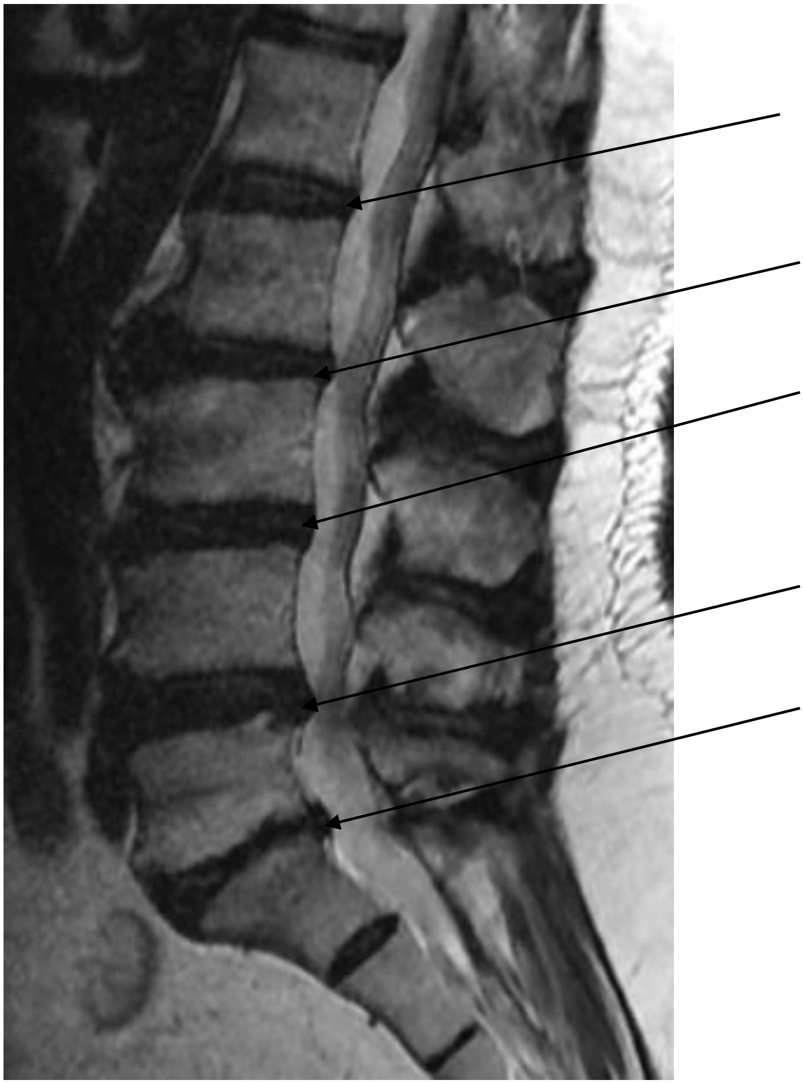

Image F: T2 sagittal image of 68 years old male patient shows that L1 with third degree of degeneration, L2, L3 and L4 with fourth degree of degeneration, L5 with fifth degree of degeneration

Image G: T2 sagittal image of 72 years old female patient shows that L1, L3 with fourth degree of degeneration, L2, L4 and L5 with fifth degree of degeneration

Image H: T2 sagittal image of 56 years old female patient shows that L1,L2 and L3 with third degree of degeneration, L4 with second degree of degeneration and L5 with fourth degree of degeneration

Image I: T2 sagittal image of 50 years old male patient shows that L1,L2 with first degree fvdegeneration, L3 with second degree of degeneration and L4 and L5 with third degree of degeneration

Image J: T2 sagittal image of 53 years old female patient shows that L1,L2.L3 and L4 with first third degree of degeneration, L5 with fourth degree of degeneration