الآيةالكريمة

قال تعالي:

(فتعالي الله الملك الحق ولا تعجل با لقرءان من قبل إن يقضي إليك وحيه وقل رب زدني علما)

صدق الله العظيم

سورة طه الايه 114

DEDICATION

We would like to dedicate this work to my subject teachers who never failed to teach and guide us.

To my families who supports us in everything.

To my friends who helped us finishing this research speciallyTAGREED MOHMMED .

And most of all to the Allah who gives us strength and good health while doing this work.

Acknowledgement

Grateful thanks and grace to Allah for guiding and helping me finishing this research.

I would like also to express sincere thanks and gratitude to my supervisor Dr**. Ahmed Mostafa Abukonna**for his keen supervision, guidance and valuable comment and support from the idea of this research until finishing.

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ABSTRACT

Degenerative spine conditions involve the gradual loss of normal structure and function of the spine over time. They are usually caused by aging, but may also be the result of tumors, infections or arthritis.

The aim of this study was to evaluate age related changes inlumbar vertebrae degeneration. The entire populations of this study were 50 patients' males and females with different ages range. They referred to MRI center for MRI examination of lumbar spine.

The result of the study showed that degenerative disc disease is more common in women than in men. Furthermore, Disc degeneration with diffuse disc changes are more commonly found at L4 - L5 and L5 – S1 leveland L1 – L2 is least common. This Cranio-caudal directionpattern is also followed by disc herniation. In addition, the Lumbar disc degeneration is the most common cause of low back pain.

MRI is the standard imaging modality for detecting disc pathology due to its advantage of lack of radiation, multiplanes imaging capability, excellent spinal soft-tissue contrast and precise localization of intervertebral discs changes.

الملخص

امراض العمود الفقري المتعلقة بالعمر تشمل الفقدان التدريجي للبنية الطبيعية ووظيفة العمود الفقري مع مرور الوقت. وعادة ما تسبب من قبل الشيخوخة، ولكن قد يكون أيضا نتيجة لأورام والتهابات المفاصل.

الهدف من هذه الدراسة تقييم التغيرات المرتبطة بالعمر في الفقرات القطنية. وقد شملت هذه الدراسة خمسين من الذكور والإناث بأعمار مختلفة. أحضروا إلى مركز التصوير بالرنين المغناطيسي لفحص العمود الفقري القطني.
وأظهرت نتائج الدراسة أن الأمراض التنكسية للغضروف أكثر شيوعا في النساء أكثر من الرجال. وعلاوة على ذلك، فان التغييرات القرص منتشرة وجدت أكثر شيوعا بين الفقارات القطنية الرابعة والخامسة و أقل شيوعا بين الاولي و الثانية وبالإضافة إلى ذلك، فان تنكس القرص القطني هو السبب الأكثر شيوعا لآلام أسفل الظهر.

التصوير بالرنين المغناطيسي هو طريقة التصوير القياسية للكشف عنأمراضللغضروف نظرا لميزته في عدم وجود إشعاع، والقدرة على التصوير متعدد المحاور ، وميزتة ايصا في الكشف عن الأنسجة الرخوة والتحديد الدقيق للتغييرات في أقراص العمود الفقري.

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LIST OF ABBREVIATION

DDD	Degenerative disc disease
PT	Patient
C	Cervical
T	Thoracic
L	Lumbar
ALL	Anterior longitudinal ligament
PLL	Posterior longitudinal ligament
MRI	Magnetic resonance imaging
EMG	Electromyography
CT	Computed tomography
MRT	Magnetic resonance tomography
T	Tesla
RF	Radio frequency

CHAPTER ONE

1.1 Introduction:

Degeneration of one or more intervertebral disc(s) of the spine, often called "degenerative disc disease" (DDD) or "degenerative disc disorder," is a pathologic process of uncertain etiology that may cause acute or chronic low back pain.

Degenerative spine conditions involve the gradual loss of normal structure and function of the spine over time. They are usually caused by aging, but may also be the result of tumors, infections or arthritis. Pressure on the spinal cord and nerve roots caused by degeneration can be caused by Slipped or herniated discs and Spinal stenosis, or narrowing of the spinal canal, Osteoarthritis, or breakdown of the cartilage at the spinal joints. These conditions may put pressure on the spinal cord and nerves, leading to pain and possibly affecting nerve function.

Disc degeneration is a disease of aging, which may result in degenerative disc disease in some people. These age-related changes include:

The loss of fluid in your discs,this reduces the ability of the discs to act as shock absorbers and makes them less flexible. Loss of fluid also makes the disc thinner and narrows the distance between the vertebrae, andtiny tears or cracks in the outer layer (annulus or capsule) of the disc. The jellylike material inside the disc (nucleus) may be forced out through the tears or cracks in the capsule, which causes the disc to bulge, break open (rupture), or break into fragments.

The symptom of degenerative disc disease is pain, which often worsens when sitting or standing and during certain types of activity. When disc degeneration affects the spine of the neck, it is referred to as cervical disc disease. When the mid-back is affected, the condition is referred to as thoracic disc disease. Disc degeneration that affects the lumbar spine can cause low back pain or irritation of a spinal nerve to cause pain radiating down the leg. Most people with degenerative disc disease

experience chronic (persistent) neck or lower back pain with intermittent episodes of acute (sudden) pain. These acute episodes can last from a few days to a few months.

There are a number of tests that can be done to confirm a diagnosis of degenerative disc disease. These tests include the following:

Imaging tests (e.g., x-rays, CT scan, MRI scan)

Electromyography (EMG)

Discography

Bone scan

1.2 Statement of problem

Any age related changes occurring in such a part of vertebral column may lead to many disorders and disabilities.

Age-related degenerative changes have been extensively studied in spine radiographs and magnetic resonance imaging (MRI) scans from asymptomatic subjects, and data from these studies are used as referable norms for diagnosing and treating patients with spinal disorders.

MRI has displaced CT and myelography as the initial imaging modality of choice in complicated LBP.

1.3 Objectives of study

1.3.1 General objectives:

To evaluate age changesrelated inlumber degeneration vertebrae in Sudanese population using MRI.

1.3.2 Specific objective:

To identify the signs of degenerative changes in different spinal levels

The objective of the study is to evaluate extent of the involvement of the degenerative disc disease.

To characterize the disc degenerative changes of the spine.

To identify the changes associated with the degenerative disc disease.

- To demonstrate disc degenerative changes of the spine.
- To determine the accuracy of MRI in detecting degenerative disc disease.

1.4 Overview of the study

This study is contains the following chapters:

Chapter one is the introduction to this study.

Chapter two is the theoretical background for the study.

Chapter three is the materials and a method .

Chapter four is the results of study.

Chapter five the discussion, conclusion and recommendations of the study.

Reference .

Appendixes .

CHAPTER TWO

LITERTURE REVIEW

2.1 Anatomy

2.1.1The Spine

The spine is made of 33 individual bones stacked one on top of the other. Ligaments and muscles connect the bones together and keep them aligned. The spinal column provides the main support for your body, allowing you to stand upright, bend, and twist. Protected deep inside the bones, the spinal cord connects your body to the brain, allowing movement of your arms and legs. Strong muscles and bones, flexible tendons and ligaments, and sensitive nerves contribute to a healthy spine. Keeping your spine healthy is vital if you want to live an active life without back pain.(Drake 2009)

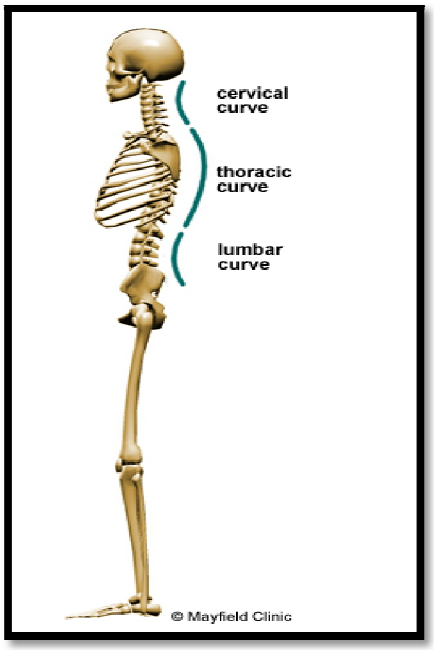


Figure 2.1 The spine has three natural curves that form an S-shape (www.wikipedia.org)

2.1.2 Thespinal curves

When viewed from the side, an adult spine has a natural S-shaped curve. The neck (cervical) and low back (lumbar) regions have a slight concave curve, and the thoracic and sacral regions have a gentle convex curve .The curves work like a coiled spring to absorb shock, maintain balance, and allow range of motion throughout the spinal column. (Drake 2009)

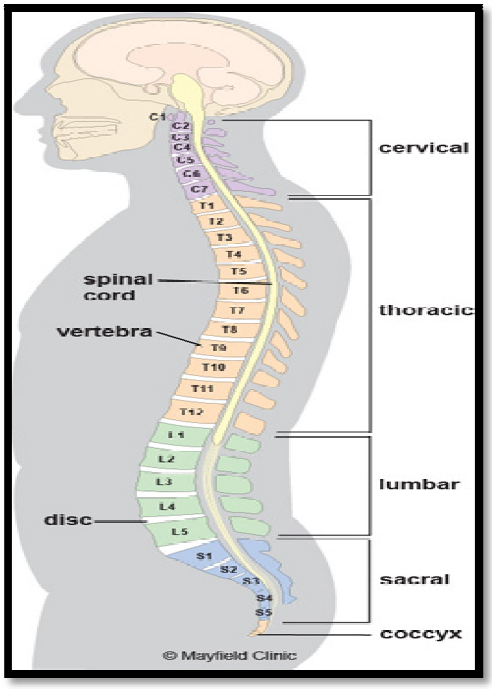


Figure 2.2 The five regions of the spinal column. (www.wikipedia.org)

2.1.3 The vertebrae

Vertebrae are the 33 individual bones that interlock with each other to form the spinal column. The vertebrae are numbered and divided into regions: cervical, thoracic, lumbar, sacrum, and coccyx .Only the top 24 bones are moveable; the vertebrae of the sacrum and coccyx are fused. The vertebrae in each region have unique features that help them perform their main functions. (Drake 2009)

Cervical (neck) - the main function of the cervical spine is to support the weight of the head (about 10 pounds). The seven cervical vertebrae are numbered C1 to C7.

The neck has the greatest range of motion because of two specialized vertebrae that connect to the skull. The first vertebra (C1) is the ring-shaped atlas that connects directly to the skull. The second vertebra (C2) is the peg-shaped axis, which has a projection called the odontoid, that the atlas pivots around. (Drake 2009)

Thoracic (mid back) - the main function of the thoracic spine is to hold the rib cage and protect the heart and lungs. The twelve thoracic vertebrae are numbered T1 to T12. The range of motion in the thoracic spine is limited. (Drake 2009)

Lumbar (low back) - the main function of the lumbar spine is to bear the weight of the body. The five lumbar vertebrae are numbered L1 to L5. These vertebrae are much larger in size to absorb the stress of lifting and carrying heavy objects. (Drake 2009)

Sacrum - the main function of the sacrum is to connect the spine to the hip bones (iliac). There are five sacral vertebrae, which are fused together. Together with the iliac bones, they form a ring called the pelvic girdle. (Drake 2009)

Coccyx region - the four fused bones of the coccyx or tailbone provide attachment for ligaments and muscles of the pelvic floor. (Drake 2009)

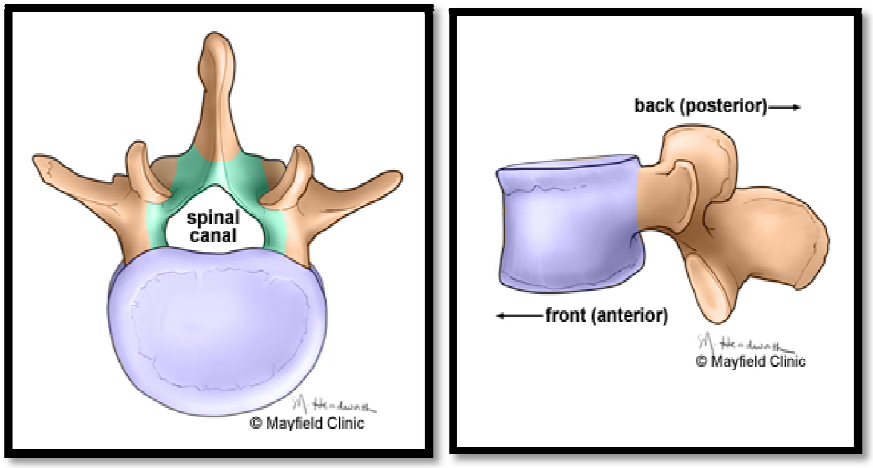


Figure 2.3 While vertebrae have unique regional features, every vertebra has three main parts: body (purple), vertebral arch (green), and processes for muscle attachment (tan).(Pansky,1996)

2.1.4 The intervertebral discs

Each vertebra in your spine is separated and cushioned by an intervertebral disc, keeping the bones from rubbing together. Discs are designed like a radial car tire. The outer ring, called the annulus, has criss-crossing fibrous bands, much like a tire tread. These bands attach between the bodies of each vertebra. Inside the disc is a gel-filled center called the nucleus, much like a tire tube.(Rosse 1997)

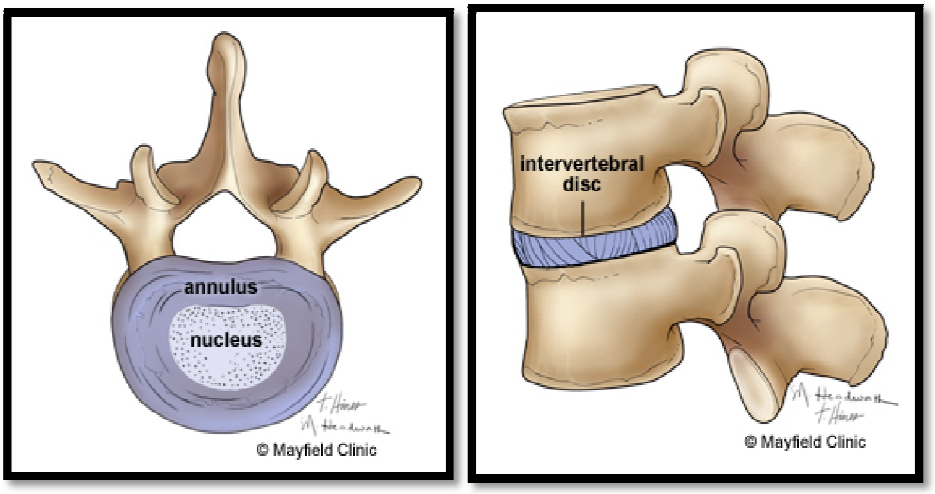


Figure 2.4 Intervertebral discs(Pansky,1996)

2.1.5 Vertebral arch & spinal canal

The arch is made of two supporting pedicles and two laminae .The hollow spinal canal contains the spinal cord, fat, ligaments, and blood vessels. Under each pedicle, a pair of spinal nerves exits the spinal cord and pass through the intervertebral foramen to branch out to your body. Seven processes arise from the vertebral arch: the spinous process, two transverse processes, two superior facets, and two inferior facets.(Rosse 1997)

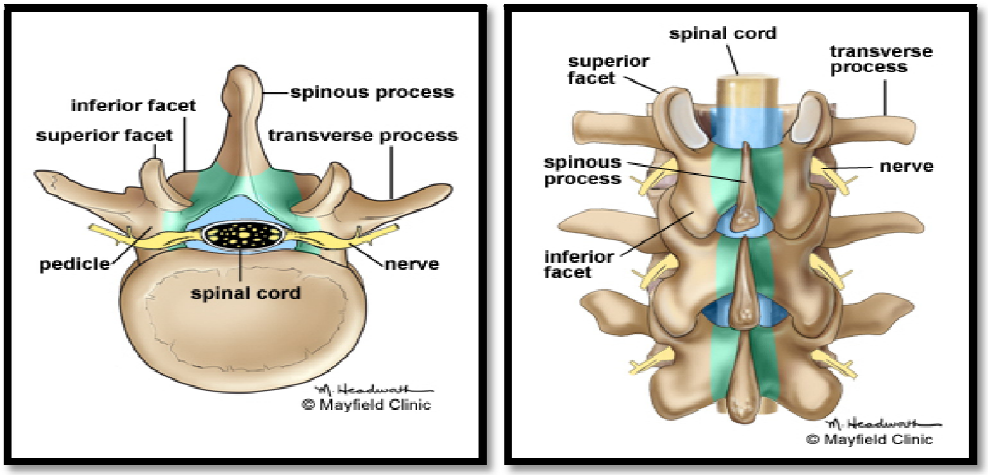


Figure 2.5 The vertebral arch (green) forms the spinal canal (blue) through which the spinal cord runs.(Pansky,1996)

2.1.6. The ligaments

There are different ligaments involved in the holding together of the vertebrae in the column, and in the column's movement. The anterior and posterior longitudinal ligamentsextend the length of the vertebral column along the front and back of the vertebral bodies. The interspinous ligaments connect the adjoining spinous processes of the vertebrae. The supraspinous ligament extends the length of the spine running along the back of the spinous processes, from the sacrum to the seventh cervical vertebra. From there it is continuous with the nuchal ligament. (Williams 2007)

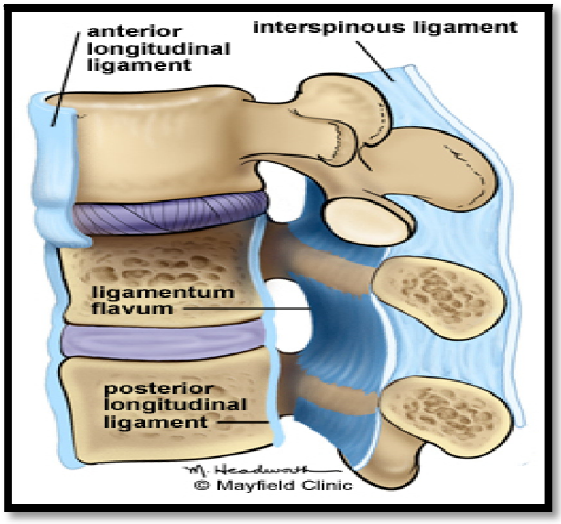


Figure 2.6 The ligamentumflavum, anterior longitudinal ligament (ALL), and posterior longitudinal ligament (PLL).(Pansky,1996)

2.1.7 The muscle

The two main muscle groups that affect the spine are extensors and flexors. The extensor muscles enable us to stand up and lift objects. The extensors are attached to the back of the spine. The flexor muscles are in the front and include the abdominal muscles. These muscles enable us to flex, or bend forward, and are important in lifting and controlling the arch in the lower back. (Williams 2007)

2.1.8 Spinal cord

The vertebral column surrounds the spinal cord which travels within the spinal canal, formed from a central hole within each vertebra. The spinal cord is part of the central nervous system that supplies nerves and receives information from the peripheral nervous system within the body. The spinal cord consists of grey and white matter and a central cavity, the central canal. Adjacent to each vertebra emergespinal nerves. The spinal nerves provide sympathetic nervous supply to the body, with nerves emerging forming the sympathetic trunk and the splanchnic nerves. (Williams 2007)

The spinal canal follows the different curves of the column; it is large and triangular in those parts of the column which enjoy the greatest freedom of movement, such as the cervical and lumbar regions; and is small and rounded in the thoracic region, where motion is more limited. The spinal cord terminates in the conusmedullaris and cauda equina. (Williams 2007)

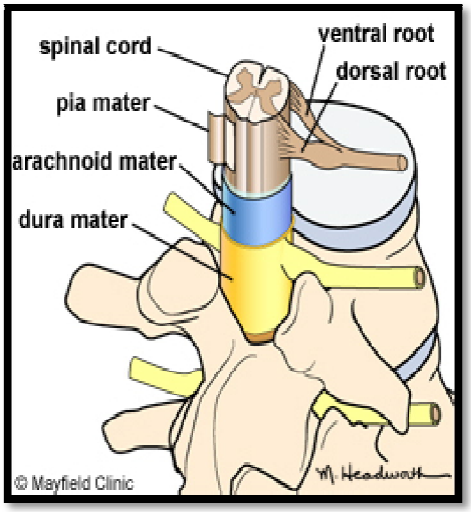


Figure 2.7 The spinal cord is covered by three layers of meninges: pia, arachnoid and dura mater.(Pansky,1996)

2.2 Pathology

2.2.1 Annular Disc Tear

An intervertebral disc is a strong ligament that connects one vertebral bone to the next. The discs are the shock-absorbing cushions between each vertebra of the spine. Each disc has a strong outer ring of fibers, called the annulus fibrosus, and a soft, jelly-like center, called the nucleus pulposus. The annulus is the strongest area of the disc and connects each vertebra together. (Underwood, 1996)

The annulus can tear or rupture anywhere around the disc. If it tears and no disc material is ruptured, this is called an annular tear. The outer 1/3 of the disc's annular ring is highly innervated with pain fibers. Thus, if a tear involves the outer 1/3 it may be extremely painful. This tear will heal with scar tissue over time but is

more prone to future tears and injury. Studies also indicate that annular tears may lead to premature degeneration of the disc, endplates, and facet joints. (Underwood, 1996)

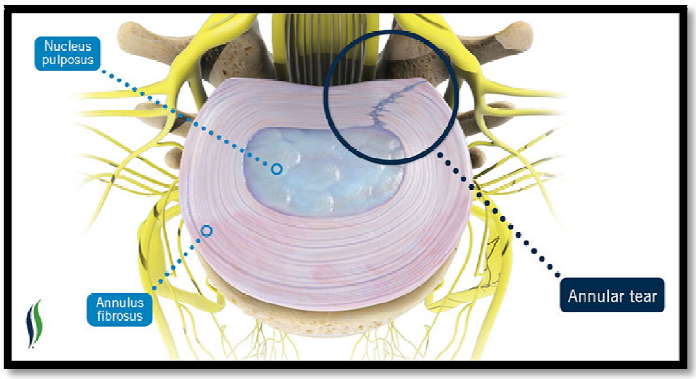


Figure2.8annular disc tear(www.wikipedia.org)

2.2.1.1 Types of annular tear

The annulus fibrosus is constructed of several layers, each of which can become torn. The nature of the tear and the layers it affects will be the basis for how the tear is categorized:

1- **Radial tears** — Typically caused by the natural aging process, radial tears begin at the center of the disc and extend all the way through the outer layer of the annulus fibrosus. These tears can cause a disc to herniate, which occurs when the center nucleus of a disc extrudes through the tear to the outside of the disc. (Underwood, 1996)

2- **Peripheral tears** — (also known as rim lesion or transverse tear) These tears occur in the outer fibers of the annulus fibrosus and are usually brought on by traumatic injury or contact with a bone spur. Peripheral tears can lead to the degeneration or breakdown of an intervertebral disc. (Underwood, 1996)

3- **Concentric tears** — (also known as circumferential tears, or delaminations), the broken fibers are parallel with the borders of the intervertebral disc at

some distance in between the center and edge[1]. Tears here create spaces between adjacent concentric fibers which can fill with fluid, such as the nucleus pulposus. These tears often occur with compressive stress on older discs[3], which is usually caused by injury. (Underwood, 1996)

4- **Horizontal tear** —also known as a transverse tear), which are usually small and may represent early stages of age-related disc deformity[1]. These are often found in conjunction with radial tears. (Underwood, 1996)

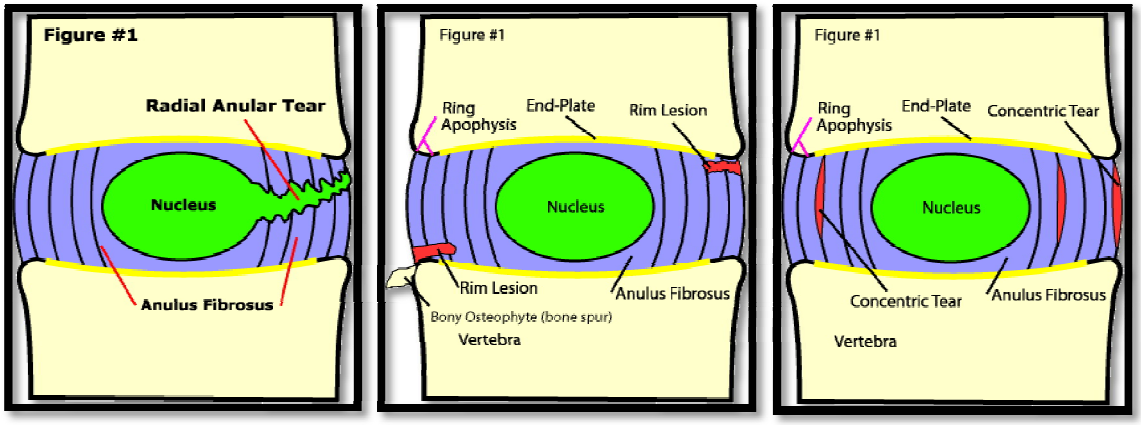


Figure 2.9 Types of annular tear(www.wikipedia.org)

2.2.2 Herniated disc (nucleus pulpous)

A herniated disc occurs when the inter vertebral disc outer fibers (the annuls are damage and the soft inner material of the nucleus pulpous protrude out of its normal space if the annulus tear near the spinal canal). This can cause mush pressure on the spinal cord and nerve root. There is also some evidence that the nucleus pulpous material cause a chemical irritation of nerve root and the chemical irritation can lead to problems the nerve function. a herniated disc is common in lumbar spine because of the all pressure it supports . Herniated lumber disc often produce sciatica, condition where the lower back pain and numbness radiation down to the back of the leg. (Underwood, 1996)

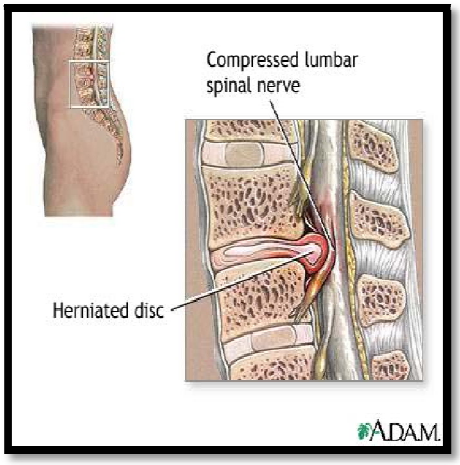


Figure 2.10 A spinal disc herniation (www.wikipedia.org)

2.2.3 Bulging Disc

A bulging disc is the same as a herniated disc, but there is a difference. With a herniated disc, a crack occurs in the outer layer of the disc, called the annulus. The crack usually affects a small part of the disc, and it allows the soft inner material of the nucleus pulposus to rupture out of the disc. A bulging disc is different because the disc simply bulges outside the space it normally occupies between your vertebrae, but it doesn't rupture. A herniated disc is more likely to be painful. It's possible for you to have a bulging disc without feeling any pain at all.(Underwood, 1996)

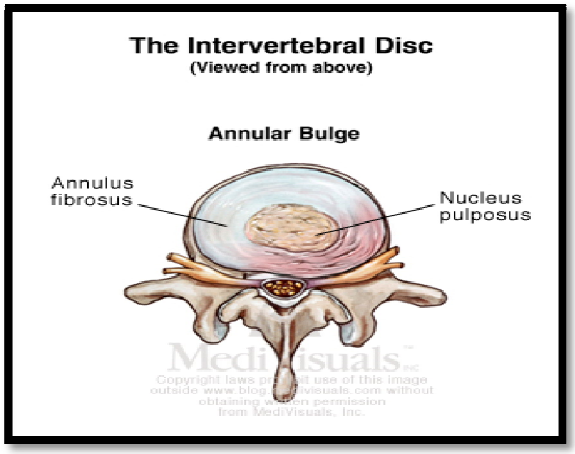


Figure 2.11bulging disc(www.wikipedia.org)

2.2.4Spinal Stenosis

Spinal stenosis the narrowing of the spinal canal. This narrowing of the spinal canal limits the amount of space for the spinal cord and nerves. Pressure on the spinal cord and nerves due to limited space can cause symptoms such as pain, numbness, and tingling. The most common reason to develop spinal stenosis is degenerative arthritis, or bony and soft tissue changes that result from ageing. Spinal stenosis is usually seen in patients over 50 years of age, and becomes progressively more severe with increased age, Spinal canal diameter less than 12 mm indicates narrowing of the canal.(Edward f. Goljan, 1998)

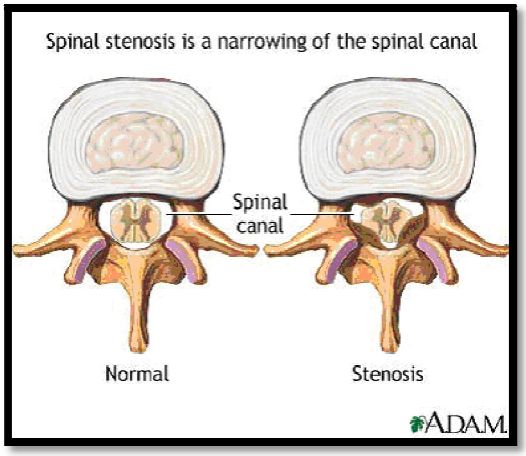


Figure 2.12 Spinal Stenosis(www.wikipedia.org)

2.2.5Osteophytes

Lumbar osteophytes, also known as bone spurs, are smooth growths that form on the facet joints and/or around the vertebrae in the lower spine. Bone spurs do not always cause pain, but in some cases may compress nerves in the lower back causing symptoms of radiating pain, weakness, tingling, or numbness in the legs and feet, along with stiffness and lack of movement in the lower back. (Edward f. Goljan.1998)

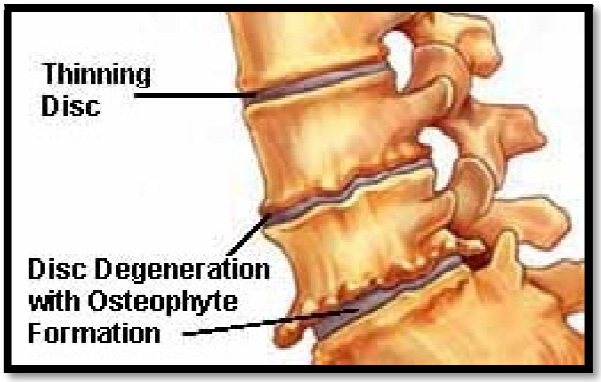


Figure 2.13 Lumbar osteophytes(www.wikipedia.org)

2.2.6 Ligamentumflavum thickening

Ligamentumflavum thickening was measured on the axial image, perpendicular to the spinal canal axis and parallel to the lamina, where ligamentumflavum were seen along their entire length & measurement were taken at the half length of ligament flavum. According to Park et al., a mean thickness of the ligamentumflavum of 4.44 mm in the patients with the spinal canal stenosis labeled as thickened and 2.44 mm thickness in the control group. So, we had labeled a >4 mm ligamentumflavum thickening as thickened. (Edward. Goljan.1998)

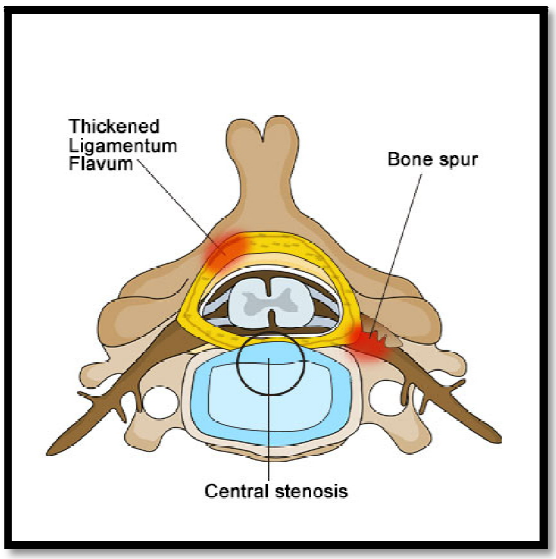


Figure 2.14 Ligamentumflavum thickening(www.wikipedia.org)

2.2.7 Spondylosis

Spondylosis is a general term for degenerative arthritic changes of the spine, or more simply arthritis. Most degenerative changes of the spine are part of the normal aging process, much like developing grey hair. Everyone is expected to have some evidence of spondylosis as they get older. Many times, patients who have spondylosis on imaging studies do not have any symptoms. In fact, more than 90% of adults over 65 show signs of arthritis. These degenerative changes most commonly occur at the vertebral body and openings for nerve roots. (Edward .Goljan, 1998)

2.2.8Degenerative disc disease

Degenerative disc disease (DDD) is a condition in which the discs, or fluid filled sacs, that sit between each vertebrae of the spinal column deteriorate over time. The purpose of these discs is two-fold--the jelly-like center provides shock absorbency as the vertebrae move atop one another, and the cartilaginous outer ring provides vertical lift so that the nerves that come off of the spinal cord can travel freely to the rest of the body. A deteriorating disc causes pain--most commonly of the neck and low back--as well as narrowing of the spinal column and osteoarthritis.(Battié 2006)

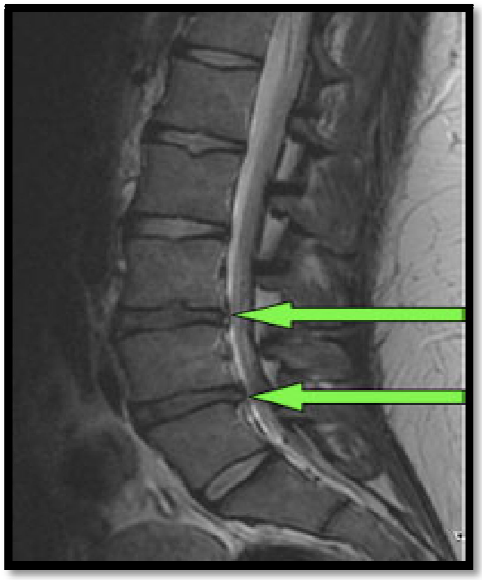


Figure 2.15MRI of the lumbar spine showing multilevel degenerative disc disease (DDD). Note the loss of hydration demonstrated at L3-4 and L4-5 (Modic,1999)

2.2.8.1Pathophysiology

The normal intervertebral disk consists of the nucleus pulposus surrounded by the anulusfibrosus. Both the anulus and the nucleus are composed of collagen and proteoglycans (chondroitin-6-sulfate, keratan sulfate, hyaluronic acid, and chondroitin-4-sulfate). The nucleus contains relatively more proteoglycans to give it a looser gelatinous texture. It blends in with the surrounding anulus without clear anatomic demarcation. The anulus has more collagen, and the collagen becomes progressively more compact and tougher at the periphery. The outer anulus is attached to the adjacent vertebral bodies at the site of the fused epiphyseal ring by Sharpey's fibers and to the anterior and posterior longitudinal ligaments. Normal disks are well hydrated, the nucleus containing 80 to 85% water and the anulus about 80%. Together with the cartilaginous end plates of the adjacent vertebral bodies, the intervertebral disk forms a disk complex that gives structural integrity to the interspace and cushions the mechanical forces applied to the spine. (Battié 2006)

With aging, certain biochemical and structural changes occur in the intervertebral disks. There is an increase in the ratio of keratan sulfate to chondroitin sulfate, and the proteoglycans lose their close association with the disk collagen. The disk also loses its water-binding capacity and the water content decreases down to 70%. These changes are reflected by a 6% decrease in MR signal intensity over a span of 79 years. The vertebral end plates also become thinner and more hyalinized. This degree of disk degeneration is considered a normal part of aging. (Battié MC 2006)

With more advanced degeneration, dense disorganized fibrous tissue replaces the normal fibrocartilaginous structure of the nucleus pulposus, leaving no distinction between the nucleus and anulusfibrosus. Development of anular tears weakens the

anulus and allows nucleus to protrude into the defect. Tears that extend through the outer anulus induce ingrowth of granulation tissue and accelerate the degenerative process. Advanced degeneration can lead to gas formation or calcification within the disk. Also, fissures develop in the cartilaginous end plates, and regenerating chondrocytes and granulation tissue form in the area. (Battié 2006)

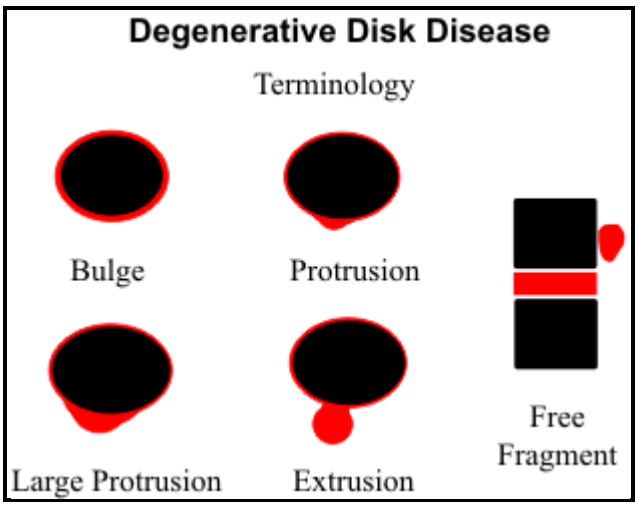


Figure 2.16 Desiccation - loss of disk water

Disk bulge - circumferential enlargement of the disk contour in a symmetric fashion.Protrusion - a bulging disk that is eccentric to one side but < 3 mm beyond vertebral margin.

Herniation - disk protrusion that extends more than 3 mm beyond the vertebral margin.Extruded disk - extension of nucleus pulposus through the anulus into the epidural space.

Free fragment - epidural fragment of disk no longer attached to the parent disk. (Battié 2006)

2.2.8.2 Causes

2.2.8.2.1 Aging

Aging as a cause of DDD is the culmination of years upon years of use, also known as wear and tear. According to Cedars-Sinai Hospital, normal wear and tear over a 20 to 30 year period causes small tears of the disc cartilage in nearly everyone, but does not translate into pain for every aging person. The discs do not receive a direct blood supply like other tissues in the body and, the wear and tear can accumulate to the point that degeneration will set in. This causes altered function, instability and pain in some people. (Pearce,1991)

2.2.8.2.2 Injury/Trauma

A blunt or acute injury to the back can lead to a tremendous tear in one or more disc in an instant. Ceders-Sinai Hospital notes that the effects of a direct trauma can cause swelling, soreness and instability, promoting further deterioration and interfering with any potential healing in the area. Injuries of this magnitude can occur secondary to sports injuries or as a result of slip-and-fall accidents. Repetitive injury, similarly to aging, occurs over a longer period of time and can expedite the damage caused by the aging process. In particularly susceptible individuals, repetitive bending, twisting, lifting and even the constant vibration from driving as an occupation, can induce DDD. (Pearce,1991)

2.2.8.2.3 Genetics

Although the aging process and repetitive injury of occupation consistently results in degenerative disc changes, it does not cause pain and altered function in all people. Scientists are currently looking into whether genetics may play a part in who suffers from DDD. The vast difference in the subjective responses to the changes of DDD has been linked to a number of genetic variables and expressions. A 2002 Annuals of Medicine journal article lists genetic imbalances between enzymes that break down disc cartilage versus those that inhibit this action,

variations in other markers of cartilage function and differences the body’s use of vitamin D as genetic factors that may dictate an individual's experience with DDD. (Pearce,1991)

2.2.8.2.4 Dehydration

The center portion of the disc is filled with fluid. Adequate hydration of this sac determines its ability to be plump and absorb the shock of movement and small trauma. Without proper nutrition, the discs can become flat and dry. Chiropractor Kenneth Erickson notes that decreased hydration of the discs is the most common finding on an MRI when diagnosing degenerative disc disease. Dr. Erickson notes that dehydration occurs when less fluid is pulled into the disc than is squeezed out with the compressions of movement. (Pearce,1991)

2.2.8.2.5 Smoking

Nicotine, the main ingredient in cigarettes, is implicated as a promoter of DDD, especially when combined with other risk factors and causes. The effects of nicotine on the nucleus pulposus, or the fluid -filled sac at the center of the disc, were published in a 2004 "Spine" article. Researchers concluded that nicotine starved the discs of adequate nutrients and oxygenation, instigated the dehydration of the disc and inhibited normal cell growth and reproduction. (Pearce,1991)

2.2.8.2.6 Immune System

The immune system is a new area of study in the etiology of degenerative disc disease. Besides the contribution that genetics plays into the unequal distribution of DDD among aging or similarly injured people, the inflammatory state of the body appears to also selectively promote deterioration. Rheumatologist Dr. Mark Borigini writes that a particular inflammatory chemical, IL-17, has been specifically isolated in approximately 70% of tissue samples from DDD sufferers but is rarely found in normal tissue. (Pearce,1991)

2.2.8.3 Signs and symptoms

Most patients with lumbar degenerative disc disease will experience low-grade continuous but tolerable pain that will occasionally flare (intensify) for a few days or more. Symptoms can vary, but the general characteristics usually include:

- Pain that is centered on the lower back, although it can radiate to the hips and legs
- Lower back pain that is continuous and has lasted more than 6 weeks
- The sensation is often described as more of a painful ache in the lower back, as opposed to searing or burning pain that radiates
- Pain that is frequently worse when sitting, when the discs experience a heavier load than when patients are standing, walking or even laying down. Prolonged standing may also aggravate the pain, as can bending forward and lifting an object
- Pain that is exacerbated by certain movements, particularly bending, twisting or lifting
- Severe symptoms can include numbness and tingling in the legs, as well as difficulty walking. (Pfirrmann,2001)

2.2.8.4Complications:

Complications and sequelae of Degenerative Disc Disease from the Diseases Database include:

- Radiculopathy
- Muscle weakness
- Neurogenic bladder
- Incontinence, urine
- Lower motor neurone lesion
- Neck pain

- Raynaud's phenomenon
- Back pain
- Leg pain(Pfirrmann,2001)

2.2.8.5 Diagnosis modalities

2.2.8.5.1 Physical examination

The diagnosis of degenerative disc disease begins with a physical examination of the body, with special attention paid to the back and lower extremities.

Your doctor will examine your back for flexibility, range of motion, and the presence of certain signs that suggest that your nerve roots are being affected by degenerative changes in your back. This often involves testing the strength of your muscles and your reflexes to make sure that they are still working normally.(Schneiderman, 1987)

2.2.8.5.2 X-ray

X-rays are effective at showing narrowed spinal channels (spinal stenosis), fractures, bone spurs (osteophytes), or osteoarthritis On the plain films, your surgeon will be looking for vertebral alignment, scoliosis, and fracture—other spinal issues that can come along with DDD, Your surgeon may also order flexion and extension x-rays to evaluate the stability of your spine and your range of motion (how well your joints move). You'll be asked to bend forward (flexion) and backwards (extension) during these x-rays. (Schneiderman, 1987)

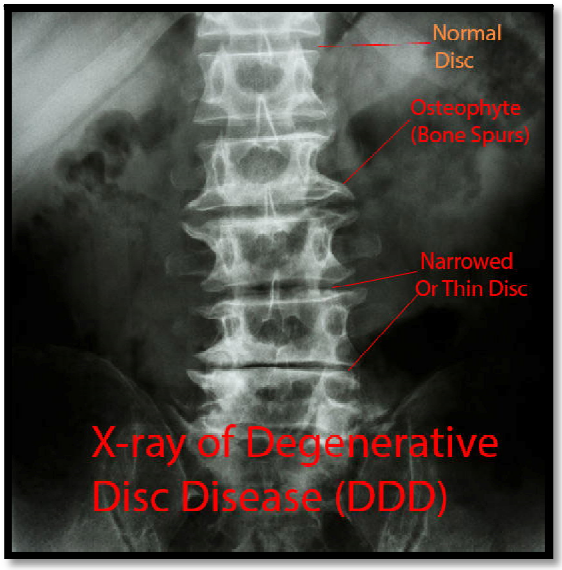


Figure 2.17X-ray of degenerative disc disease (Modic,1999)

2.2.8.5.3 CT

A CT scan works by shooting an X-ray beam through the body. Next, a computer is used to reformat the image into cross sections of the spine. This process is repeated at multiple different intervals, a CT scan is often used to evaluate the bony anatomy in the spine, which can show how much space is available for the nerve roots and within the neural foramina and spinal canal.

CT scans should not be performed for women who may be pregnant..(Schneiderman, 1987)

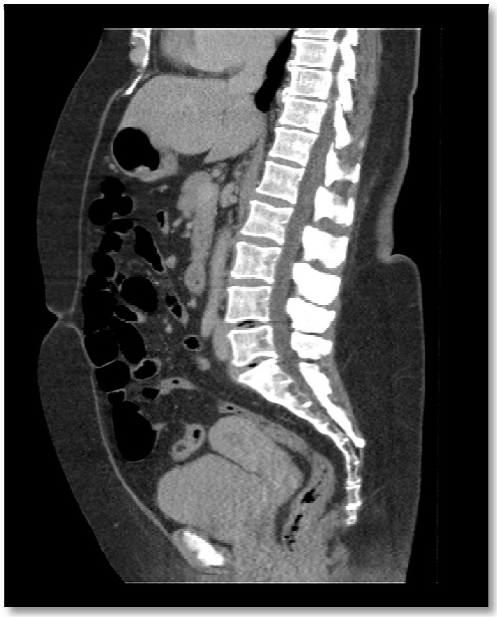


Figure 2.18 reconstruction of a CT lumbar spine demonstrating multilevel degenerative disc disease (www.conciergeradiologist.com)

2.2.8.5.4 MRI

The most common test to diagnose a herniated disc is the MRI scan. This test is painless and very accurate. It is usually the preferred test to do (after X-rays) if a herniated disc is suspected.(Schneiderman, 1987)

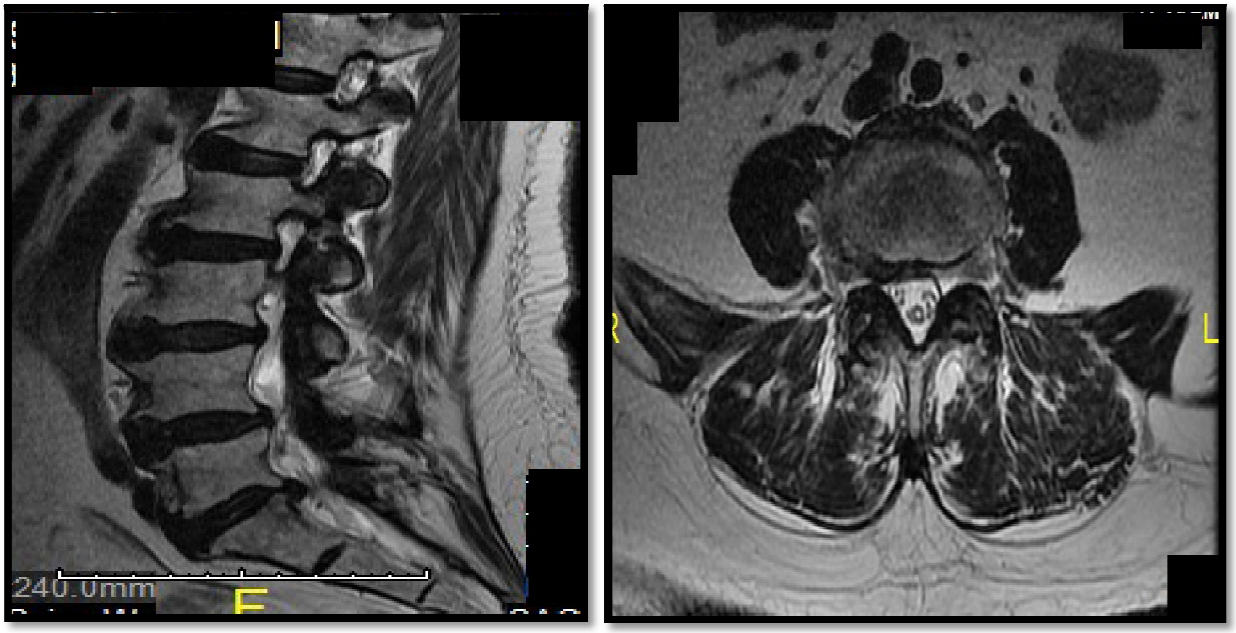


figure 2.19 Sagittal and axial MRI. reveal herniated nucleus pulposus, DDD and foraminal stenosis at L4-L5 and L5-S1(www.conciergeradiologist.com)

2.2.8.5.5Electromyography (EMG)

Electromyography (EMG) is a diagnostic procedure to assess the health of muscles and the nerve cells that control them (motor neurons), motor neurons transmit electrical signals that cause muscles to contract. An EMG translates these signals into graphs, sounds or numerical values that a specialist interprets, an EMG uses tiny devices called electrodes to transmit or detect electrical signals, during a needle EMG, a needle electrode inserted directly into a muscle records the electrical activity in that muscle, a nerve conduction study, another part of an EMG, uses electrodes taped to the skin (surface electrodes) to measure the speed and strength of signals traveling between two or more points, EMG results can reveal nerve dysfunction, muscle dysfunction or problems with nerve-to-muscle signal transmission..(Schneiderman, 1987)

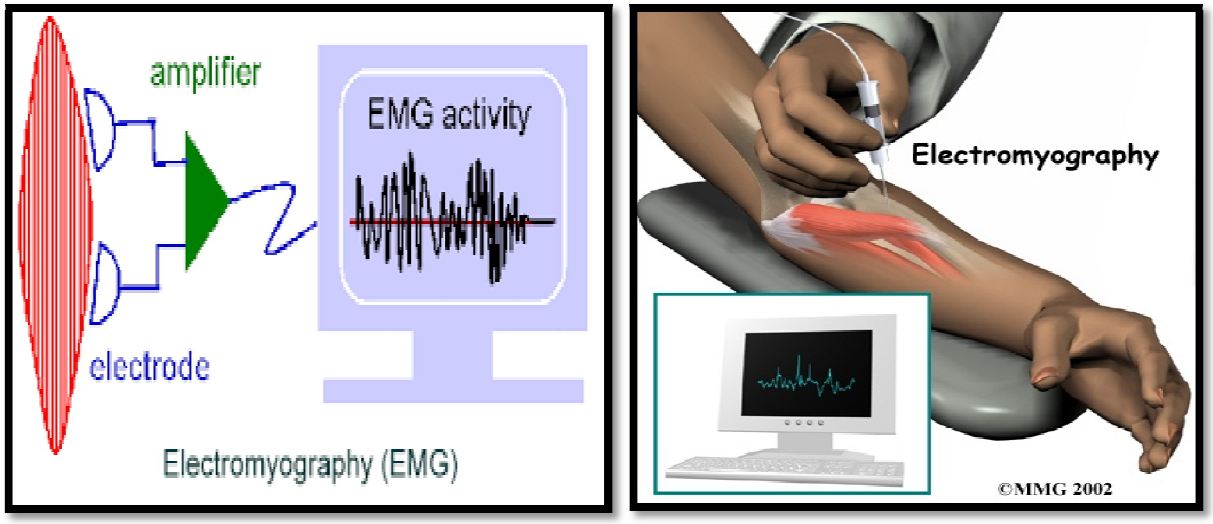


Figure 2.20 Electromyography (EMG)(www.conciergeradiologist.com)

2.2.8.5.6 Bone scan:

The bone scan to help your surgeon detect spinal problems such as osteoarthritis, fractures, or infections (which can all be related to DDD), you may have a bone scan. You will have a very small amount of radioactive material injected into a blood vessel. That will travel through your bloodstream and be absorbed by your bones. More radioactive material will be absorbed by an area where there is abnormal activity, such as an inflammation. A scanner can detect the amount of radiation in all your bones and show the "hot spots" (the areas with more radioactive material) to help your surgeon figure out where the problem is. (Schneiderman, 1987)

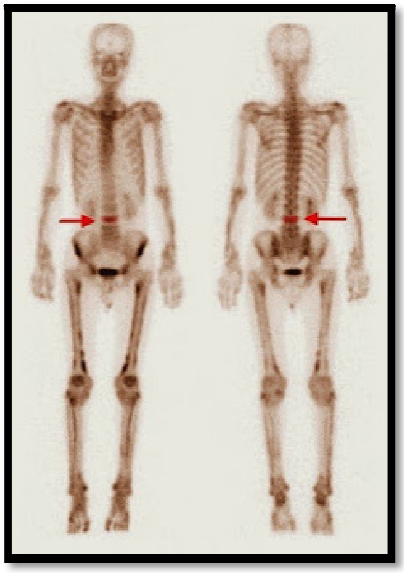


Figure 2.21 This image is a Nuclear Bone Scan of the whole body, taken from the front on the left and back on the right. An area if increased activity is seen in one of the vertebrae of the low-back (lumbar spine) (www.conciergeradiologist.com)

2.2.8.5.7 Discogram or discography:

This is a procedure that confirms or denies the disc(s) as the source of your pain. You will have a harmless dye injected into one of your discs. If there's a problem with your disc—like it's herniated—the dye will leak out of the disc. The surgeon will be able to see that on an x-ray, and that will show him/her that there's something wrong with your disc. (Schneiderman G, 1987)

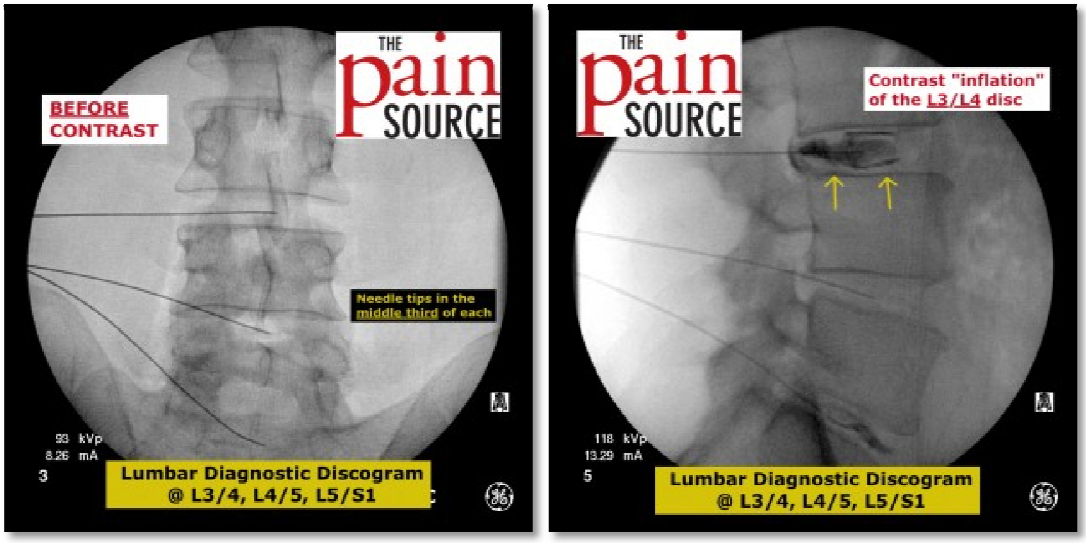


Figure 2.22 Injection of contrast into the L3/L4 disc (our control disc) with a digital manometer. Note the extravasation of contrast posteriorly.Before injecting the contrast, needles are checked in the AP view to make sure they are in the middle third of the discs(www.conciergeradiologist.com)

2.2.8.5.8 Myelogram:

The myelogram to see if you have a spinal canal or spinal cord disorder perhaps nerve compression causing pain and weaknessyou may have a myelogram. In this test, you'll have a special dye injected into the area around your spinal cord and nerves. (Before that happens, the area will be numbed.) Then you'll have an x-ray or a CT scan. The image will provide a detailed anatomic picture of your spine, especially of the bones, that will help your spine surgeon to identify any abnormalities. (Schneiderman, 1987)

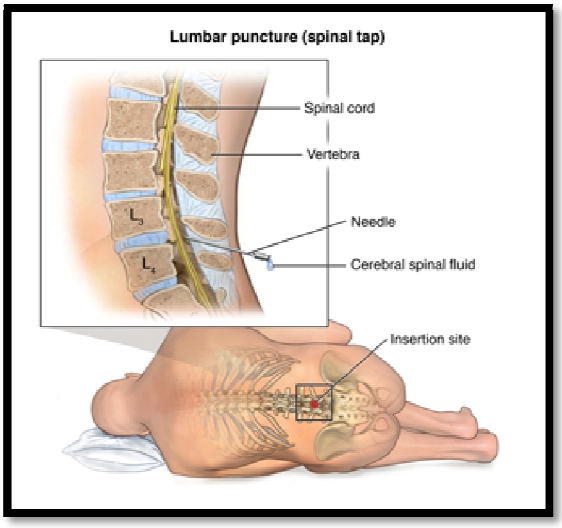


Figure 2.23myelogram(www.conciergeradiologist.com)

2.2.8.6Treatment

Treatments can vary depending on the severity of your symptoms and how much they limit your everyday activities. Here are some treatments you may want to discuss with your doctor, depending on your level of pain:

2.2.8.6.1 Non-surgical treatments

Not all patients with pain from degenerative disc disease require surgery. For mild to moderate pain, more conservative treatment methods can include medications, physical therapy, andchiropractic care.

2.2.8.6.2 Surgical treatments

A procedure called a spinal fusion can be used to surgically treat degenerative disc disease. (Schneiderman, 1987)

2.3 Magnetic Resonance Imaging (MRI)

2.3.1Background

Magnetic resonance imaging (MRI), nuclear magnetic resonance imaging (NMRI), or magnetic resonance tomography (MRT) is a medical imaging technique used in radiology to image the anatomy and the physiological processes of the body in

both health and disease. MRI scanners use strong magnetic fields, radio waves, and field gradients to form images of the body. (Pfirrmann,2001)

2.3.2 History of MRI

1882- Nikola Tesla discovered the Rotating Magnetic Field in Budapest, Hungary. This was a fundamental discovery in physics.

1937- Columbia University Professor Isidor I. Rabi working in the Pupin Physic Laboratory in New York City, observed the quantum phenomenon dubbed nuclear magnetic resonance (NMR). He recognized that the atomic nuclei show their presence by absorbing or emitting radio waves when exposed to a sufficiently strong magnetic field .

1973- Paul Lauterbur, a chemist and an NMR pioneer at the State University of New York, Stony Brook, produced the first NMR image. It was of a test tube.

1993- Functional MR imaging of the brain is introduced .

2000's - Cardiac MRI, Body MRI, fetal imaging, functional MR imaging are further developed and become routine in many imaging centers. Research centers make significant strides forward in imaging cartilage on high field scanners. The number of free standing MRI centers, most of which utilize low or moderate field MR scanners significantly increases. (Pfirrmann,2001)

2.3.3 Principle of MRI

The basis of MRI is the directional magnetic field, or moment, associated with charged particles in motion. Nuclei containing an odd number of protons and/or neutrons have a characteristic motion or precession. Because nuclei are charged particles, this precession produces a small magnetic moment.

When a human body is placed in a large magnetic field, many of the free hydrogen nuclei align themselves with the direction of the magnetic field. The nuclei precess

about the magnetic field direction like gyroscopes. This behavior is termed Larmor precession. (Pfirrmann,2001)

In a 1.5 T magnetic field at room temperature this difference refers to only about one in a million nuclei since the thermal energy far exceeds the energy difference between the parallel and ant parallel states. Yet the vast quantity of nuclei in a small volume sum to produce a detectable change in field. Most basic explanations of MRI will say that the nuclei align parallel or anti-parallel with the static magnetic field; however, because of quantum mechanics quantum mechanical reasons, the individual nuclei are actually set off at an angle from the direction of the static magnetic field. The bulk collection of nuclei can be partitioned into a set whose sum spin are aligned parallel whose sum spin are anti-parallel. (Pfirrmann,2001)

2.3.4 Scanner construction and operation

2.3.4.1 Magnet

The magnet is the largest and most expensive component of the scanner, and the remainder of the scanner is built around it. The strength of the magnet is measured in Teslas (T). Clinical magnets generally have field strength in the range 0.1–3.0 T. Three types of magnet have been used:

1-Permanent magnet: Conventional magnets made from ferromagnetic materials.

2-Resistive electromagnet: A solenoid wound from copper wire is an alternative to a permanent magnet.

3-Superconducting electromagnet: most common type found in MRI scanners today. (Pfirrmann,2001)

2.3.4.2 Radio frequency(RF) system

The RF transmission system consists of a RF synthesizer, power amplifier and transmitting coil. This is usually built into the body of the scanner. The power of

the transmitter is variable, but high-end scanners may have a peak output power of up to 35 kW, and be capable of sustaining average power of 1 kW. The receiver consists of the coil, pre-amplifier and signal processing system. (Pfirrmann,2001)

A recent development in MRI technology has been the development of sophisticated multi-element phased array coils which are capable of acquiring multiple channels of data in parallel. This 'parallel imaging' technique uses unique acquisition schemes that allow for accelerated imaging, by replacing some of the spatial coding originating from the magnetic gradients with the spatial sensitivity of the different coil elements. However the increased acceleration also reduces SNR and can create residual artifacts in the image reconstruction. Two frequently used parallel acquisition and reconstruction schemes are sense. (Pfirrmann,2001)

2.3.4.3 Coils

A Coil are part of the hardware of MRI machines and are used to create a magnetic field by voltage induced in the wire, coil consists of one or more loops of conductive wire, looped around the core of the coil. (Pfirrmann,2001)

Different types of MRI coils are used in MR systems**:**

2.3.4.3.1 Surface Coil

Is essentially a loop of conducting material, This type ofreceiver coil is placed directly on or over the region of interest for increased magnetic sensitivity.

2.3.4.3.2 Volume Coil

That surrounds either the whole body, or one specific region, such as the head or a knee. Volume coils have a better RF homogeneity than surface coils, which extends over a large area.

2.3.4.3.3 Gradient Coil

Current carrying coils designed to produce a desired magnetic field gradient, Gradient coils in general vary the main magnetic field, so that each signal can be related to an exact location. (Pfirrmann,2001)

2.3.5 Tissue Signal Characteristics

Signal in MR images are high or low (bright or dark), depending on the pulse sequence used, and the type of tissue in the image region of interest.(Pfirrmann,2001)

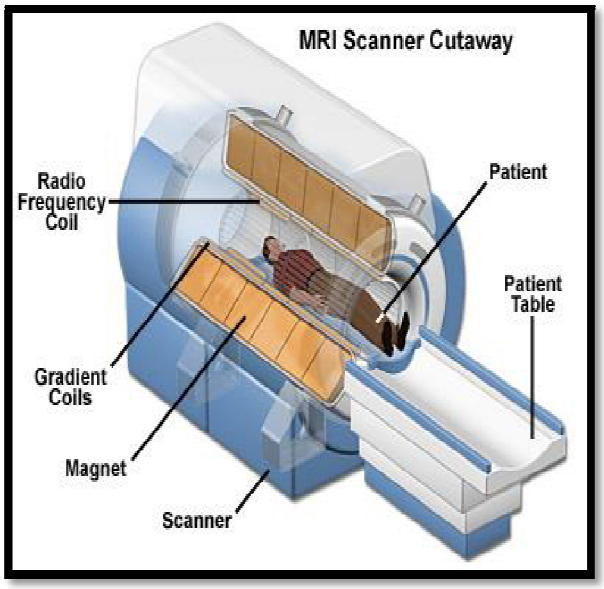
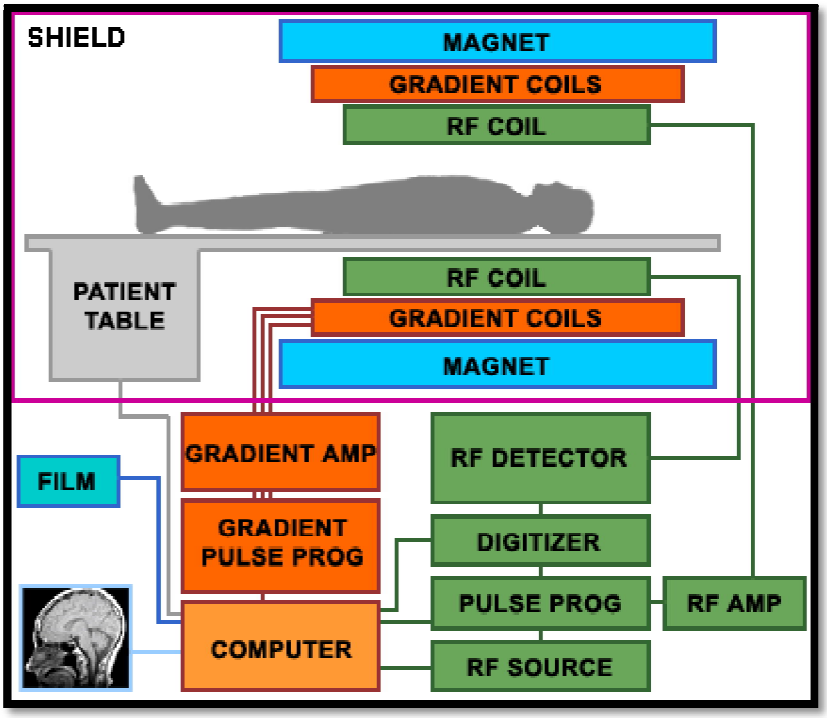


Fig 2.24 Permanent magnet MRI scanner .**Fig 2.25** Electromagnet MRI Scanner . (www.wikipedia.org)(www.wikipedia.org)



1. **Fig 26.2** Diagram of MRI Unit (MRI Hardware). (www.wikipedia.org)

2.4 Pervious Study

Ali Hassan A.Ali (2010) studied evaluation of age related changes in lumbar spine in Saudi Arabian adult population: using magnetic resonance Images, the main objective of our study was to investigate the frequency of lumbar spine degeneration in magnetic resonance images. We evaluated magnetic imaging (MRI) results from 210 patients complaining low back pain for age-related degeneration in the lumbar spine. In this study, 210 adult cases ranging between 18-90 years of age were included. The cases were classified into 3 groups: young age group (18 – 35 years old) (66 cases), middle age group(36 -55 years old) (75 cases)and old age group(56-90 years old) (69 cases).their MRI scans were performed in the department of radiology, King Khalid Hospital, Al kharj and studied for any age related changes. The most common feature observed in young age group was reduced signal intensity and modic type changes were more frequently seen in the old age group. Degenerative findings in the lumbar spine, suggesting degeneration, were common subjects. These results provide normative data for evaluating patients with degenerative lumbar diseases in Saudi adult symptomatic subjects.

Gamal Abdel Salam (2015) studied of the age related changes in the lumbar spine in Egyptian People Detected by Magnetic Resonance Image (MRI). Lumbar region is the mobile part of the vertebral column which bearing region. Unfortunately, the available data detecting the lumbar spine degenerative changes by MRI are still limited, particularly in Egypt. The present study aimed to the examination of possible age related changes in the lumbar spine in Egyptian people detected by MRI. Mid sagittal MRI scan were obtained from eighty symptomless persons (30 female’s 37.5% and 50 males 62.5% of cases) between 25-70 years of age. They were divided into two groups: first group forty cases, 25-40 years (21males& 19 females) and the second group forty cases 41-70years (29 males & 11 female).

From all samples, there were 38 normal (47.5%) and the abnormal cases were 42 (52.5%). It was found collectively that the abnormality were more in males than females and that was supplemented by x^{2-} test (4.83) and p value (0.028). The following diseases were seen: subchondral sclerosis, osteophytes, disc degeneration, subchondral multiple small cyst, disc prolapsed and spondolysis with variations in ages and sexes. In conclusion it was found that, the lumbar region affected early by the age and more affected in males than in females.

CHAPTER THREE

MATERIAL AND METHODS

3.1 Material

3.1.1 Area of Research

The study was performed in the MRI center in Khartoum Advanced Diagnostic Center.

3.1.2 Data sample

The entire populations of this study were 50patients' males and females with different agesrange. They referred to MRI center for MRI examination of lumbar spine. With clinical history of back pain.

3.1.3 Machine used

For MRI was used 1.5 Tesla scanner (PHILIPS) closed permanent magnet unit.

3.1.4 Patientpreparations

-Written consent from the pt before entering the scanner room.

-Ask the pt to Remove all metal object

- Pt with electrically, magnetically or mechanically activated implants including cardiacpacemaker, insulin pups should be identified before undergoing MRI.

-Note the weight of the pt.

3.1.5 Type of coil used

Surface Coil

3.1.6 Contrast usage

It is gadolinium DTPA, given intravenously (IV), the recommended dose is 0.1mmol/kg

3.1.7 Patient position

Patient head first Supine.

-The longitudinal alignment light lies in the midline and horizontal alignment light over the mid abdomen (4 inches abovethe iliac crest)

-Straps and foam pads are used for immobilization.

3.1.8 Protocol used

-Sagittal, axial SE T1

-Sagittal, axial SE T2

-When contrast is indicated:

-Sagittal, axial T1

3.2 Method

3.2.1 Data Collection

Data is collected from image reports and from data collection sheet that demonstrate weight, age and site of degenerative changes, symptoms, and MRI finding.

The images were interpreted and confirmed by the radiologists who were unaware of all clinical information to determined pathological finding seen.

3.2.1 Data analyzed

Data analyzed by using statistcal package and then using Microsoft Excel for data presentation(Appendex1).

3.3 Ethical consideration

During this study the patient name or individual details won't be mentioned**.**

CHAPTER FOUR

Results

The MR images of 50 patients were evaluated. For pathological finding, the site, weight, ageand symptoms. All this information was shown in the following tables and graphs.

Table 4.1 show study group according todescriptive statistics

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
weight	50	65	93	77.90	6.923
Age	50	24	75	50.22	12.461
Valid N (listwise)	50				

Table 4.2 show study group according to gender

Gender					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	22	44.0	44.0	44.0
	Female	28	56.0	56.0	100.0
	Total	50	100.0	100.0	

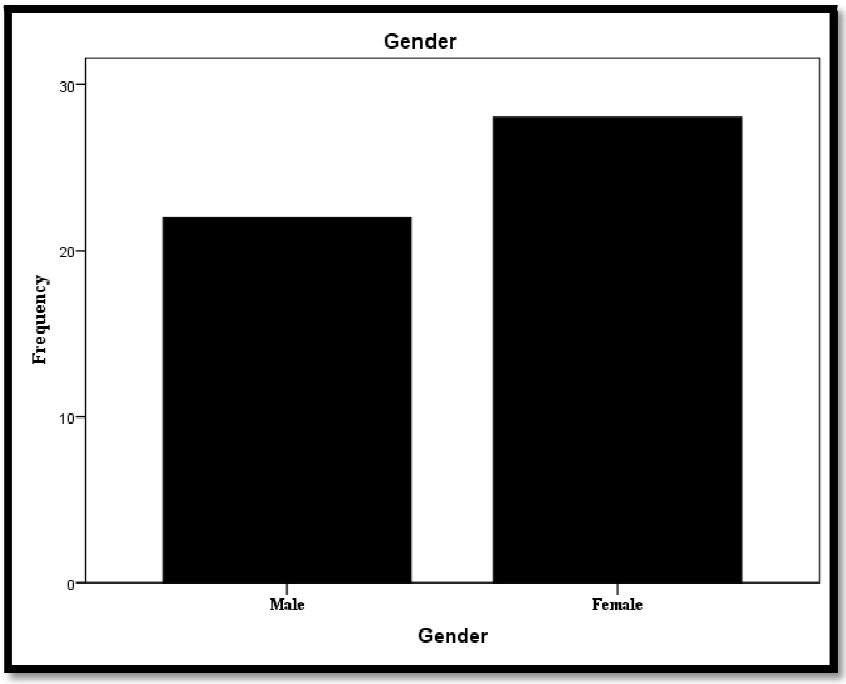


Fig 4.1 illustrated study groups according to gender

Table 4.3 show study group according Symptoms

Symptoms					
		Frequency	Percent	Valid Percent	Cumulative Percent
	Lower Back Pain	29	58.0	58.0	58.0
	Pressure in the Leg	10	20.0	20.0	78.0
	Heating in the Region	6	12.0	12.0	90.0
	Others	5	10.0	10.0	100.0
	Total	50	100.0	100.0	

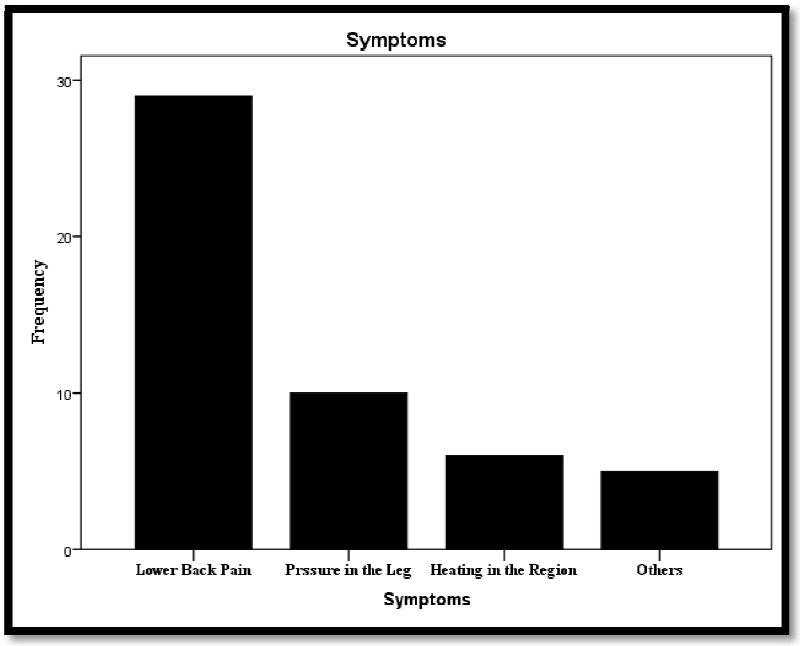


Fig 4.2 illustrated study group according Symptoms

Table 4.4 show study group according Site of Degenerative changes

Site of Degenerative changes				
	Frequency	Percent	Valid Percent	Cumulative Percent
L2 - L3	7	14.0	14.0	14.0
L3 - L4	6	12.0	12.0	26.0
L4 - L5	23	46.0	46.0	72.0
L3 - L5	14	28.0	28.0	100.0
Total	50	100.0	100.0	

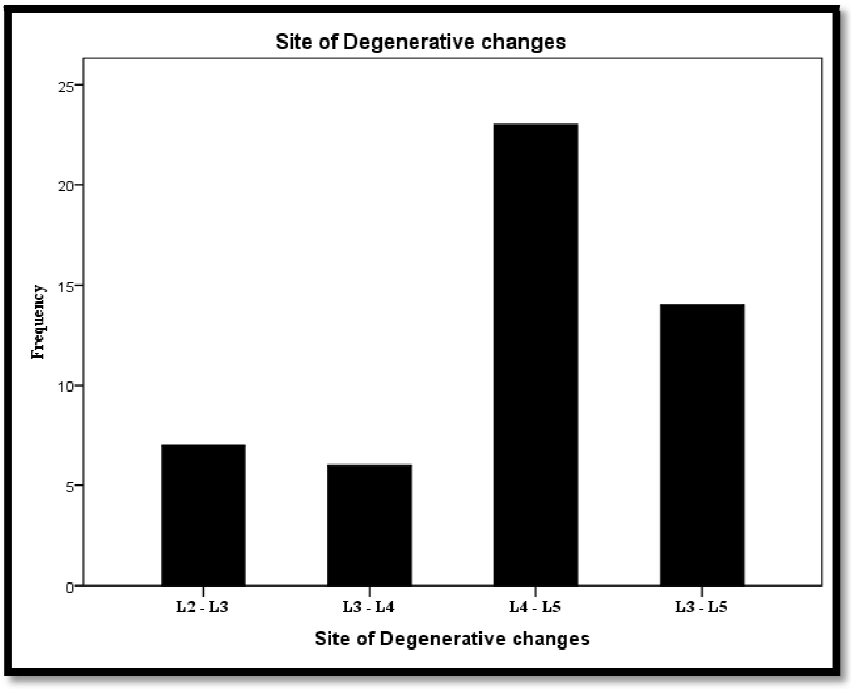


Fig 4.3 illustrated study group according Site of Degenerative changes

Table 4.5 show study group according MRI Findings

MRI Findings				
	Frequency	Percent	Valid Percent	Cumulative Percent
Herniation	21	42.0	42.0	42.0
Stenosis	8	16.0	16.0	58.0
Spondylosis	15	30.0	30.0	88.0
Others	6	12.0	12.0	100.0
Total	50	100.0	100.0	

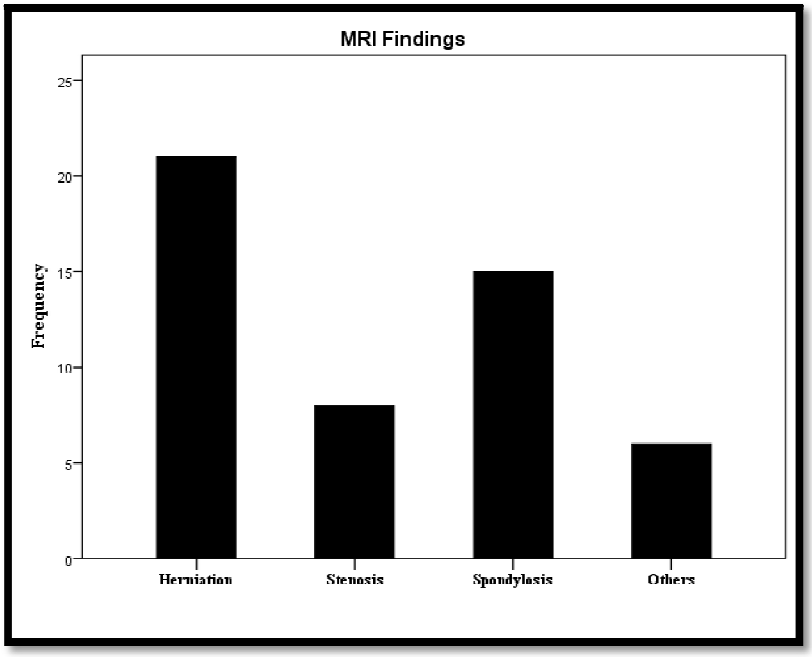


Fig 4.4 illustrated study group according MRI finding

Table 4.6 show study group according Site of Degenerative changes * MRI Findings Crosstabulation

		MRI Findings				
		Herniation	Stenosis	Spondylosis	Others	Total
Site of Degenerative changes	L2 - L3	3	0	3	1	7
	L3 - L4	2	1	2	1	6
	L4 - L5	10	4	5	4	23
	L3 - L5	6	3	5	0	14
Total		21	8	15	6	50

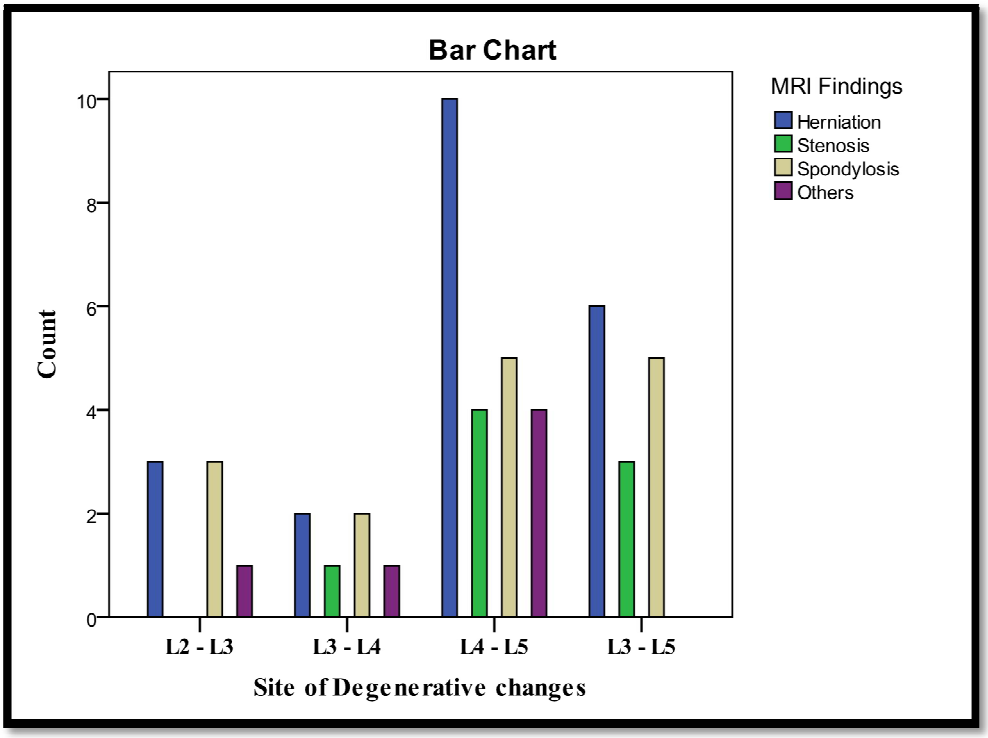


Fig 4.5 illustrated study group according Site of Degenerative changes * MRI Findings Crosstabulation

Chapter FIVE

Discussion, Conclusion and Recommendation

5.1 Discussion

This study was carried out to evaluation of age related change inlumber degeneration vertebrae in Sudanese population using MRI.

Thetable (4.1)showedthe mean weight of the sample of the studyabout 77.90 kg, and the mean of age was 50 years.

Thetable4.2 and figure 4.1 showeddegenerative disc disease according to gender,22 patient (44.0%) were male and 28 patient (56.0%) were female ,Subsequently degenerative disc disease are more common in men than in women as stated by the previous studies, in this study the women were affected more than men, this is may be due to sampling.

Thetable 4.3 and figure 4.2showed that the degenerative disc diseaseaccording tosymptoms, There were 29 patients withlower back pain(58%), the second common symptoms was Pressure in the Legwhich found in 10 patients (20.0%), the third symptom washeating in the region found in 6 patients (12.0%). This result was in line with the previous studies which stated that the Lumbar disc degeneration is the most common cause of low back pain (SUTHARet.al, 2015).

Thetable 4.4 and figure4.3 showed degenerative disc diseaseaccording to site of degenerative changes,inthe level L1-L2 not found, in L2-L3 in 7 patients about (14.0%), in L3-L4 in6 patient about (12.0%)and in L4-L5 in 23 patient about (46.0%). In L3-L5 in 14 patients about (28.0%). The most common sites in level L4-L5. This is consistent with the previous studies which stated that Disc degeneration with diffuse disc changes are more commonly found at L4 - L5 and L5 – S1 leveland L1 – L2 is least common. This Cranio-caudal directionpattern is

also followed by disc herniation. It also can be deduced that lower the lumbar level the higher is the prevalence of disc herniation(Cheung, 2009).

The table4.5and figure 4.4showed degenerative disc disease according to MRI finding, there were 21 patientswithherniation about (42.0%), stenosis seen in 8 patient about (16.0%), and Spondylosis was detected in15 patients about (15.0%), others in 6 patient about (12.0%), the most common is herniation about (42.0%).

Multiplicity in the disc level involvement is common as compare to the single disc involvement; which is also concordance with past studies (Takatalo et.al, 2009). The lower back pain and sciatica were due to nerve root compression, which was significantly associated with disc degeneration (Cheung, 2009). Spondylolisthesis was more commonly found in the patients of lumbar stenosis as compare to disc herniation, reflecting the fact that during stenosis, laxity of capsule and ligament may result in the development of spondylolisthesis. Spondylolisthesis was most commonly present at L5 – S1 disc level.

5.2 Conclusion

In conclusion, this study has showed that MRI is the best modality to of age related change inlumber degeneration vertebrae, MRI has become an attractive means for a safe, highly accurate, cost-effective diagnosis of degeneration vertebrae and may provide alternative diagnoses and explanations for symptoms in the absence of degeneration disc disease.

The incident of degeneration disc diseases are common in elder patients the mean (50.22) years.

The degeneration disc diseases are more common in female than male about (56.0%).

The most common symptoms in the patient lower back pain about (58.0%).

The L4-L5 is common site of degeneration disc disease about (46.0%).

The herniation is most common is about (42.0%).

The degenerative disc disease in L4-L5 the most common patient (23) withherniation , stenosis, and Spondylosis.

5.3 Recommendation

- This study showed that MRI is better for evaluation of age related change inlumber degeneration vertebrae.
- This study showed that , the sensitivity of MRI depends ,on the experience of operator so ,the radiologist and technologist should be continuously trained
- Future studies must used large sample to support the findings
- Technologist must be interpreted how to read MRI images if needed for other sequence or protocols to help the radiologist in evaluation of age related change inlumber degeneration vertebrae MRI.
- Requests for MRI lumbar spine must be written by experienced physician with clinical data to aid technologist in selecting proper MRI protocol.

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Appendix

Data Collection Sheet (questionnaire)

A- Data

1- Sex……

2- Weight …...……..

3- Age...…….....

B- Symptoms

1- Lower back pain

2- Numbness and tingling in the legs

3- Heating the region of the pain

4- Others ……

C- Site of degenerative disc

1- L1-L2 ( )

2- L2-L3 ( )

3- L3-L4 ( )

4- L4-L5 ( )

5- L3-L5 ( )

D- Causative factor

1- Herniaion ( )

2- Spinal stenosis ( )

3- Spondylosis ( )

4- others ( )