CHAPTER ONE

INTRODUCTION

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1.1 Background Lumbar Spine Degenerative Diseases

Normal aging of the lumbar spine involves a sequence of degenerative changes that likely start on a biochemical and cellular level and ultimately manifest as the changes that are seen clinically. Each component of the three-joint complex that makes up a functional spinal motion segment (intervertebral disc, two facet joints, ligamentous structures, and vertebral bodies) undergoes changes with aging and degeneration ,While the initiating factor is rarely identified and while it is not clear how each of these degenerative processes contribute to the observed clinical picture, it is important to consider the changes that occur in each part of the spinal motion segment in designing clinical trials to study spinal devices intended to treat lumbar degenerative disease. The intervertebral disc is thought to show decreased proteoglycan water binding within the nucleus pulposus and often a loss of disc space height. It is hypothesized that as the nucleus loses water, stresses are unevenly distributed to the annulus fibrosus altering the mechanical loading characteristics. This, coupled with the shift in collagen content and distribution that is thought to occur in the annulus with aging, can lead to bulging and/or radial tears. As the degenerative process continues, the disc becomes more fibrous and disorganized until ultimately there is no clear distinction between the nucleus and the annulus. The vertebral end-plates are thought to thin and become less permeable with aging thus compromising the nutrition of the disc and impacting disc metabolism, and as degeneration progresses, osteophytes form at the end-plate-annulus junction. The facet joints are thought to settle, become more lax, and carry more load as disc height decreases as a result of degeneration. It is thought that this load transfer may contribute to accelerated face joint

degeneration. As degeneration progresses, patients may experience degenerative spondylolisthesis and/or degenerative spinal stenosis as a result of chronic disc degeneration and the resulting secondary spinal instability (Borden et al, 1999)

1.3 Problem of study

Degenerative of lumbar spine disease is public health problem (Urban & Roberts,2003).Lumbar spine is the common area affected by degenerative changes, as it is a part of spine which is subjected to heavy mechanical stress (Ong, Anderson& Roche. 2003). This disorder is common among middle-aged individuals, who are at large the working population hence an enormous economic burden may be created in the society (Urban & Roberts ,2003).Features associated with spinal degeneration such as intervertebral disc degeneration, facet joint OA, spondylolysis, spondylolisthesis, spinal stenosis, and degenerative changes in paraspinal muscles are often identified on advanced imaging studies but are also commonly seen in asymptomatic individuals (Boden et al,1990). The role of CT scan in diagnosing lumbar spine degenerative changes is to provide accurate anatomic information and to affect the management decision making.

1.4 Objectives of study

1.4.1 Main Objective

To evaluate radiographic features of lumbar spine degeneration changes

1.4.2 Specific objectives

1. To evaluate the accuracy and sensitivity of CT in diagnosing of lumbar spine degenerative diseases.
2. To determine frequency distribution of types of degenerative of lumbar spine
3. To determine proportion of individuals with lumbar spine degenerative findings by age ,sex and spine level
4. To compare between the finding of lumbar spine degenerative diseases on CT and MRI.

1.5 Thesis outline

This study consist of five chapters Chapter one, which is an introduction, deals with theoretical frame work of the study. It presents the statement of the study problems, objectives of the study. Chapter two is divided into two sections, section one deal with theoretical background of anatomy, physiology and pathology related to the study and Section two deals with CT imaging and radiation units and measurement, literature review (previous studies). Chapter three presents the material and method. Chapter four includes result presentations. Finally chapter five will include the discussion, conclusion, recommendation and appendices.

1.6 Thesis outcome

The following scientific papers have been published during thesis period

1. **Gamaredin E. Eltayb**. *The modic vertebral endplate and marrow changes in lumbar spine: mri finding and relation to low back pain: A narrative review*. Asian Academic Research Journal of Multidisciplinary.vol 1(27),487-496, 2014.

2. **Gamaredin E. Eltayb**, Hussain A. Hassan, Abdelmoneim A. Sulieman. *Diagnostic imaging of low back pain in the elderly patients*. Asian Academic Research Journal of Multidisciplinary.vol 1(30),542-560, 2015.

3. **Gamaredin E. Eltayb**, Hussain A. Hassan, Abdelmoneim A. Sulieman. Characterization of degenerative lumbar spinedegenerative disease ‑ using CT scan. Asian Academic Research Journal of Multidisciplinary.vol 1(33),341-352, 2015.

CHAPTER TWO

THEORETICAL BACKGROUND

Chapter Two

2.1 Lumbar Spine Functional Anatomy and Physiology

2.1.1 Lumbar Vertebrae

The lumbar spine is formed by five vertebrae. The vertebrae are commonly referred to as L1 through L5. L1 is the most superior vertebra in the lumbar spine, and it abuts the thoracic spine, whereas L5 is the most inferior vertebra and abuts the sacral spine. The anterior or ventral element of each vertebra is called the vertebral body. The vertebral bodies of the middle and lower lumbar spine are more substantial in size to allow them to bear greater loading forces. Posterior, or dorsally, each vertebra has a bony arch that encircles the spinal canal. It is composed of two transverse processes, two sets of facet joints, two pedicles, two laminae, and one spinous process. The bony arch, also referred to as the posterior elements, is quite bulky. It provides the necessary support for upright posture (Fig 2-1). The non compromised spinal canal has ample room for the cauda equina and for cerebrospinal fluid (CSF). (Choi , 2009).

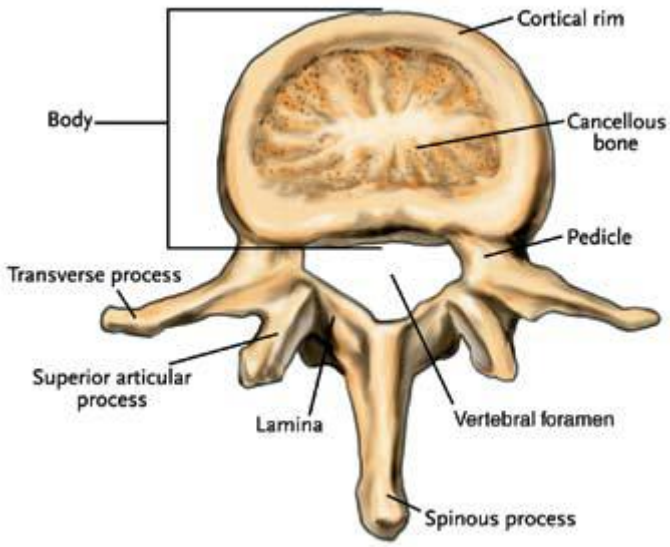


Figure (2.1): Lumbar vertebra (Chou et al,2009)

Facet joints (bilaterally) are composed of a superior articulating process and an inferior articulating process. The superior articulating process forms a joint with the inferior articulating process of the vertebra above (e.g., superior articulating processes of L3 forms two facet joints with the inferior articulating processes of L2). They have a loose capsule and asynovial lining; thus they are apophyseal joints (Fig 2-2).

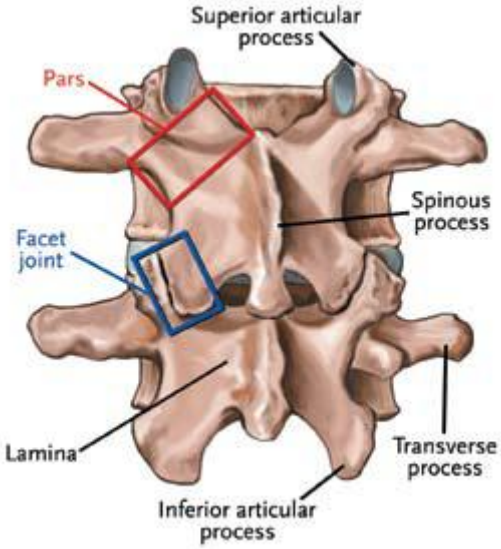
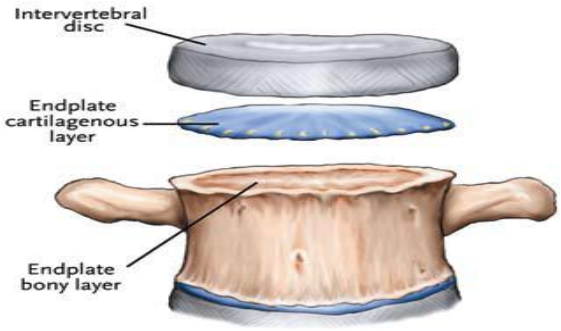


Figure (2.2): Lumbar spine: Posterior view (Parker &Son ,2011)

The nerve root canal, also called the lateral recess, is adjacent to the pedicles and facet joints in the region of the foramina. It encompasses the nerve root as it exits the spinal cord .The neural foramina, also referred to as the intervertebral foramina, is the actual far-lateral exit opening of the nerve root canal (Chou et al,2009). The lumbar vertebral, or spinal, canal is supported anteriorly by the posterior edge of the vertebral body as well as the posterior longitudinal ligament. This ligament lies on the posterior vertebral body surface. The lateral elements of the vertebral canal are the pedicles and the facet joints, with corresponding articular capsules. Posteriorly, the vertebral canal is formed by the laminae and ligamenta flava (Chou et al,2009).

2.1.2 Intervertebral Disc

Each Intervertebral disc in the lumbar spine provides support and facilitates movement while resisting excessive movement. The disc permits slight anterior flexion, posterior extension, lateral flexion, rotation, and some circumduction (Shankar,Scarlett & Abraham, 2009). The disc is the largest a vascular structure in the body (Singh et al, 2009).It is composed of the nucleus pulposus and the annulus fibrosus. In someone less than 35 years old, the nucleus pulposusis soft, rather like crab meat in texture. With aging, the nucleus pulposus dehydrates. Surrounding the nucleus pulposus is the annulus fibrosus, which is tough and fibrous. The fibers of the annulus fibrosus are concentric, like the layers of a radial tire. The concentric arrangement provide great resistance and strength. Each disc is bonded to the vertebral body below and above it by a thin cartilaginous plate, referred to as the endplate (Fig 2-3). The endplate resists herniation of the disc into the vertebral body and gives the disc its shape (Hicks, Morone &Weiner 2009).

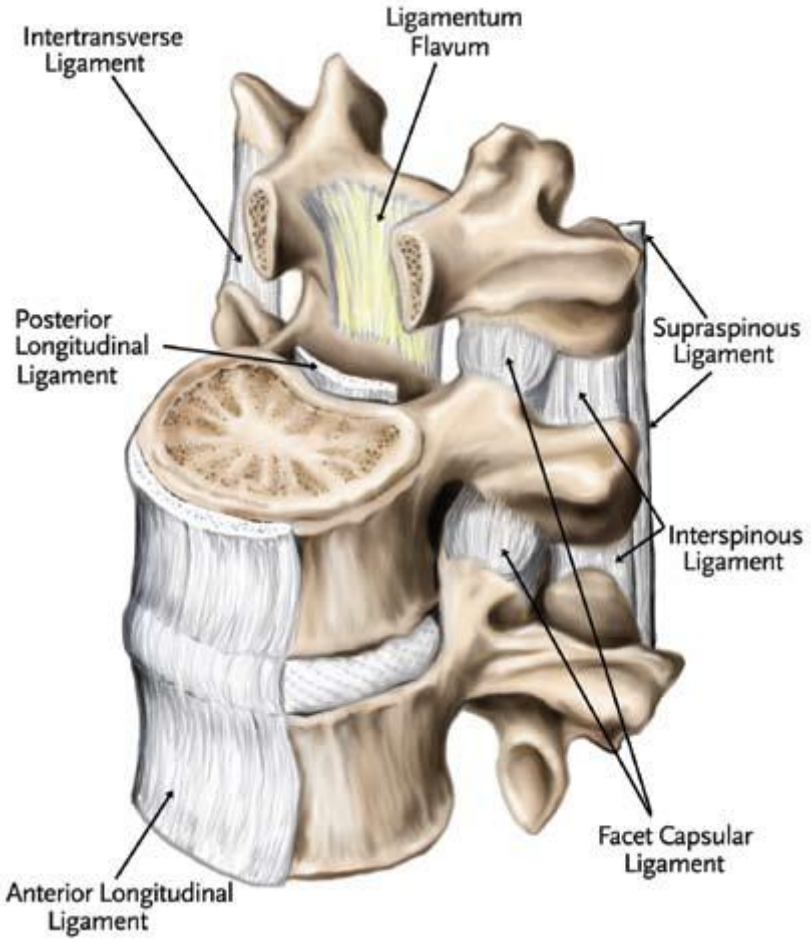


Figure(2.3): Intervertebral disc (Parker &Son 2011)

2.1.3 Ligaments

By the posterior longitudinal ligament. The laminae are connected by an elastic yellow ligament called the flavum. Each facet joint is connected to a capsular ligament. The transverse processes are connected by

intertransverse ligaments. The rotator brevis and rotator longus ligaments connect the transverse processes to the laminae of the superior two vertebrae. The spinous processes are connected by the supraspinous and infracspinous ligaments (Fig 2-3), (Chou et al,2009).



Figure(2.4): Ligaments of the lumbar spine (Chou et al,2009)

2.1.4 Biomechanics

The functional unit of the spinal column is the motion segment. A motion segment is composed of two adjacent vertebrae, the disc between them, the facet joints connecting them, and the ligaments attached to the vertebrae. The geometry and health of the functional units help a surgeon determine which patients will benefit from surgery, as well as the most

appropriate surgical intervention for a given patient (McGill & Karpowicz 2009).

2.1.5 Spinal Cord

The spinal cord ends at approximately the L1–L2 level in an adult. The conus medullar is the end of the spinal cord. The filum terminale is an extension of the pia mater,which descends below the conus medullaris and is anchored to the coccyx(Shankar,Scarlett & Abraham 2009).

2.1.6 Nerve Roots

The cauda equina is a fanning bundle of lumbar and sacral nerve roots exiting off the spinal cord at the conus medullaris.This mass of nerve roots provides communication the lower extremities and controls bowel, bladder, and sexual function The cauda equina is relatively resistant to neurologic insults, compared with the spinal cord The exiting nerve root in the lumbar spine is numbered according to the pedicle above it. For instance, the L5 nerve root passes below the L5 pedicle(Shankar,Scarlett & Abraham 2009).

2.1.7 Vasculature

The abdominal aorta follows the left side of the spine until L4, where it bifurcates into the left and right common iliac arteries . The femoral arteries arise from the common iliac arteries. The middle sacral artery, iliolumbar artery, and internal iliac artery supply blood to L5 and the sacrum. Segmental arteries branch off the aorta and supply the vertebral body, posterior elements, and paraspinal muscles of the lumbar spine. Near the posterior wall of the vertebrae, each segmental artery bifurcates into a posterior branch and spinal branch. The spinal branch enters the vertebral canal through the intervertebral foramen and supplies portions of the posterior vertebral body. It joins other spinal branches at other levels to form the anterior spinal artery. The anterior spinal artery

supplies the anterior two-thirds of the spinal cord. Segmental veins drain into the inferior vena cava, which originates at the convergence of the left and right common iliac veins at the L4 level The inferiorvena cava terminates in the right atrium of the hear(Becske & Nelson ,2009).

2.2 Imaging Techniques for the Lumbar Spine

All imaging techniques have one feature in common: the basis is the interaction between energy and matter. This applies even to a conventional photograph: light (electromagnetic radiation in the visible wavelength spectrum) is reflected with different frequencies (colours) and intensities (brightness) from the surface of an object, thus, producing an image visible to our eyes. This image can then be reproduced on photographic film by a camera, or captured on canvas by an artist. In a medical diagnostic setting, ultrasound waves can be reflected from tissue interfaces within the body to produce an echographic image. Electromagnetic energy in the high-energy X-ray part of the spectrum is capable of passing through the human body but is not entirely unaffected: the X-ray photons are weakened (attenuated) to a varying degree depending on their wavelength (hardness) on the one hand, and the electron density and thickness of tissues within their path on the other. The residual radiation which has passed through the body is registered by an X-ray film or another type of photon detector, and the distribution of grey shades (contrast) in the resulting image represents local variations in the tissue density.Besides being reflected from, or transmitted through the body, energy can also be emitted from the body itself, for instance, by injecting a substance containing a radioactive isotope into the body. This principle is the basis of nuclear medical imaging techniques. Another emission-based technique is magnetic resonance imaging (MRI), in which the protons incorporated in water molecules of the body tissues emit radiofrequency (RF) signals under the influence of a combination of

a magnetic field enclosing the body and RF energy which is beamed into the body from an external source, causing the protons to “resonate” in electromagnetic terms. All techniques presently employed for spinal imaging have short comings. Conventional X-ray images have the drawback that potentially harmful radiation is employed, in addition to possessing a limited contrast resolution. In the early decades of the last century, various methods were developed to artificially enhance image contrast by injecting contrast substances with very low (air) or high radiographic density (usually iodinated fluids) into various soft tissue structures or compartments. In the spine, myelography is the best known of these techniques. The development of new diagnostic methods, such as computed tomography and magnetic resonance imaging, has resulted in a dramatic improvement in low-contrast resolution, coupled with the advantages provided by sectional (tomographic) imaging. The downside is an increase in irrelevant detail demonstrated by these improved techniques. This applies particularly to spinal imaging. Even conventional X-ray films of the spine often demonstrate age-related and degenerative changes which are not necessarily associated with the presence of disease. An MRI study can present an even greater abundance of morphologic details whose pathologic relevance is unclear. False positive interpretation of an incidental finding is an ever-present pitfall in all imaging studies, and this is especially the case when insufficient attention is paid to the correlation of high-resolution CT and MR imaging findings with clinical signs and symptoms (Wilmink, 2010).

2.2.1 Conventional X-ray Studies

Plain films of the spine offer a quick and inexpensive evaluation of bony structures and are frequently used as an initial screening examination in, for instance suspected fractures, misalignment, and congenital spinal defects. Abnormal spinal curves can be assessed in scoliosis and the

anatomy of individual vertebrae can be defined, although superimposition of anatomical structures is a problem. Spondylolysis and spondylolisthesis are well demonstrated. Spinal metastases can be detected on plain X-ray films, but only in a late stage, when cortical bony structures of the vertebrae are affected, or the vertebra is deformed or collapsed. Manifestations of spondylodiscitis are also detected relatively late. At present, plain film spinal imaging is still ordered frequently in patients presenting with low back pain and neck pain, but the diagnostic value of the examination in the evaluation of such complaints is low. Contrast resolution in conventional X-ray images is limited: only four tissue densities, namely bone, water, fat, and air, can be distinguished and soft tissue pathology such as a disc herniation cannot be visualized. On the other hand, so-called degenerative features such as disc space narrowing, spondylosis, and spondylarthrosis can be demonstrated in asymptomatic as well as symptomatic individuals (Fullenlove &Williams, 1957).The diagnostic yield of plain film studies in low back pain is very limited unless so-called red flags (indicators for specific disease conditions such as neoplasm, disc herniation or infectious disease) are present (Staiger et al, 1999).As mentioned above, however, the sensitivity for early detection of specific pathology by plain films is low, and in such cases alternative techniques with higher sensitivity, such as CT or MRI, are preferable. A plain film examination of the lumbar spine usually consists of a lateral and a postero-anterior view. Oblique views are sometimes performed of the isthmus region in case of spondylolysis, but these substantially increase the X-ray dose to the patient, and are not always necessary. Studies of the spine in flexion (kyphosis) and extension or retroflexion (lordosis) can be used in the assessment of post-traumatic or degenerative instability.

2.2.2Contrast Studies

The following conventional X-ray studies featuring contrast injection are presently still performed in the lumbosacral spine: Lumbar myelography . In this examination an iodinated radiologic contrast fluid is injected into the dural sac so that the cerebrospinal fluid is opacified, outlining the dural sac, the dural root sleeves and their contents (Bates &Ruggieri, 1991).Structures of interest are the conus medullaris of the spinal cord, whose tip is located approximately at the L1–2 level, and the nerve roots forming the cauda equina which originate from the conus medullareis and traverse the lumbar dural sac in craniocaudal direction. These nerve roots exit the dural sac by way of a dural root sleeve which accompanies the emerging dorsal and ventral root fibers over a variable distance . Lumbar disc herniations which are located in the central, paracentral and subarticular regions of the spinal canal can produce impressions upon the dural sac and displacement of the intradural nerve roots, as well as cut-off of contrast filling of the root sleeve . Sometimes also swelling of the nerve root proximal to the site of compression is seen. The myelographic image of the nerve root ends when it leaves the contrast-filled subarachnoid space. Thus, lateral disc herniations compressing the dorsal root ganglion or nerve ramus inside or outside the intervertebral foramen, and which are reported to occur in around 10% of cases, (Abdullah et al, 1988), will frequently be missed by myelography (Jackson & Glah, 1987). Contrast myelography is not a very invasive procedure, but it is not completely innocuous (Bates & Ruggieri, 1991), Even in experienced hands, a lumbar puncture followed by injection of contrast fluid may be difficult and painful, especially when the dural sac is constricted or collapsed and the nerve roots are crowded together by a large herniations or by narrowing of the spinal canal at the puncture site. The iodised oils which were initially employed for myelography frequently gave rise to

adhesive arachnoiditis resulting in crippling back complaints. The water-soluble contrast media which were later introduced produced better images of the root sleeves but the first generation of these agents possessed a high osmolality and neurotoxicity and could also cause adhesive arachnoiditis (Skalpe,1978). Modern low osmolality contrast media do not share these severe side effects. Nowadays, the most common indication to perform contrast myelography is when MRI is contraindicated or not available, and when CT does not provide adequate image of the dural sac and of possible intradural pathology. In these cases the conventional myelographic study will almost invariably be followed by CT myelography (Penning & Wilmink ,1981)

2.2.3 Computed Tomography

Acquisition of sectional (tomographic) images by the use of an X-ray tube rotating around the patient. This made it possible to study spinal anatomic relationships in the axial plane which could not previously be visualized. A much better insight was obtained in the morphology and classification of, for instance, spinal stenosis. Detection of smaller differences in X-ray attenuation (tissue density) by using more sensitive scintillation detectors instead of an X-ray film, thus, greatly improving soft tissue contrast resolution. Image reconstruction by a computer algorithm permitting selection of window and level settings appropriate for viewing bony or soft tissue structures as required. The improved contrast resolution of CT made it possible to image disc herniations and other intraspinal normal and abnormal soft tissue features without the necessity of contrast injection into the dural sac. Visualization of intradural details by unconstructed CT is limited; the spinal cord can sometimes be seen faintly, and intradural nerve roots not at all. CT and myelography are complementary techniques: the first is more suitable for assessing the cause of radicular complaints, herniated disc, spinal stenosis

etc., while the second is better for imaging the effect, the compressed intradural nerve root (Wilmink ,1989). CT can also be combined with discography to produce CT discographic images, thus improving the sensitivity with which small annular tears can be detected. The sensitivity of CT for bony vertebral pathology such as metastasis and fracture is better than that of plain films. Multi-slice spiral CT scanning with multi-planar reformatting. This technique permits rapid scanning of a large tissue volume by a thin continuous spiral or helical section, and this has proven to be of special value, for instance, in case of spinal trauma where subtle fractures and dislocations, especially in the posterior spinal elements, can be detected with an ease and accuracy unrivalled by any other imaging method. CT can provide an acceptable diagnostic alternative to MRI in many cases with disc herniation or spinal stenosis. Soft tissue resolution by CT, however, is less than when MRI is employed, and some disc herniations can be overlooked. Anatomical detail is also less in reformatted sagittal CT images when compared to direct sagittal MRI cuts; in addition bone marrow pathology annular fissures and other subtle changes cannot be detected by CT. CT has for many years formed the mainstay of diagnostic imaging in patients with radicular pain and related conditions, despite the drawback that compression of the intradural nerve root could not be visualized directly (Wilmink, 1989).

2.2.4 CT Myelography

This technique which was first reported by Di Chiro and Schellinger 1976 is a useful adjunct to conventional myelography as well as to non-contrast CT. The presence of an intrathecal contrast medium makes it possible to clearly discern the spinal cord and individual nerve roots within the dural sac, which is not possible on non-contrasted CT images. These structures are presented in the axial plane, which is not possible on conventional

myelograms. The conventional myelographic image of the nerve root ends after its departure from the dural root sleeve, whereas with CT myelography the root can first be followed through the CSF compartment where it is outlined by the contrast medium . When MRI is not available or contraindicated, CT myelography can be used for the detection of intraspinal space occupying lesions: intradural (intramedullary neoplasm or cyst, extramedullary meningioma or nerve root tumour) extradural (disc herniation, vertebral neoplasm or extradural hematoma) or both (dumbbell schwannoma). Cord atrophy or transection can also be demonstrated, but spinal cord lesions without mass effect, such as cord infarct or multiple sclerosis plaques can only be visualized by MRI. Other drawbacks of CT myelography compared to MRI are the necessity for intrathecal contrast injection and the employment of ionising X-rays. On the other hand, spatial resolution in CT myelographic images is usually better than in axial MR images, and this is especially important in diagnosis of nerve root compression, for instance in the lateral recess of the spinal canal, where MRI often does not provide sufficient detail (Wilmink,2010).

2.2.5 Magnetic Resonance

Imaging (MRI) Imaging by nuclear magnetic resonance (NMR) (Mansfi & Maudsley 1977), presently better known as magnetic resonance imaging or MRI, produces computed tomographic sections similar to X-ray CT, but makes use of a different imaging principle. In X-ray CT, image contrast is derived from differences in X-ray attenuation due to variations in electron density in various structures within the body. In MRI the protons of the body are induced to act as radiofrequency (RF) transmitters by being positioned in a magnetic field and subjected to RF energy directed from an antenna, or coil. The electromagnetic resonance of the protons is analogous to the resonance of a tuning fork when

exposed to sound of the appropriate frequency. The RF signals from the protons can be manipulated or “weighted” to selectively amplify signal intensity of various substances and structures within the body, and are spatially encoded to produce an image. An MR image in which contrast is dependent on differences in longitudinal magnetic relaxation times as defined by so-called T1 values between various tissues is called “T1-weighted”. When image contrast is predominantly determined by differences in transverse magnetic relaxation values (T2), the image is called “T2-weighted”. For spinal imaging, MRI has significant advantages over CT: soft tissue contrast resolution is better and there are no artifacts due to high-density skeletal structures. The signal intensity of bony spinal structures is less bright in MR than in CT images, and the latter method is better for diagnosing bony cortical lesions such as in vertebral fractures. Although some consider that spinal stenosis is better demonstrated by CT than by MRI, in fact cortical bone can be well distinguished as a dark line bordering the brighter bone marrow in T1-weighted MR images. Also, spinal stenosis has an important ligamentous as well as a bony component. Even in cases with severe developmental stenosis, compression of the dural sac and the cauda equina takes place mainly at the level of the intervertebral disc, and is not due only to bony narrowing of the spinal canal but rather to superimposed ligamentous encroachment by bulging of the annulus fibrosis and hypertrophy of the flaval ligaments , and sometimes deformation of the spinal canal by degenerative anterolisthesis.Subtle changes in shape and composition of the spinal cord can be demonstrated by MRI, and intradural nerve roots can be seen without the necessity for contrast injection into the dural sac. MR images can be acquired in any plane desired, and are superior to reformatted sagittal or coronal CT images of the spine, especially for showing soft tissues. The largest single indication for spinal MR imaging

is presently in degenerative spinal disease, usually performed to diagnose a possible disc herniation (Ruggieri ,1999)

2.3 Lumbar Spine Degenerative Diseases

Degenerative disease of the spine is a definition that includes a wide spectrum of degenerative abnormalities. Degeneration involves bony structures, intervertebral disk, spinal canal and ligement although many aspects of spine degeneration are strictly linked because the main common pathogenic factor is identified in chronic overload. During life the spine undergoes continuous changes as a response to physiologic axial load. These age-related changes are similar to pathologic degenerative changes and are a common asymptomatic finding in adults and elderly persons. A mild degree of degenerative changes is paraphysiologic and should be considered pathologic only if abnormalities determine symptoms. Imaging allows complete evaluation of static and dynamic factors related to degenerative disease of the spine and is useful in diagnosing the different aspects of spine degeneration(Modic et al, 1988) .

2.3.1 Osteophyte Formation

Vertebral osteophyte formation is a well-documented phenomenon that is associated with degeneration and altered mechanics of the spine, both of which have been considered to be the result of aging, a purely physiologic response to load bearing, or intrinsic spinal disease as etiologic factors (Lane et al, 1993), they are recognized radiologically as hyperostosis at the region of the attachment of the annular fibers to the vertebral body and localized increases in bone mineral density(Nathan& Grobler,1994).As the etiologic factors, the compressive forces on the vertebral endplates (Nathan & Islael,1962), bone mineral density (Kinoshita et al, 1998), obesity and genetic factors (O'Neill et al,

1999),have been reported as causes, although the absence of a single definitive factor causing spinal degeneration has led to a suggestion that several factors including both genetic and nongenetic ones contribute to the development of osteophyte formation(Sambrook, MacGregor& Spector, 1999).On the other hand, low back pain (LBP) is one of the most common musculoskeletal disorders of the elderly, of which risk factor seems to be related to lumbar disc degeneration(Harada et al, 1998) .While data from many studies suggest an association with lumbar disc degeneration and LBP (Van et al, 1997) ,asymptomatic lumbar disc degeneration is common (Lawrence, 1969) ,and the correlation between LBP and disc degeneration observed in radiographs is only moderate or poor (Powell et al, 1986) .Osteophyte formation in the lumbar spine is a characteristic feature of intervertebral disc degeneration, however, the relationship between osteophytes and LBP is less clear (Harada et al, 1998) Symmons et al. reported that osteophytes were no more common among women with recurrent back pain compared to those without (Witt, Vestergaard& Rosenklint, 1984).

2.3.2 Facet joints OA

Facet joints are true synovial articulations and undergo degenerative changes identical to those of OA seen in other synovial joints. (Lewin ,1964)In general, a synovial joint with OA shows swelling, stiffness, deformity, instability, and decreased range of motion of the joint. The facet joints are one of the main structures for the stability of the spinal motion segment. There also is evidence in the literature that the load-bearing role of the facet joints is altered by the progression of spinal degeneration. (Adams & Hutton, 1980)Although the prevalence of facet joint arthritis is not yet well understood in terms of the number of joints involved and the severity, OA is more prevalent in men younger than 45 years of age, whereas it is more prevalent in women older than 55 years

of age (Moskowit et al, 1997).

2.3.3 Degenerative Disc Disease (DDD)

Degenerative disc disease (DDD) is described as a change in the composition and function of the disc. A disc's water content and vascularity decreases with age. By the age of 30, there is no longer a direct vascular supply to the discs, and they become desiccated, providing less support and resistance to movement. During the aging process, the nucleus pulposus becomes less elastic, and tears develop in the annulus fibrosis. It is commonly accepted that the disc may become painful if the outer third is exposed to anoxious stimulus. Many patients are asymptomatic despite radiographic degenerative changes . Symptoms include pain,dysfunction, and disability.Patients are generally relatively young; they present with a history of gradually worsening back pain. The pain is described as deep, midline, and aching. Pain may radiate into the buttocks or upper thighs; it is worse when patient stands in one position (Baisden et al, 2009).

2.3.4 Modic Change MC

MC are bone marrow and endplate lesions visible on MRI. Bone marrow signal changes in the vertebral bodies were first reported by de Roos (de Roos et al, 1987). Modic were credited with the classification of these signal intensity changes. Among 474 lumbar MRI performed in patients with LBP or sciatica, they observed MC type I hypointense signal in T1-weighted imaging (T1WI) and hyperintense signal in T2-weighted imaging (T2WI), corresponding to vertebral body edema and hypervascularity in 20 patients (4%) and MC type II (hyperintense signal in (T1WI) and hyperintense signal in (T2WI), reflecting fatty replacements of the red bone marrow in 77 patients (16%) in 1988. Afterwards, MC type III (hypointense signal in T1WI and hypointense

signal in T2WI, consisting of subchondral bone sclerosis were described by Modic et al (Modic et al,1988).The prevalence of Modic changes among patients with degenerative disk disease (DDD) of the lumbar spine varies between 19% and 59%, with type 1 and 2 changes being the most common and type 3 and mixed-type changes being relatively rare. (de Roos et al, 1987) Modic changes are uncommon in asymptomatic individuals without DDD (Toyone et al,1994).

2.3.5 Vacuum phenomenon

Gas in the intervertebral disc space is a relatively common radiologic finding, seen in 46% of cases on CT examinations (Larde et al,1982).Accumulation of gas in the epidural space is an unusual cause of radiculopathy. In most cases of degenerative disc disease, gas composed of nitrogen and carbon dioxide is produced within the disc (Ford et al,1977). If the anulus fibrosus ruptures, this air is released and collects in the epidural space. Trauma, pyogenic infections, pneumothorax, and iatrogenic instrumentation such as percutaneous vertebroplasty and spinal surgery are the other less-common underlying mechanisms (Hidalgo- et al,2004).Epidural gas is sometimes present in asymptomatic patients.

(Yoshida et al, 1997), described those gas pockets as free gas bubbles that originated in the intervertebral disc and eventually because of the motion of lumbar spine had migrated outside to the epidural space along a pressure gradient because of the motion of the lumbar spine. (Tsitouridis et al,2005),reported that this theory may justify the exacerbation of symptoms on standing, sitting and lifting and its relief when changing positions or lying down and sleeping. Gas in the epidural space may be absorbed spontaneously. Therefore, in patients with gas-related neurologic symptoms, conservative treatment with nonsteroid anti-inflammatory drugs and muscle relaxants should be the first choice. Percutaneous, intravenous, and oral steroids have also been reported as

treatment options. Aspiration of the gas under fluoroscopic guidance has also been used. Surgery is the preferred treatment in chronic encapsulated lesion, which does not resolve with conservative management (Giraud et al,2001).

2.3.6 Spondylolisthesis

Spondylolisthesis is defined as the anterior migration, or slip, of one vertebra in relation to the next caudad vertebra. Spondylolisthesis is considered to have two main etiologies, spondylolytic and degenerative (Wiltse et al, 1976). The incidence of degenerative spondylolisthesis is approximately 4.1 percent and it rarely occurs before the age of 50. It is four times more common in women than in men and typically occurs at the L4-L5 level. However, men with spondylolisthesis more often reported higher levels of physical activity or walking daily for exercise than men without spondylolisthesis. The clinical presentation can include back pain, radiculopathy, neural claudication, and referred sclerotomal pain. Approximately 75 percent of patients present with lower extremity symptoms and 40 percent will have neurologic findings, most commonly in the L5 distribution. On physical examination these patients will often have an increased ability to forward flex without the loss of normal lumbar lordosis (Abumi et al, 1990).

2.3.7 Spinal stenosis

Spinal stenosis is defined as any condition that results in narrowing of the spinal canal or foramina. Most of the causes of spinal stenosis are degenerative in nature. Degenerative lumbar stenosis is primarily associated with spinal disease, but it may also result from underlying spinal instability (spondylolisthesis), scoliosis, metabolic bone disorders, neoplastic or infectious processes, or posttraumatic degenerative changes. Degenerative lumbar spinal stenosis is seen primarily in patients older

than 60, with an average age of 73 at presentation (Spivak 1998). Males are predominantly affected, with reported male-to-female ratios ranging from 3:1 (Arnoldi et al, 1976). Although the exact prevalence of degenerative spinal stenosis is unknown, advancements in diagnostic imaging have increased recognition of this disorder (Jones & Thomson, 1968).

2.3.8 Spondylosis

Spondylosis is the result of disc degeneration, which leads to bulging of the annulus fibrosus. The degenerated, bulging annulus fibrosus creates an elevation of the periosteum. Bony reactions occur, resulting in osteophyte formationThe osteophytes commonly occur in the lordotic spinal canal of the lumbar and cervical spine (Middleton & Fish 2009). In addition, there may be hypertrophy and buckling of the ligamentum flavum, leading to further lumbar spine canal narrowing. With disc collapse ,the neural foramina will decrease in height, which may result in nerve root compression. Alterations in axial loads may lead to posterior facet osteophyte formation, which can also result in nerve root compression (Singh & Phillips, 2005).

2.4 Computed Tomography (CT)

2.4.1 Technical development

The first CT scanners were introduced in the early 1970s (Ambrose & Hounsfield, 1973) .The first clinical application for this novel imaging modality was evaluation of the parenchyma of the brain. Technical evolution of CT scanners 19 made it possible to examine a variety of abnormalities in different organ systems in a manner not previously possible. The establishment of total-body CT scanning in 1974 gradually altered the radiological approach to diagnosis of diseases (Schellinger et al, 1975) .The first CT scanners in Finland were introduced in 1978

(Suoranta, 2006). The advent of continuously rotating CT scanners provided the necessary technical basis for the invention of the helical CT scanning technique.Helical CT scanning enabled covering of extended and complete organ volumes during a single held breath .Although three-dimensional post processing methods were now available due to continuous volume data, there was still a considerable mismatch between transverse (in plane)and longitudinal (axial) spatial resolutions (Kalender et al, 1990) .This drawback was overcome when subsecond multi-slice/multi-detector CT scanners were introduced in 1998 (Klingenbeck et al,1999).MDCT brought a major improvement in performance, as it could be used to shorten scanning time, reduce scan collimation, or increase scan length substantially (Prokop et al, 2003).

2.4.2 CT Scanning Parameters

CT technologists and radiologists should be knowledgeable about how the manipulation of various scanning parameters may influence dose and image quality. With the rapid changes in CT technology, technologists, radiologists, and medical physicists need to work closely with CT vendors because there will be parameters unique to each make and model of CT scanner that will influence dose and image quality. Parameters that can influence dose and image quality include, but are not limited to: tube current (milliamperes or mA), tube rotation time, tube potential (peak kilovoltage or kVp), collimation, table speed, pitch, scanner geometry, x-ray filters, and reconstruction kernel or algorithm (Kalra et al, 2004).A common and effective method of reducing dose while maintaining diagnostic image quality with MDCT scanners is the use of automatic tube current modulation, also known as automatic exposure control (AEC). Each make and model of CT scanner may construct and apply AEC differently. Therefore, it is imperative that technologists and

radiologists understand how this feature influences dose and image quality in their specific equipment. In newer MDCT scanners that can be adjusted to reduce dose, the ability to select a user-defined noise level that will influence image quality is an important parameter that is closely related to the AEC feature (McCollough ,Bruesewitz & Kofler ,2006).

2.4.3 CT Radiation dose

The CT technique is associated with a relatively high inherent radiation dose, and recent technological development with consequent changes in practice has even increased the dose burden (Dawson ,2004). In order to optimize CT examinations, the radiation dose given to patients should be minimized without significantly deteriorating the diagnostic accuracy of the examinations (Kiljunen, 2008).Median effective doses may range from 2 mSv for a routine head CT scan to 31 mSv for a multiphase abdomen and pelvis CT scan, but there may be even more than ten-fold variation in effective doses within and across institutions (Smith et al, 2009).Although radiographs are taken much more frequently than CT scans are performed, the latter may account for up to two thirds of the total radiation dose that critically ill patients are exposed to (Kim et al, 2004).Consequently, physicians should always consider the expected risks and benefits of CT scanning (Tien et al, 2007).

2.4.4 Advantages CT scan

CT has gained acceptance as the most accurate modality for imaging of the thorax and abdomen(Kumta et al, 2002) .Compared with other imaging modalities, CT is able to cover the whole body in a short moment of time, undisturbed by bowel gases, wounds, catheters, tissue defects, or edemic tissues. CT may depict faint pneumothorax and lung contusion as well as inflammatory changes in the lung more accurately

than chest radiography (Elmali et al, 2007) .Fractures of the spine and pelvis are revealed more robustly than with plain radiographs .Abdominal injuries and diseases are evident at least as clearly as with ultrasonography and regarding the retroperitoneal space, CT is superior to ultrasonography (Fang et al, 2006).

2.4.5 Disadvantages of CT scan

Despite the many benefits mentioned above, several hazards and disadvantages are present with CT imaging. One of the main hazards of CT imaging is the risk of allergic reaction (nephrotoxicity) to the contrast agent which may cause itching, hives or swelling of body parts. CT imaging involves exposure to small amount of ionized radiation which is considered a hazard for pregnant women and children. CT scanning may also involve uncomfortable body posture in order to obtain imaging of the desired body part. In addition, due to the physical shape of the CT equipment, claustrophobic patients may experience anxiety (Garvey et al, 2002).

2.5 Previous studies

Several studies have attempted morphometrically to characterize degenerative lumbar spinal with diverse results (Amundsen et al, 1995).Some radiological studies have reported that the changes in the anterior–posterior (AP) diameter, transverse diameter and cross-section area (CSA) of the spinal canal and dural sac are risk factors for developing spinal stenosis (Ogikubo, Forsberg & Hansson ,2007).Other studies focused on degenerative changes of the intervertebral disc, zygapophyseal joints and ligamentum flavum as dominant contributors of degenerative LSS (Kirkaldy et al,1982).

Kalichman et al retrospectively evaluated spinal degeneration in a subset of 187 participants with a mean age of 52.6 years of age who initially underwent multidetector CT scans primarily to assess aortic calcifications. While degenerative changes were extremely prevalent, the only degenerative feature associated with self reported LBP was spinal stenosis. Intervertebral disc space narrowing (present in 63.9 % of spines), and facet joint osteoarthrosi (64.5 %) were unassociated with LBP (Kalichman et al, 2010).

O'Neill et al explored osteophytosis within a UK adult population over age 50 years, finding 84% of men and 74% of women to demonstrate at least one vertebral osteophyte, with increased incidence among individuals with more physical activity, self reported back pain, or higher BMI scores. Despite marked variability within the population, men appear to have more significant degenerative changes than women, both with regard to number and severity of osteophyte formation (O'Neill et al,1999).

Rothman et al conducted a retrospective review of the CT findings of 150 patients with degenerative spondylolisthesis. The authors described the pathological findings, which included canal stenosis, facet overgrowth, joint-capsule hypertrophy, ligamentum flavum enlargement and gas within the facet joints. All patients were examined on GE 8800 CT scanners using axial scans of 5 mm-thick sections at 3mm spacing, with sagittal and coronal reformats. The authors found only 19% had subluxation greater than 6 mm. Severe facet degeneration with marked hypertrophy, erosive changes or gas within an irregular joint was noted in 91 patients. Severe canal stenosis was detected in 15 patients as a result of narrowing of the central canal secondary to a combination of subluxation, facet boney overgrowth, joint-capsule hypertrophy, ligamentous hypertrophy, bulging and end plate osteophyte formation. Foraminal stenosis was observed in 38 patients. Anterior soft tissue bulge/herniations of greater than 5 mm was present in only three patients. The authors concluded that CT is useful in evaluating the severity of stenosis in patients with symptomatic degenerative spondylolisthesis. Stenosis is frequently secondary to soft tissue changes and facet hypertrophy, and does not always correlate with the severity of slip (Rothman et al, 1998).

Boden's paper examined lumbar facet joint tropism and its relationship with degenerative disc disease, as well as degenerative spondylolisthesis. A total of 140 patients with MRI scans were divided into four groups. Groups I and II consisted of 67 asymptomatic volunteers, 46 without a herniated disc, and 21 with a herniated disc, respectively. Groups III and IV consisted of 73 symptomatic patients, 46 with aherniated disc at L4-5 confirmed operatively and 27 with degenerative spondylolisthesis at L4-5, respectively (Boden et al, 1996).

According to the North American Spine Society (NASS) evidence-based clinical guideline for the diagnosis and treatment of degenerative lumbar spinal stenosis (DLSS) MRI is the most appropriate, noninvasive test for imaging degenerative lumbar spinal stenosis. These guidelines further recommend that CT myelography is useful in patients who have contraindications to MRI, patients with MRI findings that are inconclusive, or patients with a poor correlation between symptoms and MRI findings. CT without myelography is useful in patients who have contraindications to MRI, patients with MRI findings that are inconclusive, or patients with a poor correlation between symptoms and MRI findings and those who are not candidates for CT myelography (Watters et al, 2008)

Symmons, et al reviewed X-rays of 742 women aged 45 or older and then repeated the X-rays 8 to 11 years later. They divided the women into two groups, those with back pain and those without back pain. They found that 40% of those with back pain had degenerative disc disease, which did not get worse. They also found that 70% of the women without back pain had degenerative disc disease, which did not get worse(Symmon et al, 1991).

Hutton,et al reviewed two groups of patients with lumbar-related endplate changes. Endplate changes are another type of degenerative change in the spine.The first group was 36 patients with a low level of endplate changes and the second group was 22 patients with a more advanced stage of such changes. In the first group, half remained the same; a little less than half got worse; and two patients reversed back to normal. In the second group with the more advanced changes, most remained the same; some got better and none got worse (Hutton et al, 2011)

Jarvik, at al performed essentially the same study on 123 patients over a three-year period. Their subjects had no recent history of back pain at the beginning of the study. Over the course of the three years, 67% of their sample reported having an onset of back pain. Upon MRI scanning, only 9% showed evidence of adverse change in their spine – whether it was onset of degenerative disc disease or progression of a pre-existing degenerative disc disease(Jarvik at al, 2006).

CHAPTER THREE

METRIALS & METHODS

CHAPTER THREE

3.1 Study design

This is a hospital based cross-sectional descriptive study conducted from June 2012 to June 2015

3.2 Study population and study area

Study population included 168 patients in both genders (86 males and 82 females), above 30 years of age who were referred for lumbar spine CT scan at different Radiology departments from Ribat Teaching Hospital ,Alfiasal Hospital and Khartuom Modern Diagnostic Center.

To evaluate the association of spinal degeneration features with age, the prevalence of degeneration features was calculated in four age groups (31years -44years) , (45years -59years) , (60years -74years) and above 74 years old , Mean age was 52±11.5 years. 25 patient with degenerative from different age old 31to 83 were scan by MRI for comparisons.

3.2.1 Sampling and Sample size.

A total of 198 individuals had lumbar CT scan from, but only 168 whom fulfilled the study criterion were studied.

3.2.2 Inclusion criteria

Patient above 30 years of age , with/without history of low back pain without radiculopathy.

3.2.3 Exclusion criteria

Thirty patients were excluded from the study, included prior lumbar surgery, vertebral fractures, spinal infection , tumor, inflammatory and pregnancy.

3.3 Research instruments

3.3.1 Collection data sheet for socio demographic information of patient and CT and MRI findings recording form

Self-administered Collection data sheet (appendix 1&2) were used to collect socio demographic information such as age, sex and addition CT and MRI findings

3.3.2 Equipments

Siemens CT scanner Germany 16 slices (Fig 3.1), Toshiba CT scanner Japan 4 slices ,Philips MRI Germany1.5 Tesla and GE (USA) 1.5 Tesla

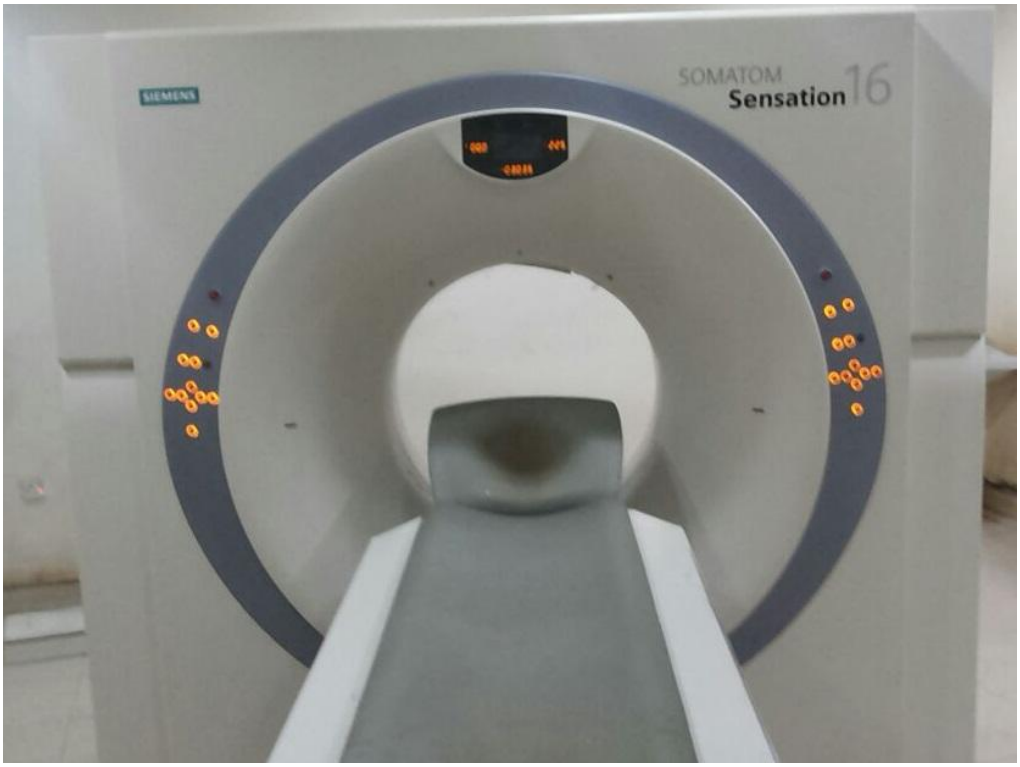


Figure (3.1):Siemens CT scanner Germany16 slice

3.4 Image acquisition

For CT, researcher used transverse plan images as well as sagittal and coronal reconstructions, where needed. All scans were performed from the midportion of the T12 vertebra to the midportion of S1, beam collimation of 5.0 mm; slice thickness of 2.5 mm to 5mm ; 120 to140kV , 180 to 230, mAs. MRI scans consisted of sagittal and axial T1-weighted and T2-weighted The slice thickness of 3.5mm to 4 mm was used for both sagittal and axial images.

3.5 Image Interpretation

Six degenerative findings were looked by CT scan : (i) osteophyte formation (ii) intervertevral disc narrowing (iii) facet joints arthropathy (iv) scrolotic endplate (v) vacuum phenomenon (vi)spondylolisthesis and seven degenerative findings were looked by MRI : (i) disk hydration (ii) disk herniations (iii) disk bulge (iv) modic changes (v) facet joints OA (vi) osteophyte formation (vii)spondylolisthesis. Consultant radiologist more than ten years experiences read all the CTs and MRI images.

3.6 Data Management and Analysis

Data analysis was done using SPSS version . Data quality check was done by running frequencies daily. Data transformation by recoding, counting and cross tabulation was performed and obtained information was processed using Pearson chi-square and Fisher's exact test to compare CT findings and patient demographic formation . Fisher's exact test was used on cells with values less than. A p-value of <0.05 was considered to indicate statistically significant difference

CHAPTER FOUR

RESULTS

Chapter Four

Results

4.1 Socio-demographic

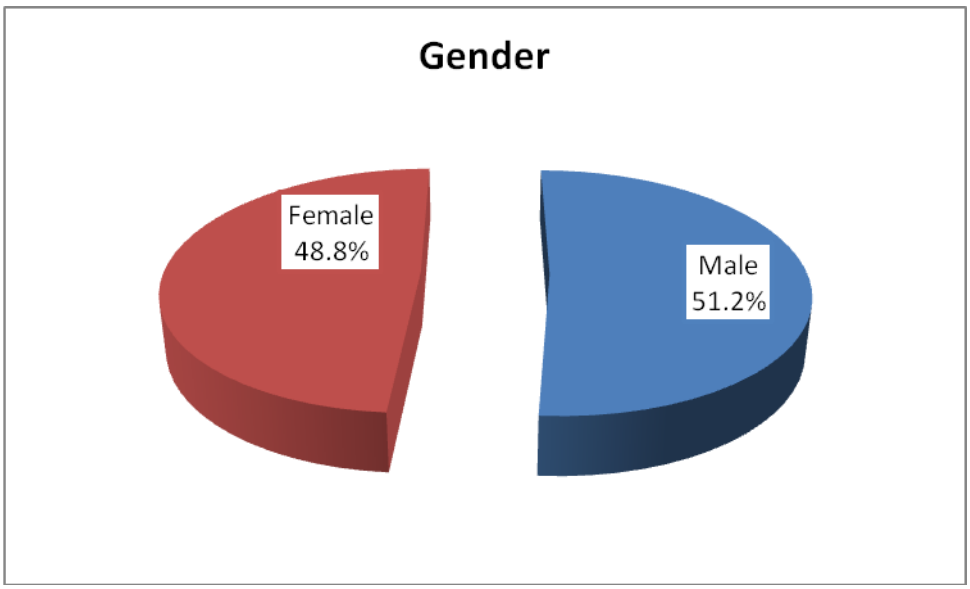


Figure (4.1): Distribution of the study sample according to (Gender)

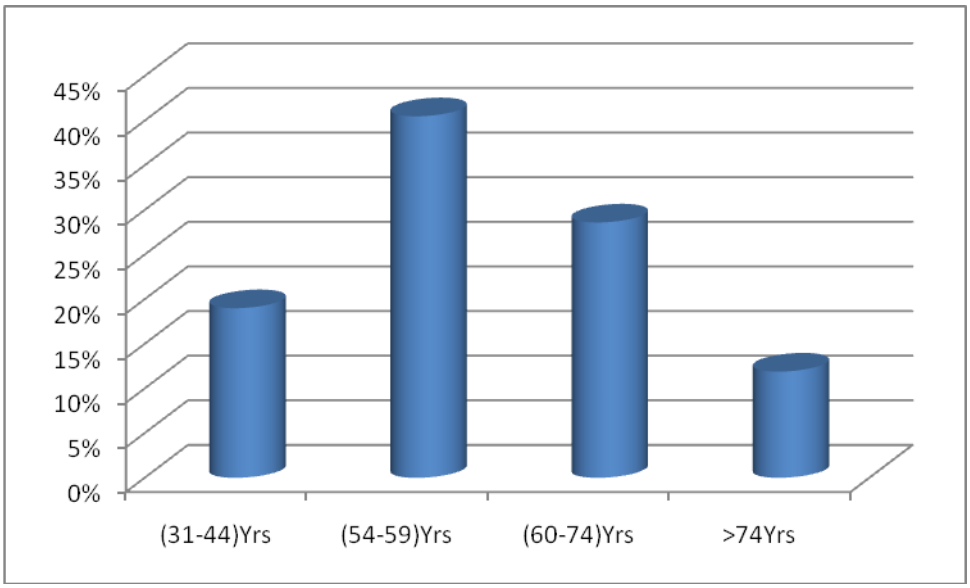


Figure (4.2): Distribution of the study sample according to (Age)

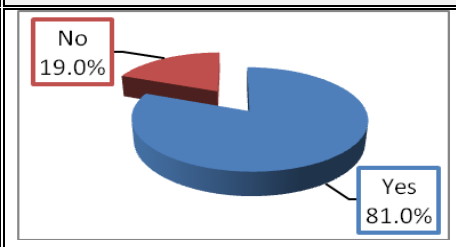
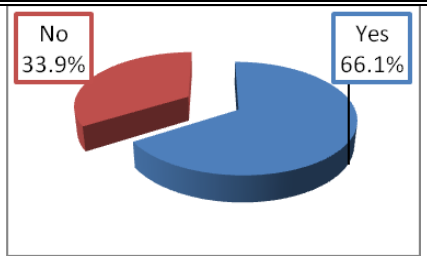
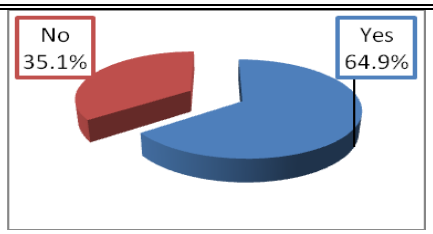
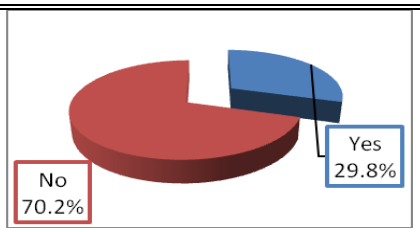
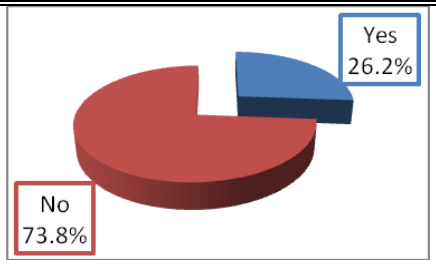
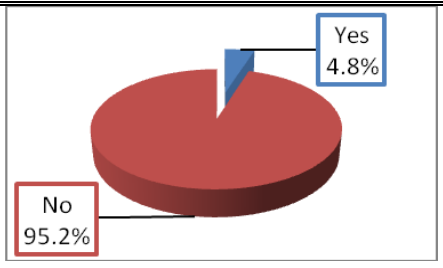
Findings	Yes	% Yes	Figuration
1. Osteophyte formation	136	81.0%	 **A**
2. Disc narrowing	111	66.1%	 **B**
3. Facet joints OA	109	64.9%	 **C**
4. End plate scrolotic	50	29.8%	 **D**
5. Vacuum phenomenon	44	26.2%	 **E**
6. Spondylolisthesis	8	4.8%	 **F**

Figure (4.3): Frequency distribution of CT scan imaging degenerative findings

Table(4.1): Distribution of patients with degenerative imaging findings by age (N=168)

Finding	31 – 44 n=(3 2)	45 -59 n=(68)	60 -74 n=(48)	> 74 n= (20)	Total N=(168)	P-value
Oestyphyte	14 (43.3)	57 (83.3)	45(93.8)	21(100)	136(81)	*0.000*
Disc narrowing	8 (25)	46 (67.6)	39(81.3)	18 (90)	111 (66.1)	*0.000*
Facet Joint	7 (21.9)	46 (67.6)	40 (83.3)	16 (80)	109 (64.9)	*0.000*
End plate scrolotic	2 (6.3)	24 (35.3)	19 (39.6)	5 (25)	50 (29.8)	*0.008*
Vacuum phenomenon	3 (9.4)	15 (22.1)	18 (37.5)	8 (40)	44 (26.2)	*0.015*
Spondylolisthesis	0 (0)	(0)	6 (12.5)	2 (10)	8 (4.8)	*0.006*

Table(4.2): Percentage distribution of degenerative imaging findings by gender (N=168)

Finding	Gender			
	Male (n=86)	**Female (n=82)**	**Total (N= 186)**	***P-value***
Osteophyte formation	74 (86)	62 (75.6)	136(81)	*0.085*
Disc narrowing	53 (61.6)	58 (70.7)	111 (66.1)	*0.213*
Facet joints OA	57 (66.3)	52 (63.4)	109 (64.9)	*0.697*
End plate scrolotic	28 (32.6)	22 (26.8)	50 (29.8)	*0.417*
Vacuum phenomenon	24 (27.9)	20 (24.4)	44 (26.2)	*0.604*
Spondylolisthesis	3 (3.5)	5 (6.1)	8 (4.8)	*0.604*

Table (4.3):Percentage distribution of degenerative imaging findings by spine level (N=136)

Spine Level	Degenerative imaging findings						
	OST	**FJ**	**DN**	**EP**	**VC**	**SP**	**Total**
L1/L2	32(23.5)	4(3)	3(2.2)	3(2.2)	5 (3.7)	0(0)	47(5.8)
L2/L3	51(37.5)	6(4.4)	7(5.1)	6(4.4)	9(6.6)	0(0)	79(9.8)
L3/L4	82(60.3)	30(22.1)	19(14)	16(11.8)	8(5.9)	1(0.7)	158(19.6)
L4/L5	78(57.3)	69 (50.7)	80(58.8)	41(31.1)	36(26.5)	5(3.7)	309(38.3)
L5/S1	65(48.8)	44(32.3)	58(42.6)	19(14)	25(18.4)	2(1.5)	213(26.4)

Table(4.4): Distribution of patients with degenerative imaging findings by age (n=25)

Finding	**31 – 44 n=(3)**	**45 -59 n=(9)**	**60 -74 n=(8)**	**> 74 n= (5)**	**Total N=(25)**
Disk Dehydration	2	6	7	5	20
Disk Bulge	1	2	2	3	8
Disk Herniations	0	1	2	3	6
Modic Change	0	2	1	1	4
Facet joints OA	0	2	3	2	7
Osteophyte formation	1	1	2	2	6
Spondylolisthesis	0	0	1	1	2

Table (4.5):Distribution of degenerative MRI findings by spine level

Spine Level	Degenerative imaging findings							
	DD	**DB**	**DH**	**MC**	**FJ**	**OST**	**SP**	**Total**
L1/L2	2	0	1	1	0	2	0	6
L2/L3	5	2	2	1	1	1	0	12
L3/L4	9	4	3	2	4	3	1	26
L4/L5	16	6	7	3	6	2	1	41
L5/S1	13	4	5	2	5	1	0	30

CHAPTER FIVE

DISSCUSION

CHAPTER FIVE

5.1 Discussion.

This cross-sectional hospital based study used CT to diagnose spine degenerative changes as it can show degenerative changes at an early stage as compared to other imaging techniques (such as MRI) .168 patients underwent CT of the lumbar spine and both sagittal and axial views of all images were interpreted to locate the degenerative findings. 81%of participants had at least one degenerative finding.

Percentage distribution of participants by age and sex The study included 168 patients, the age range was from 31 to 84 years (mean; 52±11.5 years) whereby eighty-six(51.2%) of them were male and eighty-two (48.8%) of them were females as presented in (Figure 4-1) and. The degenerative imaging findings were increasing significantly with age p-value <0.05. All patients above aged 74 years had Oestyphyteformation , whereby in 31 to 44 , 45 to 59 years and 60 to 74 years of age,prevalence was 43.3% , 83.3% and 93.8% respectively (Table 4.1). Prevalence of various degenerative imaging findings were more common among males, only disk narrowing and spondylolisthesis were common among females, though the differences were not statistically significant (p-value >0.05) (Table 4.4). Most of the degenerative findings were seen at lower lumbar levels L4/L5 and L5/S1, 38.3% and 26.4% respectively. At L4/L5 the prevalence of oestyphyte, facet Joint, disc narrowing, disc narrowing, vacuum and spondylithieth 78 (58%), 69(51%), 80 (60%), 41(31%), 36(30%) and 5(4%) respectively, whereby these findings at L1/L2 were; 32(24%), 4(3%), 3(3%), 3(3%), 5(4%) and 0(0%) respectively (Table 4.3). On lumbar MRI, Disk dehydration (sign of reduced disk signal intensity) being the most frequent finding seen in 20patients, followed by

disk bulge 8, disk herniation 6, facet joints OA7, osteophyte formation 5 and modic changes 4. The least common finding was spondylolisthesis which was seen in 2 patients (Table 4.4)

Most of these degenerative findings were seen at levels L4/L5 and L5/S1, 39.3% and 26% respectively .Though a degenerative change of the begins early in life and is partly a consequence of aging, the actual cause is not known but many factors (autoimmune, genetic, re-absorption and biochemical) have been implicated in accelerating the process. Since lumbar spine is subjected to heavy mechanical stress, it is a common area affected by degenerative changes (Thome,2008).This could partly explain such observation in this study group. The mean age of this study group is 52±11.5 years , could be another explanation, as degenerative changes is common in individuals above 40 years of age (Dahnet & Waris, 2007).The study show there are significant relationship between degenerative findings (osteophyte formation , disc narrowing , facet Joint OA , endplate scrolotic , vacuum phenomenon and spondylolisthesis) and age because P-value is less than 0.05 (0.000, 0.000, 0.000, 0.008, 0.015, and 0.006) respectively, see table (4.1).Degenerative disease of the spine is a worldwide problem. Its prevalence increases with age. It ranges from 85% to 95% among adults aged 50 to 55 years, with no sex difference (Takarad 2008 &Cheung, 2009).The study showed there were no statistically significant between male and female (p-value >0.05).

Oesteyphyte formation was the most frequent finding , this study shows a strong correlation between advancing age and osteophyte formation. 136(81%) patients in this study. The prevalence was observed to increase with age above 74 years 100%, , whereby in 31 to 44 , 45 to 59 years and 60 to 74 years of age, prevalence was 43.3% , 83.3% and 93.8% respectively. The difference observed between the age groups was

significant (p-value 0.000) . (Watanabe et al. 1985).documented that the size osteophyte increases with advancing age . Osteophytes usually follow Sharpey's fibers. At the beginning they have a triangular shape and extend on the horizontal plane; in the more advanced phase they become hooked and grow vertically. Sometimes osteophytes develop on both sites of a disc space and grow until they fuse together to form a "bridge osteophyte" (O'Neill et al,1999). Anterior osteophytes are more common than lateral and posterior osteophytes. This is because the anterior part of the vertebral body is the most mobile and therefore the most unstable part of the vertebrae. The most likely sites of osteophyte location in this study are the anterior margins of L3/L4vertebral bodies 103(61.3), this observation was similarly reported in other studies (O'Neill et al,1999).

A CT scan is very useful to help assess inter vertebral disc narrowing and vacuum phoemima , which are sign to findings of degenerative disc disease (Modic et al, 1988) .The results show a high prevalence of intervertebral disc narrowing (66.1%) and facet vacuum (28.2%) in the studied sample. The reported prevalence of disc space narrowing is slightly higher than that previously reported in MRI studies (Battie & Videman, 1995) .In those studies, the reported prevalence of disc space narrowing for asymptomatic subjects varied between 37% (Evans 1989)and 56% (Jarvik et al, 2001).The prevalence of vacuum is (28.2%). The gas collection can range in size from a few millimeters to 1 centimeter and in density from – 200 to – 900 Hounsfield units. Rim enhancement can be seen (Giraud et al,2001).An MRI is capable of evaluating the change in within the discs. Disk degeneration is a loss of disk signal on T2W images with/without disk height reduction. The dark signal of the disk on T2W images is due to loss of water content. Initially there are biochemical changes within a disk, resulting in dehydration of

disk . In later stages of the disease morphological changes such as loss of disk height, annular tears, rim lesions and osteophyte formation materialize (Chenyang et al, 2007).The occurance of annular tears leads weakening of the annulus fibrosus hence disk displacement beyond the vertebral margins.

Several authors have reported that high prevalence and severity of facet joint arthritis at the L4-5 (Kalichman & Hunter, 2007).In this study a total of 109 patient (64.9%) had facet joints OA . (Lewin ,1964) stated that facet joints showed only minor cartilage changes before the age of 45 years and that the osteoarthritis advanced with age. Kalichman and Hunter, also reported that the prevalence of facet joints increases with age (Kalichman & Hunter, 2007). However, some authors (Gries et al, 2000), (Tischer, 2006) have reported the presence of facet joints in younger patients. In this study the prevalence was observed to increase with age 60 to 74 years of age was 83.3%, whereby in 31 to 44 and 45 to 59 years of age was 67.6% and 219.3% respectively. The difference observed between the age groups was significant (p-value 0.000) .The typical imaging findings of facet joints are joint space narrowing, subchondral sclerosis and cysts, osteophytosis, ligament thickening, intra-articular vacuum and joint fluid. Osteophytes can involve the whole facet that appears hypertrophic; however, they more often involve the articular surface of the superior facet of the lower vertebra, because the inferior is covered by the ligamentum flavum. Plain films can show the presence of degenerative changes; however, the anatomic complexity of this region requires CT or MRI for a complete evaluation of the degenerative process(Jinkins, 2004). CT provides detailed imaging of the structural lesions secondary to facet joint degeneration: osteophytes, subchondral sclerosis and geodes, facet joint impingement, capsular and ligamentous calcifications (Friedrich et al, 2007). CT is better able to demonstrate the

degenerative changes of the facet joints because of the high contrast between bony structures and the surrounding soft tissues (Carrera et al. 1980).MRI has proved superior over CT in demonstrating the spread of infection to the epidural space and associated soft tissues, including the psoas and paraspinal muscles (Lakadamyali et al, 2008). Typically, finding decreased signal intensity in the infected disc and adjacent vertebral bodies on T1-weighted images and increased signal intensity on the fluid-sensitive T2- weighted image**.**

CT scanning allows earlier detection of endplate involvement and bone destruction than plain films and may allow identification of paraspinous inflammatory changes and psoas abscess formation, especially on contrast-enhanced scans. Post-contrast studies and sagittal and coronal reconstructed images are helpful in defining extent of disease. CT is not ideal for detection of bone marrow changes or epidural involvement(Varma, Lander & Assaf, 2001).In addition to the changes within the disc, changes at the endplate adjacent to the disc have been described by MRI .Modic noted reactive endplate changes at the endplates of the discs and graded them as Modic 1, Modic 2, and Modic 3 changes.(i)Modic 1 reactive endplate changes demonstrate decreased disc signal on T1 images and increased disc signal on T2 images. These changes are associated with disruption and fissuring of the endplate and vascular fibrous tissue adjacent to the endplate. (ii)Modic 2 reactive endplate changes are represented by increased signal intensity on T1 images and neutral signal on T2 images. These changes represent yellow marrow replacement in the adjacent vertebral body at the endplates. (iii)Modic 3 reactive endplate changes demonstrate decreased disc signal on both T1 and T2 images. This represents bony sclerosis at each endplate. There are sclerotic endplate changes representing near-end-stage disease at the endplates. These are also associated with decreased

blood supply at the endplates (Modic et al, 1988).

CT sagittal plane is the optimal plane for evaluating the entire pars inter-articularis, because the obliquity in this plane is minimal (Aono et al, 2010).Our results showed that sagittal MPRs can clearly demonstrate very small degrees of slippage of a vertebral body that are not clearly recognized on axial CT. The type and severity of spondylolisthesis can also be classified more accurately, and the entire pars interarticularis visualized more completely with sagittal reconstructions. Spondylolisthesis was demonstrable in 8(4.8%) of the cases, most of which were anteriorly located and at L4/L5 and L5/S1 disc spaces . Grade I spondylolisthesis was observed the most constituting 4 cases while grade II was seen in 3 cases . No case of grade III or IV spondylolisthesis was seen, all the patients with spondylolisthesis were aged above 60 years, these observations were similarly reported in other previous studies by MRI (Jinkins, 2004), (Metwally, 2008). MRI sagittal plane is best for displaying the abnormal anatomy of spondylo-listhesis, T_2-weighted images for the canal and T_1-weighted images for the pars interarticularis and neural foramina. The sagittal view clearly shows the degree of subluxation and the relationship of the intervertebral disk to the adjacent vertebral bodies and the spinal canal.Parasagittal images are good for showing encroachment on the foramina by disk or hypertrophic bone. Loss of the normal fat signal cushioning the nerve root is a sign for significant foraminal stenosis (Metwally, 2008).

5.2 Conclusion:

Eighty one percent of studied patients had lumbar degenerative imaging findings. Oestephyte formation was the most frequent finding followed by disc narrowing ,facet Joint OA ,end plate scrolotic ,and Vacuum phenomenon .The least common finding was Spondylolisthesis . (19% of participants) had normal lumbar CT scan findings.

Prevalence of degenerative findings was increasing with age (p-value < 0.05), being more common among males than females, though the difference was not statistically significant (p- value >0.05). Findings were more frequent at lower lumbar levels(L4/L5 & L5/S1).

MR imaging is ideally suited in identifying pathology related to the soft tissues, including the disk, nerve roots, spinal cord, and ligaments, which are most often involved and causing symptoms in degenerative condition. Other advantages of MRI is having no known side effects or morbidity, non invasive and no radiation exposure However, CT scans still have some advantages over MRI for the imaging of osseous lesions. CT clearly delineated most degenerative changes including process hypertrophy, osteophytosis, subchondral sclerosis ,calcifications and vacuum phenomena .

5.3 Recommendations:

- Careful evaluation of images is needed as different types of lumbar spine degenerative findings are common among patients referred for Lumbar CT scan
- There is a need of more studies to be conducted on spine degenerative disease using bigger sample size (from different regions)

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