Sudan University of Science and Technology

Collage of Graduate Studies

Assessment of lower back pain using lumbar spine radiography

تقييم ألم أسفل الظهر باستخدام صور الأشعة السينية للفقرات القطنية

A thesis submitted for partial fulfillment of the requirements of M.Sc. degree in radiologic imaging diagnosis

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Dedication

This humble work is dedicated, first and foremost, to my parents, the schoolteachers who taught me everything that is worth knowing.

To my teachers in all stages of my education, colleagues and specially my friends, who helped shape my experience in life and provided support and council whenever needed.

To Mr. H, my friend and brother.

To Miss E, always and forever.

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Abstract

Lower back pain is a very common public health problem throughout the world, as it will affect three quarters of all humans in some point of their life. It's causes vary considerably, from simple muscle sprain to metastatic malignancy. This descriptive study was conducted in Khartoum state to assess the role of lumbar radiographs in patients with acute and sub-acute lower back pain. Anteroposterior and lateral radiographs of 83 subjects (40 males and 43 females) were evaluated for lumbar lordosis, lumbosacral junctions disc height and angle, vertebral body condition and alignment for features associated with lower back pain.

The results of this study showed an average of 50.7^{o} (SD=11.1) in lumbar lordosis angle, with males showing lower angles and a slight increase with age. The average height of L5/S1 intervertebral disc was 1.2 cm, higher in men and did not affect any of the other parameters measured; Lumbosacral junction disc angles average was 14.5^{o} and increased steadily with age. A serious degree of Spondylolisthesis was uncommon, the majority of cases were of the first grade (39 of 48), however Schmorl's node and osteophytes were common (30 % and 47%), but transitional vertebra and spinal canal stenosis were not.

It was concluded that major causes of lower back pain are rarely shown on lumbar radiographs taken in the first two months of the onset, and considering the financial aspects and radiation dose, it becomes apparent that adhering to the recommended guidelines dictating that lumbar radiographs for non-specific LBP should be taken only for patients with clinically identified "red flags"

الخلاصة:

تعتبر الام أسفل الظهر من أكثر الامراض شيوعا في كل انحاء العالم، إذ ان ثلاثة ارباع البشر سيشتكون منه في مرحلة ما، تتراوح أسبابه من بسيطة، كشد عضلي، الى أسباب خطيرة كغزو سرطاني.

أجريت هذه الدراسة في ولاية الخرطوم لتقييم دور الصورة الاشعاعية للفقرات القطنية في المرضى الذين يشتكون من الم غير مزمن في أسفل الظهر. تم تقييم كلتا الصورتين الامامية والجانبية الخاصة بثلاثة وثمانون مريضا، (40 رجل و43 امرأة)، قيمت الصور لاعتبارات: درجة انحناء العمود الفقري ارتفاع وزاوية قرص الارتباط القطني-العجزي بالإضافة الى عدد وحالة الخمس فقرات.

كان متوسط درجة الانحناء في المدى الطبيعي عموما، اظهر الرجال درجات اقل وزيادة مضطردة مع العمر. ارتفاع القرص كان 1.2 سم في المتوسط، أكثر ارتفاعا في الرجال ولم يؤثر على بقية القياسات، اما زاويته فكانت 14.5 درجة في المتوسط تزيد تدريجيا مع تقدم العمر. انزلاق الفقرات لدرجه خطيره كان نادرا نسبيا، ومعظم الحالات المكتشفة كانت من الدرجة الأولى، لكن "عقد شومرل" ونتوءات العظم الشوكية كانت شائعه (بنسبه 30% و47%)، على عكس الفقرات المتحولة وضيق القناة الفقرية النادرين نسبيا.

خلصت الدراسة الى ان المسببات الرئيسية لألم أسفل الظهر نادرا ما تظهر في الصورة الاشعاعية للفقرات في اول شهرين منذ بدايته، وعند الاخذ في الاعتبار الاثار الاقتصادية و جرعه الأشعة، تصبح اهمية اتباع التوجيهات المتفق عليها عالميا واضحة، بأخذ صور الظهر الاشعاعية لالم اسفل الظهر غير المحدد فقط في حالات محددة، تظهر فيها سريريا علامات تحذيرية معينة.

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List of abbreviations

Abbreviation	**Full explanation**
BMI	body mass index
CT	computed tomography
LBP	lower back pain
LLA	lumbar lordosis angle
LDA	lumbosacral disc angle
LSA	lumbosacral angle
LSTV	lumbosacral transitional vertebra
MRI	magnetic resonance imaging
SIA	sacral inclination angle
SN	schmorl's nodes

Chapter one

1.1: Introduction:

The spinal column, an elegantly stacked 33 vertebrae, is the central axis of the body, serving a numerous function, generally put in two large divisions, a supportive role, in that it supports the whole weight of the trunk, transmitting the forces through the pelvic girdle to the ground, beside carrying the head and upper limbs. The protective role of the spine is that it houses and guards the vital and fragile spinal cord. (Standring, 2015)

It is an immensely complex structure, formed by the thirty-three vertebrae that are separated by an intervertebral disk, held by various ligaments, and strengthen and moved by even a greater number of muscles. It assume a C-shaped curve at birth, known as the primary curvature, then gradually develop a posterior concavity (secondary curvature) in the cervical region followed by a another one in the lumbar region as one start to lift one's head and sit respectively.(Bogduk, 2005)

This complexity combined with the functions of carrying heavy load while protecting delicate structure requires a very fine balance, both physically and physiologically, and maybe even a bit of luck to maintain a healthy pain free spine.

Pain in the lower back (LBP), defined by European guidelines for the management of low back pain in primary care as ‘‘pain and discomfort’’ localized below the costal margin and above the inferior gluteal folds, with or without leg pain. is a problem shared by all the human species, it has prevalence as high as 80% by most accounts (Walker, 2000), and almost every single person will be plagued by it at least once in their lifetime. It surpasses time, countries, profession and even social classes. The pain leads to sleep disorders, anxiety, depression absence from work which – due to its very prevalence – leads to lowered productivity and finical losses, both individually and nationally, this indirect loss combined the losses of directly treating it make for great deal of costs. For example in the US alone, it is estimated that between $84.1 and $624.8 billion dollars are spent on LBP, and that is without considering the pharmacological expenses.(Gore et al., 2012)

Many guidelines have been developed in different areas of the world to efficiently deal with the problem of LBP, they all aim to improve treatment outcomes in a cost effective manner, treatment targets being, reducing pain, improving participation in activities, maintain work ability, and at least prevent disability. (Koes et al., 2001) studied such guidelines in 11 countries and came to the conclusion: "The comparison of clinical guidelines for the management of low back pain showed that diagnostic and therapeutic recommendations were generally similar. Updates of the guidelines are planned in most countries, although so far produced only in the United Kingdom. However, new evidence may lead to stronger conclusions and enable future guidelines to become even more concordant".

The general agreement among those guideline's authors is that imaging is grossly overused, this leads to wasted resources and lower quality of care, so they emphasize on the clinical evaluation, thorough medical history, and careful consideration for imaging options, in order to save costs, and reduce general medical radiation exposure. (Koes et al., 2001)

Imaging of the spine usually start with plain radiography, inexpensive abundant tool for the initial evaluation of the spine, characteristics of the bony parts and some of the soft tissues could be adequately represented. As in many of the other body parts, CT and MRI gives far better tissue contrast and the advantages of cross sectional imaging, but the availability of such advanced imaging equipment is generally limited and costly, especially in the third world, in Sudan for example there is as little as 30 MRI machines to service over 30 million Sudanese.

Each set of images is carefully evaluated for masses (including lytic and sclerotic), fractures and subluxations, degeneration (osteophytes, etc.), and general alignment and curvature. unless the spine is fully straight, the curvature of the spine will be judged subjectively if specific lordosis angles are not measured.

1.2: Problem of the study:

The role of lumbar spine radiographs in patients with non-specific lower back pain, and its value in terms of diagnostic information, cost and radiation dose, are surrounded with much controversy. No study has examined the issue, to the best of the author's knowledge, in Sudanese population.

1.3: Objectives of the study:

1.3.1: General:

This study was undertaken to assess lower back pain using lumbar spine radiographs.

1.3.2: Specific:

- To assess the inter-gender and age distribution of LBP
- To measure The angle of lumbar lordosis on lumbar x-ray of patients with LBP
- To measure The angle of lumbosacral junction disc on lumbar x-ray of patients with LBP
- To measure The height of lumbosacral junction disc on lumbar x-ray of patients with LBP
- To study the distribution of the following lumbar spine features, Schmorl's nodes, spondylolisthesis and transitional vertebrae
- To evaluate spinal canal stenosis with LBP

1.4: overview of the study:

This thesis is constructed in five main chapters, the first one introduces and briefly describes the issue examined in general terms, the second chapter provides detailed explanation of all areas of the study and reviews the relevant, previous published studies in the subject. The third chapter discusses the design of this study, describes the methodology, and list the materials used. The results obtained are detailed in the fourth chapter, the fifth chapter discuses those results, offer a conclusion and recommendations.

CHAPTER TWO

2.1: Theoretical background:

2.1.1: The lumbar spine:

The lumbar vertebrae are, in human anatomy, the five vertebrae lying between the thoracic spine and the rib cage above, and the sacrum and the pelvis below.

As in all of the vertebral column, the individual vertebra increase in size as its level descends, thus making the lumbar vertebrae the largest.

"Each vertebral body is more or less a cylinder with a thin cortical shell which surrounds cancellous bone. From L1 to L5, the posterior aspect changes from slightly concave to slightly convex, and the diameter of the cylinder increases gradually because of the increasing loads each body has to carry. At the upper and lower surfaces, two distinct areas can be seen: each is a peripheral ring of compact bone – surrounding and slightly above the level of the flat and rough central zone – which originates from the epiphysis and fuses with the vertebral body at the age of about 16 The central zone – the bony endplate – shows many perforations, through which blood vessels can reach the disc." (Ombregt, 2013)

"the vertebral foramen is triangular, larger than at thoracic levels but smaller than at cervical levels. The pedicles are short. The spinous process is almost horizontal, quadrangular and thickened along its posterior and inferior borders. The superior articular processes bear vertical concave articular facets facing posteromedial, with a rough mammillary process on their posterior borders. The inferior articular processes have vertical convex articular facets that face anterolaterally. The transverse processes re thin and long, except on the more substantial fifth pair. A small accessory process marks the posteroinferior aspect of the root of each transverse process. The accessory and mammillary processes are linked by a fine ligament, the mammillo-accessory ligament, which is sometimes ossified, and beneath which runs the medial branch of the dorsal primary ramus of the spinal nerve (Bogduk, 2005) Strong paired pedicles arise posterolaterally from each body near its upper border. Superior vertebral notches are shallow and the inferior ones are deep. The lamiae are broad and short, but do not overlap as much as those of the thoracic vertebrae. The fifth spine is the smallest, and its apex is often rounded and down-turned. Upper lumbar superior articular processes are further apart than inferior ones, but the difference is slight in the fourth and negligible in the fifth. The articular facets are reciprocally concave (superior) and convex (inferior), which allows flexion, extension, lateral bending and some degree of rotation. There are sex differences in the angle of inclination and depth of curvature of the articular facets. The facets are sometimes asymmetrical. Transverse processes, except the fifth, are anteroposteriorly compressed and project posterolaterally. The lower border of the fifth transverse process is angulated, and passes laterally and then superolaterally to a blunt tip; the whole process presents a greater upward inclination than the fourth. The angle on the inferior border may represent the tip of the costal element and the lateral end the tip of the true transverse process. The lumbar transverse processes increase in length from first to third and then shorten. The fifth pair incline both upwards and posterolaterally. The costal element is incorporated in the mature transverse process." (Bogduk, 2005)

"The shape of the lumbar lordosis is achieved as a result of several factors. The first of these is the shape of the lumbosacral intervertebral disc. This disc is unlike any of the other lumbar intervertebral discs in that it is wedge shaped. Its posterior height is about 67 mm less than its anterior height. Consequently, when the Lumbar vertebra is articulated to the sacrum, its lower surface dos not lie parallel to the upper surface of the sacrum. It is still inclined forwards and downwards but less steeply than the top of the sacrum. The angle formed between the bottom of the L1 vertebra and the top of the sacrum varies from individual to individual over the range 6--29- and has an average size of about 16 degrees. The second factor that generates the lumbar lordosis is the shape of the Lumbar vertebra. Like the lumbosacral disc, the Lumbar vertebral body is also wedge shaped. The height of its posterior surface is some 3 m less than the height of its anterior surface. Because of the wedge, shape of both the Lumbar body and the lumbosacral disc, the upper surface of L5 lies much closer to a horizontal plane than dos the upper surface of the sacrum. The remainder of the lumbar lordosis is completed simply by indentation of the vertebrae above L5. (Bogduk, 2005)

Each vertebra is inclined slightly backwards in relation to the vertebra below. Because of this inclination, the anterior parts of the auli fibrosi and the anterior longitudinal ligament are stretched. Posteriorly, the intervertebral discs are compressed slightly, and the inferior articular processes slide downwards in relation to the superior articular processes of the vertebra below, and may impact either the superior articular process or the pedicle below. The form of the curve thus achieved is such that. In the upright posture, the LJ vertebra is brought to lie vertically above the sacrum. The exact shape of the lumbar lordosis at rest varies from individual to individual, and it is difficult to define what might be called the 'normal' lumbar lordosis “ (Bogduk, 2005)

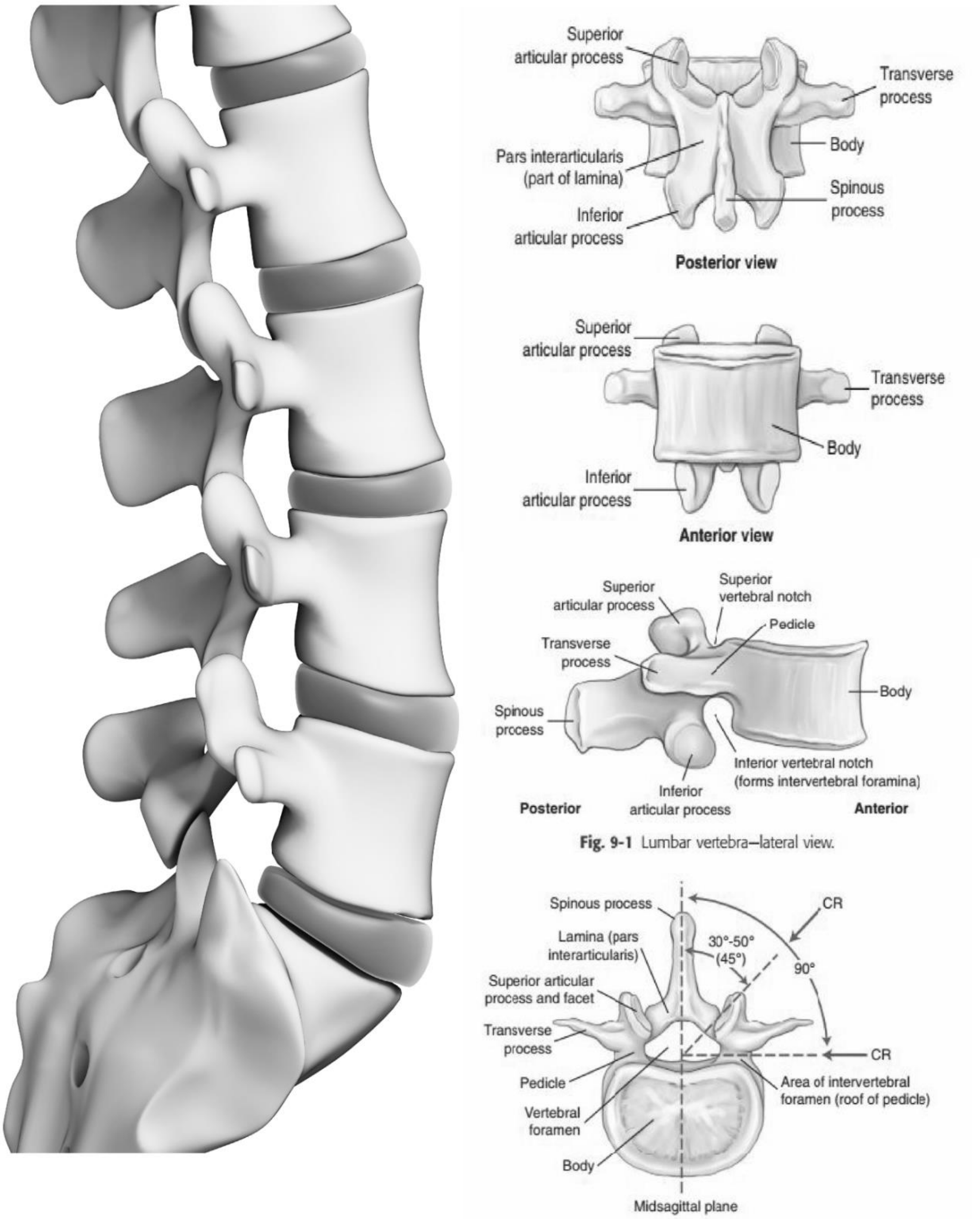

Figure 2:1 lumbar spine anatomy (Bontrager and Lampignano, 2013)

“The upper and lower borders of lumbar bodies give attachment to the anterior and posterior longitudinal ligaments. The upper bodies (three on the right, two on the left) give attachments to the crura of the diaphragm lateral to the anterior longitudinal ligament. Posterolaterally, psoas major is attached to the upper and lower margins of all the lumbar bodies, and between them, tendinous arches carry its attachments across their concave sides. The posterior lamella of the thoracolumbar fascia, erectors spinae, spinales thoracis, multifdi, interspinal muscles and ligaments, and supraspinous ligaments are all attached to spinous processes. All lumbar transverse processes present a vertical ridge on the anterior surface, nearer the tip, which marks the attachment of the anterior layer of the thoracolumbar fascia, and separates the surface into medial and lateral areas for psoas major and quadratus lumborum respectively. The middle layer of the fascia is attached to the apices of the transverse processes; the medial and lateral arcuate ligaments attach to the vertical ridge on the anterior aspect of the first pair, and the iliolumbar ligament attaches to the apices of the fifth pair. Posteriorly, deep dorsal muscles cover the transverse processes, and fibers of longissimus thoracis are attached to them and to their accessory processes. (Standring, 2015)

The ventral lateral intertransverse muscles are attached to their upper and lower borders, while the dorsal attach cranially to the accessory process and caudally to the upper border of the transverse process. The mammillary process, homologous with the superior tubercle of the twelfth thoracic vertebra, gives attachment to multifdus and the medial intertransverse muscle. The latter also attaches to the accessory process, which is sometimes difficult to identify. (Standring, 2015)

The lumbar vertebrae ossify according to the standard vertebral pattern and have two additional centers for the mammillary processes.

A pair of scale-like epiphyses usually appear on the tips of the costal elements of the fifth lumbar vertebra” (Standring, 2015)

2.1.2: Intervertebral discs:

Two adjacent vertebral bodies are linked by an intervertebral disc. Together with the corresponding facet joints, they form the ‘functional unit of Junghans’

Annulus fibrosus this is made up of 15–25 concentric fibro cartilaginous sheets or ‘lamellae’, each formed by parallel fibers, running obliquely at a 30° angle between the vertebral bodies.14 because the fibers of two consecutive layers are oriented in opposite directions, they cross each other at an angle of approximately 120°.(Ombregt, 2013)

This arrangement of the annular fibers gives the normal disc great strength against shearing and rotational stresses, while angular movements remain perfectly possible. The outermost fibers are attached directly to bone, around the ring apophysis, and for that reason, they are referred to as the ligamentous portion of the annulus fibrosus. The inner third merges with the cartilaginous endplate and is referred to as the capsular portion of the annulus fibrosus. Nucleus pulposus this consists of a gelatinous substance, made of a meshwork of collagen fibers suspended in a mucoprotein base, which contains mucopolysaccharides, and water.19 with advancing age, the amount of mucopolysaccharides diminishes, as does that of the water they bind. A young nucleus is 85% water, whereas it is only 65% water in the elderly.20 these biological changes are mirrored in the macroscopic aspects of the nucleus. In the second and third decades, the nucleus is clear, firm and gelatinous but subsequently it becomes drier and more friable. In the elderly, the nucleus has the texture of thickened cream cheese, and is dry, brownish and friable. At birth, the nucleus pulposus occupies the center of the intervertebral space. As the anterior part of the vertebral body grows faster than the posterior part, the nucleus comes to lie more posteriorly. Consequently, the anterior part of the annulus will have thicker and stronger fibers, which means that the annulus gives better protection against anterior than posterior displacements of the nucleus; this is disadvantageous with respect to the contiguous nerve roots and Dura. (Ombregt, 2013).

Cartilage is devoid of nerves and it has been conventional to draw the same conclusions about the disc. However, over the last few decades, there has been a great deal of research on the possibility that there is some innervation. The presence of free nerve endings has been demonstrated as far as one-third of the way into cadaveric annuli fbrosi, and as far as halfway into annuli fbrosi obtained

during posterior fusion operations. (Ombregt, 2013).

Other research has shown a few nervous elements in the periphery of the annulus fibrosus. The primary function of the disc is to join the vertebrae and allow movement between them. The other functions are typical of the erect spine: a shock absorber; a load distributor; and a separator of the posterior facets to maintain the size of the intervertebral foramen ” (Ombregt, 2013)

2.1.3: POSTURE AND ERGONOMICS:

Posture is a descriptive term for the relative position of the body segments during rest or activity. The maintenance of good posture is a compromise between minimizing the load on the spine and minimizing the muscle work required. The well-balanced erect body has a line of gravity that extends from the level of the external auditory meatus, through the dens of the axis just anterior to the body of the second thoracic vertebra, through the center of the body of the twelfth thoracic vertebra, and through the rear of the body of the fifth lumbar vertebra to lie anterior to the sacrum. (Standring, 2015)

The position of the line of gravity may move anteriorly with locomotion and may vary between individuals. The lumbar spine is held in a lordosis. The degree of this lordosis is determined by the lumbosacral angle and is normally 30–45°. The muscles responsible for this posture include erector spinae, rectus abdominus, the internal and external obliques, psoas major, iliacus, the gluteal and hamstring muscles. The lordosis can be increased (as a result of weak abdominal muscles and tight hamstring muscles), decreased flattened (common in people with either acute or chronic low back pain) or reversed. (Standring, 2015)

Ergonomics has been defined as ‘the way humans work’, and it permits an appreciation of the effects of tasks and the work environment on underlying postural biomechanics. Discs were loaded maximally in sitting and in lifting in a forward-leaning position, so sitting posture and lifting have received considerable ergonomic attention. (Standring, 2015)

In sitting, the goal has been to determine the seat type and reclining angle associated with lowest disc pressure and the least paraspinal muscle activity. When sitting with the hips and knees flexed to 90°, the pelvis rotates posteriorly, flattening the lumbar lordosis and consequently increasing the load on the intervertebral discs. Thus, it is now advised that, in sitting, the angle between trunk and thigh should be between 105° and 135°, with the sacrum tilted at 16° and the fourth and fifth lumbar vertebrae supported. In lifting heavy weights, there is considerable initial compression of lumbar intervertebral discs and large increases in thoracic and intraabdominal pressure. The compressive force acting on the spine is shared between the vertebral bodies and the neural arch. In the lumbar spine, the neural arch typically resists 20% of this force once the disc height has been reduced by diurnal fluid expulsion, and when the spine is positioned upright. However, age-related narrowing of the disc can cause more than 50% of the compressive force to be resisted by the neural arch, which may explain why osteoarthritis of the facet joints commonly follows disc degeneration. When lifting, manual handling advisers emphasize the importance of leg lifting as opposed to back lifting. Loads should also be kept close to the body to reduce the lever arm of the load. The use of deep inspiration to raise intra-abdominal pressure while lifting has also been advised, as this is believed to offer further support to the lumbar spine. The spine is at risk when lifting is combined with twisting, lateral bending and asymmetric postures. However, heavy lifting remains one of the key work-related risk factors for the spine together with whole-body vibration, prolonged sitting, twisting and bending." (Standring, 2015)

2.1.4: The lumbar radiograph:

"Radiographic examinations of the lumbar spine remain a large part of the workload in the radiology departments, and comprise 15% of all outpatient examinations. Although they are apparently innocuous tests, there is a statistical probability of 19 deaths each year nationwide as a result of radiation absorbed during the examination" (Halpin et al., 1991)

Before the availability of CT and MRI technology, full radiographic examination of the lumbar spine consisted of five views, anteropostenior, lateral, L5-S1 spot lateral, and both obliques.

In a retrospective study, (Scavone et al., 1981a) studied the diagnostic value of spot lateral and oblique lumbar spine radiographs in 782 patients, and came to the conclusion: ” Considering the additional cost, significant gonadal radiation, and limited diagnostic value, these views should be eliminated from routine lumbar spine series”

His recommendations are the accepted practice nowadays, for lumbar imagine by conventional, and unless otherwise strongly indicated by a clinical suspicion, anteroposterior and lateral are enough.

2.1.4.1: **Antero-posterior projection:**

The patient lies supine on the Bucky table, with the median sagittal plane coincident with, and at right angles to, the midline of the table and Bucky. The anterior superior iliac spines should be equidistant from the tabletop. The hips and knees are flexed and the feet are placed with their plantar aspect on the tabletop to reduce the lumbar arch and bring the lumbar region of the vertebral column parallel with the cassette. The cassette should be large enough to include the lower thoracic vertebrae and the sacro-iliac joints and is centered at the level of the lower costal margin.

The exposure should be made on arrested expiration, as the diaphragm will cause the diaphragm to move superiorly. The air within the lungs would otherwise cause a large difference in density and poor contrast between the upper and lower lumbar vertebrae.

The central ray in the midline at the level of the lower costal margin (L3). The image should include from T12 down, including all of the sacro-iliac joints. ” (Whitley et al., 2005).

2.1.4:2: **Lateral projection:**

The patient lies on either side on the Bucky table. If there is any degree of scoliosis, then the most appropriate lateral position will be such that the concavity of the curve is towards the X-ray tube. The arms should be raised and resting on the pillow in front of the patient's head. The knees and hips are flexed for stability. The coronal plane running through the center of the spine should coincide with, and be perpendicular to, the midline of the Bucky. Non-opaque pads may be placed under the waist and knees, as necessary, to bring the vertebral column parallel to the film. The cassette is centered at the level of the lower costal margin. The exposure should be made on arrested expiration. This projection can also be undertaken erect with the patient standing or sitting.

Direct the central ray at right angles to the line of spinous processes and towards a point 7.5 cm anterior to the third lumbar spinous process at the level of the lower costal margin.

The image should include T12 downwards, to include the lumbar sacral junction. Ideally, the projection will produce a clear view through the center of the intervertebral disc space, with individual vertebral endplates superimposed. The cortices at the posterior and anterior margins of the vertebral body should also be superimposed. " (Whitley et al., 2005)

Figure 2.2: Anteroposterior and lateral lumbar x-ray

(Bontrager and Lampignano, 2013)

2.1.5: low back pain:

Pain in the lower back or low back pain is a common concern, affecting up to 90% of people at some point in their lifetime. Up to 50% will have more than one episode. Low back pain is not a specific disease; rather it is a symptom that may occur from a variety of different processes. In up to 85% of people with low back pain, despite a thorough medical examination, no specific cause of the pain can be identified. Low back pain is second only to the common cold as a cause of lost days at work. It is also one of the most common reasons to visit a doctor's office or a hospital's emergency department. It is the second most common neurologic complaint in the United States, second only to headache. Low back pain accounts for approximately 15% of the sick leave, and is the most common cause of disability in persons less than 45 years of age. The prognosis for most cases of low backache is good. For 90% of people, even those with nerve root irritation, their symptoms will improve within two months no matter what treatment is used, and even if no treatment is given.(Yang et al., 2016)

An historic review shows that there is no change in the pathology or prevalence of low back pain: What has changed is our understanding and management.

2.1.5.1: Causes:

Back pain is a symptom. Common causes of back pain involve disease or injury to the muscles, bones, and/or nerves of the spine. Pain arising from abnormalities of organs within the abdomen, pelvis, or chest may also be felt in the back. This is called referred pain. Many disorders within the abdomen, such as appendicitis, aneurysms, kidney diseases, kidney infection, bladder infections, pelvic infections, ovarian disorders, uterine fibroids, and endometriosis among others, can cause pain referred to the back. Normal pregnancy can cause back pain in many ways, including stretching ligaments within the pelvis, irritating nerves, and straining the low back. Additionally, the effects of the female hormone estrogen and the ligament-loosening hormone relaxin may contribute to loosening of the ligaments and structures of the back" (Arya, 2014).

The major causes are Mechanical like Spinal disc herniation and Fractures, Inflammatory like Seronegative spondylarthritides and Rheumatoid arthritis, Infection like an epidural abscess, or osteomyelitis, Neoplastic, metabolic like Osteoporotic fractures and Ochronosis Osteomalacia. Psychosomatic, Paget's disease, Referred pain from a Pelvic/abdominal disease or a Prostate cancer.(Cox, 2012)

2.1.5.2: Diagnosis:

For most patients with acute low back pain a thorough history taking and brief clinical, examination is sufficient. The primary purpose of the initial examination is to attempt to identify any 'red flags' and to make a specific diagnosis. It is, however, well accepted that in most cases of acute low back pain it is not possible to arrive at a diagnosis based on detectable pathological changes. Because of that several systems of diagnosis have been suggested, in which low back pain is categorized based on pain distribution, pain behavior, functional disability, clinical signs etc. However, none of these systems of classification have been critically validated. A simple and practical classification, which has gained international acceptance, is by dividing acute low back pain into three categories – the so-called 'diagnostic triage': Serious spinal pathology, Nerve root pain (radicular pain) and nonspecific low back pain(Cox, 2012)

The first priority is to make sure that the problem is of musculoskeletal origin and to rule out non-spinal pathology. The next step is to exclude the presence of serious spinal pathology. Suspicion therefore is awakened by the history and/or the clinical examination and can be confirmed by further investigations. The next priority is to decide whether the patient has nerve root pain. The patient's pain distribution and pattern will indicate that, and the clinical examination will often support it. If that is not the case, the pain is classified as nonspecific low back pain. The initial examination serves other important purposes besides reaching a 'diagnosis'. Through a thorough history taking and physical examination, it is possible to evaluate the degree of pain and functional disability and the need for imaging.(Care, 2006)

2.1.5.3: Imaging:

(Arya, 2014) explains that imaging is used to provide precise anatomical information, to perform clinical diagnosis, to plan an effective treatment, to assess the efficacy of treatment, and to plan and perform a diagnostic or therapeutic intervention.

2.1.5.3.1:Plain-film radiography:

Plain-film radiography is rarely useful in the initial evaluation of patients with acute-onset low back pain. At least two large retrospective studies have demonstrated the low yield of lumbar spine radiographs (Scavone et al., 1981b).In one of these studies, plain-film radiographs were normal or demonstrated changes of equivocal clinical significance in more than 75 per cent of patients with low back pain. The other study found that oblique views of the spine uncovered useful information in fewer than 3 percent of patients. Exposure to unnecessary ionizing radiation should be avoided. The issue is of particular concern in young women because the amount of gonadal radiation from obtaining a plain radiograph of the lumbar spine is equivalent to being exposed to daily chest radiograph for more than one year. (Scavone et al., 1981a).

At the first visit, anteroposterior and lateral radiographs should be considered in patients this “red flags”:

- History of significant trauma.
- Neurologic deficits.
- Systemic symptoms.
- Temperature greater than 38°C (100.4°F).
- Unexplained weight loss.
- Medical history of Cancer, Corticosteroid use or Drug or alcohol abuse

Two major drawbacks to radiography are difficulty in interpretation and an unacceptably high rate of false positive findings. Plain films have high sensitivity and specificity for bony pathologies like acute fractures, spondylitis, or spondylolisthesis, scoliosis, kyphosis, gross degenerative disease. They have a low or no sensitivity and specificity for soft-tissue pathologies like disc herniation, marrow infiltration, spinal infection, and tambours.(Arya, 2014)

2.1.5.3.2: Myelogram :

“It is an X-ray study in which a radio-opaque dye is injected directly into the spinal canal. Its use has decreased dramatically since MRI scanning. A myelogram nowadays is usually done in conjunction with a CT scan. CT myelography has become the investigation of choice to study disc herniation and/or arachnoiditis in postoperative spine with metal hardware in place. It is also useful when clinical findings are compelling and are not adequately explained by CT and/or MRI.” (Arya, 2014)

2.1.5.3.3: Computed tomographic (CT) scanning:

the principal value of CT is its ability to demonstrate the osseous structures of the lumbar spine and their relationship to the neural canal in an axial plane. A CT scan is useful in diagnosing tambours, fractures, and partial-to-complete dislocations. In showing the relative position of one bony structure to another, CT scan is also helpful in the diagnosis of spondylolisthesis.(Arya, 2014).

2.1.5.3.4: Magnetic resonance imaging (MRI):

MRI has emerged as the procedure of choice for diagnostic imaging of neurologic structures related to low back pain. MRI is better than CT in showing the relationship of the disc to nerve, and at locating soft-tissue and non-bony structures. For this reason, it is better than CT at detecting early osteomyelitis, discitis, and epidural type infection or haematomas. MRI provides high-resolution multiaxial, multiplanar images of tissues with no known biohazard effects. The only contraindication to MRI is the presence of ferromagnetic implants, cardiac pacemaker, intracranial clips, or claustrophobia.

Magnetic resonance imaging (MRI) and computed tomographic (CT) scanning have been found to demonstrate abnormalities in “normal” asymptomatic people(Boden et al., 1990) (Wiesel et al., 1984). Thus, positive findings in patients with back pain are frequently of questionable clinical significance. In one study, MRI scans revealed herniated discs in approximately 25 per cent of asymptomatic persons less than 60 years of age, and in 33 per cent of those more than 60 years of age11. Clearly, the presence of abnormalities does not correlate well with clinical symptoms. (Arya, 2014)

2.2 previous studies:

In their study characteristics of low back pain patients and outline the best possible treatment for them, (Mohammed et al., 2016) found that Acute low backache, mostly caused by Prolapsed intervertebral, was more common in upper middle class and Lower class, (and even more so in Medium and heavy manual workers), They go on to advocate for conservative treatment instead of drugs.

(Belay et al., 2016) A cross-sectional study with internal comparison aimed determine the prevalence and to identify the risk factors of LBP among 395 Nurses (285, 72.2%were females) working in Addis Ababa City Public Hospitals, Ethiopia, in the year 2015 and found nearly half of the participants (45.8%) complained Low Back Pain. There were statistical significant association between Low Back Pain and working shift, physical activities at work; sleep disturbance and felt little pleasure by doing things. They recommended Recognition & Preventive measures like providing resting periods should be taken to reduce the risk of Low Back Pain in Nurses working in Public hospitals

(Davis et al., 2009) declares in their Appropriateness Criteria:

” uncomplicated acute LBP or radiculopathy is a benign, self-limited condition that does not warrant any imaging studies. The vast majority of these patients are back to their usual activities within 30 days, Indications of a more complicated status, often termed “red flags”.

(Care, 2006) introduced what he called ‘Yellow flags’, Psychosocial factors that increase the risk of developing, or perpetuating chronic pain and long-term disability (including) work-loss associated with low back pain.

He asserts that identification of these yellow flags lead to appropriate cognitive and behavioral management. They include:

1. Inappropriate attitudes and beliefs about back pain

2.Inappropriate pain behavior (for example, fear-avoidance behavior and reduced activity levels)

3.Work related problems or compensation issues

4.Emotional problems (such as depression, anxiety, stress, tendency to low mood and withdrawal from social interaction).

In their (van der Kraan and van den Berg) review to summarizes the current understanding of the clinical relevance and biology of osteophytes they assert that it can contribute both to the functional properties of affected joints and to clinical relevant symptoms. In addition, Osteophyte formation is highly associated with cartilage damage but osteophytes can develop without explicit cartilage damage.

(Nathan, 1962) reviewed 400 vertebral column is of both sexes and of various ages for the presence of osteophytes, he classified them into four degrees of development. He then states: " Osteophytes were first found in the twenties, and the proportion of affected spines increased directly thereafter. In the forties, 100 per cent of skeletons showed first-degree osteophytes. The other degrees of osteophytes were found iii 100 per cent of skeletons of people who were over eighty years of age. The distribution of the osteophytes in the different region of the spine, as well as their localization on each vertebral body, was found to follow characteristic patterns.

The most outstanding features of these patterns were firstly, the incidence of osteophytes is greater in the anterior aspect than on the posterior aspect of the vertebral body. Secondly, anterior or posterior osteophytes tend to develop more in the concavities of the normal vertebral column or within the concavities of scoliosis or kyphosis. Thirdly, Peaks of regional distribution are seen amid are related to the normal curvatures of the vertebral column and to the limit of gravity crossing them. These findings indicate that osteophytes tend to appear more where pressure is greatest. This leads to the concept that osteophytes develop as a defense mechanism in response to pressure." (Nathan, 1962)

According to (Gelb et al., 1995) The vertebral spine presents regional curves on sagittal plane designed to absorb impact, reduce its longitudinal stiffness, and intensify muscular function.

Values of sagittal curves measurements on spine present great variability in normal individuals, with a wide variation range for those, within normality limits. (Stagnara et al., 1982) suggests that great measurements variation must be considered as physiological, indicative, but not normative.

While (Meakin et al., 2008) claim that: "Characterizing the natural curvature of the lumbar spine in the sagittal plane (the lumbar lordosis) is of interest for a variety of clinical, biomechanical and ergonomic reasons. The spinal shape influences design of seating in the workplace, in transport and in assessing posture in an attempt to prevent low back pain.

(Chen and Lee, 1997) tried to establish a non-invasive method to measure lumbosacral angles, after admitting, "Many methods of measuring the lumbar spine and pelvic positions have been investigated, among various techniques, the radiographic method will probably always be the most accurate". They also remarked, "Measurements of lumbosacral vertebral angle are important in assessing the stresses acting on the low back in lifting."

According to both (Cailliet, 1988, Bogduk, 2005), lumbar lordosis angle is generally effected by : shape of L5, shape of L5/S1 intervertebral disc, and sacral inclination, while (Frymoyer et al., 1984) claims Increased lumbar lordosis had a significant association with decreased disc-space height and wedging deformity of the disc between the fourth and fifth lumbar vertebrae, which may explain the results of (Amonoo-Kuofi, 1992), who studied the effects of aging on ls angles, he found angles tend to increase steadily with advancing age and females to have larger angles overall in all age groups.

(Damasceno et al., 2006) also found A significant difference was seen between males and females for lumbar curvature measurements, age-related differences also were found in lumbar curvature and vertebral bodies measurements when they studied The angular value of lumbar lordosis and the role of vertebral bodies and intervertebral discs in 350 normal and asymptomatic individuals, ages ranging from 18 to 50 years, they found Average values of -61º for lumbosacral curve and of -45º for lumbolumbar curve. Vertebral bodies' discs L4-L5 and L5-S1 and the vertebral body L5 accounted for nearly 60% of the angular measurement of lumbosacral curvature.

(Skaf et al., 2011) agreed when they conducted a study to investigate this correlation between age and level of disc herniation, and to associate it with the magnitude of the Lumbar Lordosis Angle (LLA), as measured by Cobb's method their results showed decrease angle with and offered this explanation : "it has been hypothesized that with aging, an imbalance of trunk muscle due to weakness of abdominal muscles can increase the lordatic curvature of the lumbar spine."

But (Hellems and Keats, 1971) measured of the lumbosacral angle using Ferguson in 319 normal males ranging in age from 17-58 years, The mean was 41.1^{O} . With no mentionable difference between groups. This agrees with (Okpala, 2014) who also measure red the lumbosacral angle using Ferguson's technique and had results that varied between 18° and 71° and showed no significant variation with sex and between various age groups

(Papadakis et al., 2009) implemented a cross-sectional, blinded, controlled design. On 112 postmenopausal women aimed, determine whether lumbar lordosis is different between patients with either osteoporosis (OP) or osteoarthritis (OA) and healthy persons. Using Cobb's method. They patients with OP averaged a L1–S1angle of 54.1°, patients with 52.3, and patients with both 52.3, and control was 51.8then concluded that no association was found between the degree of lumbar lordosis and the presence of osteoporosis, osteoarthritis, both diseases and absence thereof. Even though patients with these diseases have some different characteristics, lumbar lordosis does not appear to be one of them".

(Onyemaechi et al., 2016) evaluated the effects of body mass index (BMI) and waist–hip ratio (WHR) on lumbosacral angles. They found heavier people had significantly higher mean LSA, LLA, sacral inclination angle (SIA), they inferred "this may result in biomechanical changes in the lumbosacral spine, which increase the incidence of low back pain."

(Peterson et al., 1989)noted that an increased lumbosacral disc angle does not appear to be associated with an increased incidence of spondylolisthesis.

(Guigui et al., 2003) measured Pelvic and spinal parameters on the standing radiographs of 250 healthy volunteers. They found a mean LLA of 59°. which is not significantly lower than what (Tsuji et al., 2001) measured in 500 Japanese elderly and found a mean of 54.2°. but earlier, Jackson et al., 1998) found a mean of 62.1° that was close to (Jackson and McManus, 1994) 60.9° mean which exactly equals that of (Damasceno et al., 2006)

In Cross-sectional magnetic-resonance imaging (MRI) study, (Luoma et al., 2004) found that lumbosacral transitional vertebra increases the risk of early degeneration in the upper disc, they found a prevalence of 30%, and that Transitional vertebra is not associated with any type of LBP.

They elaborated: "This effect seems to be obscured by age-related changes in the middle age. The degenerative process is slowed down in the lower disc. For these effects, the presence of a transitional vertebra should be noticed when morphologic methods are used in research on lumbosacral spine."

They disagreed with (Magora and Schwartz, 1977), *who beside* reporting a lower incidence of 21.5%,they found is some evidence that LBP when associated with sacralization may be more severe.

(Olofin et al., 2001) carried out a similar study using plain radiography, they found an incidence of 37% of their sample afflicted with transitional vertebra and, which they described as " quite high and cannot be discountenanced.", they also found sacralization is the commoner LSTV and men are more susceptible(ration of 1:2)

These findings also agrees with the high incidences recorded by (Bron et al., 2007, Dai, 1998) (35%), (Sugihara, 1993) (34%) and *(Castellvi et al., 1984)* (30%).

(Hilton et al., 1976) studied vertebral end-plate lesions (Schmorl's nodes) in the dorsolumbar spine. Particularly their distribution and relationship to bone density and disc degeneration in 50 post-mortem spines below D9 in subjects aged 13-96 years. They found a prevalence of 76 % of cases with predominance in males. More frequently in the lower than in the upper vertebral end plate, and more severely in the dorsolumbar (DIO-LL) region than in the lower lumbar (L2-L5 region). They suggested that end-plate lesions arising in adolescence (or before) may predispose the dorsolumbar spine to disc degeneration in later life. But In adults they were unrelated to age and bone density

(Dar et al., 2010) also studied 240 human skeleton spines (T4-L5) (from the Hamann–Todd Osteological Collection) for the presence and location of SNs, to establish the spatial distribution of SNs along the spine in order to reveal its pathophysiology, they found a total number of SNs of 511: 193 (37.7%) were located on the superior surface and 318 (62.3%) on the inferior surface of the vertebral body. They found no association between the SNs location along the spine and gender, ethnicity and age. This study suggests that the frequency distribution of SNs varies with vertebra location and surface. They went to refute the traumatic or disease explanation of the phenomenon, and attributed its occurrences to the vertebra development process during early life, the nucleus pulposus pressing the weakest part of the end plate in addition to the various strains on the vertebrae and the intervertebral disc along the spine during spinal movements (especially torsional movements).

(Takahashi et al., 1995) studied (MRI) findings in 5 symptomatic and 11 asymptomatic Schmorl's nodes cases. They found that the vertebral body marrow surrounding the Schmorl's node was seen as low signal intensity on Tl-weighted images and as high signal intensity on T2-weighted images. Those indications of inflammation and edema in the vertebral bone marrow were histologically confirmed, and were not seen in asymptomatic individuals. They concluded:

“Inflammatory changes in the vertebral body marrow induced by intraosseous fracture and biological reactions to intraspongious disc materials might cause pain. We postulate that after fracture healing and subsidence of inflammation, the

Schmorl's nodes become asymptomatic, in analogy with old vertebral compression fractures. MRI is not only useful in detecting the recently developed Schmorl's nodes but also in differentiating between symptomatic and asymptomatic (Williams et al., 2007) agreed when they Studied sagittal T1- and T2-weighted magnetic resonance images of the lower thoracic and lumbar spine 516 healthy female twins volunteers (150 monozygotic and 366 dizygotic). To determine the prevalence and clinical features associated with SN. They found SN in 30% of subjects. Of the 374 SN, 153 (41%) were in the lumbar spine and the rest in the thoracic spine. SN heritability was >70%. They also found a positive association between SN and lumbar disc disease (LDD).and discovered more frequently in subjects with back pain, but attributed this to the association of SN with LDD.

In an effort to establish criteria for the radiographic evaluation of narrowing of the L5–S1 disc height, (Inoue et al., 1999)studied degenerated disc heights of L3–4 to L5–S1 and the thickness and length of the L5 transverse in plain radiographs of the lumbar spine in 166 outpatient, among their many finding that L5–S1 disc measured in average 10.5±1.9 mm.

According to (Koompairojn et al., 2006), Lumbar spinal stenosis is the leading preoperative diagnosis for adults older than 65 years who undergo spine surgery.

Various causes have been attributed to low backache, but lumbar spinal canal stenosis as a causative factor is of great interest .especially considering that the cauda equina may be compressed within the lumbar spinal canal by constriction or narrowing of the bony ring of the canal, in contrast to impingement by soft tissues.

(Jones and Thomson, 1968) lead an attempt to recognize the presence of narrowing of the lumbar spinal canal on the plain radiographs we have for some years been relating the antero-posterior diameter of the canal and the interpedicular distance to the size of the adjacent vertebral body. Although we do not claim any detailed accuracy for the method, we have found it of some value in assessing the size of a lumbar spinal canal.

(Nelson, 1973) suggested that reduced interpedicular distance is one of the cause of primary narrowing of the spinal canal

(Nirvan et al., 2005) Studied Inter-pedicular distances of lumbar vertebral canal at levels L1 to L5 was measured in plain antero-posterior radiographs of the lumbar spine of 202 subjects. The minimum at L1 (24.0 mm in male and 23.3 mm in female) and passing L3 (26.4mm in males and 35.8 mm in females) coming to maximum at L 5 (30.9 mm in male and 29.8 mm in female) showing a gradual increase from level L1 to L5.

(Koompairojn et al., 2006) admitted that cross-sectional imaging is the best diagnosis tool for spinal stenosis, they also provide details about ligament, tendon, bone and tissue. However, he argues: “They are expensive. In addition, should only be used to confirm or diagnose for the severe symptoms and/or use before the surgery. X-ray imaging is the fundamental tool to reveal some evidence when the patient first visits. It provides some basic information before performing the advanced imaging. The lateral view of L-spine can also give some abnormal details such as osteophyte, hypertrophy of apophyseal facet joint.

(Eisenberg et al., 1980) was one of the firsts to study spine imaging efficacy, they found that up to 99.3% (699/704) of lumbar spine examinations were fully assessed using two views (anteroposterior and a single, well centered lateral). They estimated, limiting the radiographic examinations of the cervical and lumbar spines to these views would eliminate 1 93,000 radiographs in the evaluation of 100,000.

(Chou et al., 2009) analyzed randomized controlled trials to investigate the effects of routine, immediate lumbar imaging versus usual clinical care without immediate imaging on clinical outcomes in patients with low-back pain and no indication of serious underlying conditions. No significant differences at either short-term (up to 3 months) or long-term (6 – 2 months), so they concluded:

"Clinicians should refrain from routine, immediate lumbar imaging in patients with acute or subacute low-back pain and without features suggesting a serious underlying condition"

This is in agreement with (Jarvik et al., 2015), who in a Prospective cohort of 5239 old patients evaluated early imaging of the lumbar or thoracic spine within 6 weeks. At 12 months, then came to deduce that neither the early radiograph group nor the early MRI/CT group differed significantly from controls on the disability questionnaire and was not associated with better 1-year outcomes.

(Chou et al., 2012) blamed the frequent use of lumbosacral spine radiography for its major contributor to costs, although charges for lumbar spine CT generally run 5 to 10 times higher than lumbosacral spine plain radiography, and MRI 10 to 15 times higher, which is not equally accessible to all, practice variations may indicate inequalities in resource use or areas in which care is haphazard or arbitrary. High-use areas are generally not associated with better clinical outcomes but contribute significantly to overall health care costs. Signifies inefficiencies in medical care.

They continue: "In addition to direct costs, imaging can also lead to downstream cascade effects, referring to the subsequent tests, referrals, and interventions performed as a result of imaging Although the increased number of unnecessary operations that occur from unneeded imaging tests is difficult to estimate, data show that rates of spine MRIs increased sharply at the same time as back surgeries."

(Gillan et al., 2001) agreed when they performed A randomized controlled before-and-after study on 145 patients who had symptomatic lumbar spinal disorders and had been referred to orthopedists or neurosurgeons, they aimed to assess the impact of cross-sectional imaging with magnetic resonance (MR) imaging or computed tomography (CT) on clinical decision making for patients with lower back pain (LBP). They concluded it increased diagnostic confidence, but "has minimal influence on diagnostic or therapeutic decisions for patients with LBP. The results highlight the need for evidence-based guidelines for imaging in LBP treatment."

(Wilson et al., 2001) suggested another explanation:

"Patients' perceived need for radiological studies was significantly associated with use of those services for outpatients with respiratory problems and low back pain. These findings suggest that patients communicate their wishes to physicians, either directly or indirectly, regarding services they think are necessary. Differences in physicians' adherence to guidelines regarding radiology utilization may in part reflect variations in patients' perceived need for those services. Efforts to educate patients about when radiological studies are medically indicated may be an important complement to practice guidelines."

(Chou et al., 2007) drew attention to harms of exposure of the gonads to ionizing radiation, especially with oblique views or repeated exposures. This is a particular concern for younger female patients. They also highlighted the fact Plain radiography identifies many abnormalities that are unrelated to back symptoms, they equally prevalent asymptomatic people, like spondylolysis, facet joint abnormalities, some congenital anomalies, Schmorl's nodes, and mild scoliosis.

(Boden et al., 1990) before them found an abnormal lumbar discs on a magnetic resonance imaging asymptomatic subjects, they concluded: "that abnormalities on magnetic resonance images must be strictly correlated with age and any clinical signs and symptoms before operative treatment is contemplated "

(Henschke et al., 2008) conducted a diagnostic systematic review was conducted to identify red flags to screen for vertebral fractures, they found five clinical features to be useful: age O50 years, female gender, major trauma, pain and tenderness, and a distracting painful injury.

but in children the same rules doesn't apply, ass (Afshani and Kuhn, 1991) explain: "Low back pain in children and adolescents is often caused by a serious problem." Then he proceed to suggest a complete patient history, complete physical examination, laboratory testing, and plain radiography should start the investigation, the results of can be used to steer toward advanced imaging .

Chapter three

3.1. Materials:

3.1.1Subject:

83 Adults complaining of acute and subacute lower back pain (in the last 8 weeks before presentation), who referred for a lumbar x-ray by orthopedists or general practitioner, in the state of Khartoum, were randomly selected

3.1.2Machine used:

3.1.2.1: major x-ray machine:

Allengers (FLOATEX MARS 40), max output power of 40 KW, rotating anode dual focus x-ray rube.

3.1.2.2: computed radiography system:

FCR PRIMA II image reader (model: CR-IR 391RU) see figure (3.2)

3.2. Method

3.2.1 Protocol:

This is a descriptive, prospective study, of the digital lumbar x-rays taken in the supine and lateral decubitus positions, the relevant patient information (age and gender, obtained from PACs) were recorded directly into SPSS, which is also used for all the statistical operations carried out in the analysis. A radiologist analyzed each radiograph was for vertebral body anomalies (spondylolisthesis, degeneration and transition).

The various measurement in this study were carried out using the computer program (K-pacs), as The use of computers for lumbar lordosis measurements has been shown to be equivalent, if not superior, to the manual method (Rajnics et al., 2001) and (Jackson and McManus, 1994).

the following parameters were calculated (Yochum and Rowe, 2005) :

3.2.1.1: lumbar lordosis angle using Cobb's method:

The angle formed by two lines perpendicular to lines drown parallel to the superior endplate of the first lumbar vertebra, and the superior surface of the sacrum. (Yochum and Rowe, 2005) (figure 3.1-A)

The range of 50 to 60 degrees in considered as "the normal range" according to (Banks, 1983) and (Busche-McGregor et al., 1981).

3.2.1.2.: the lumbosacral disc angle:

The angle formed between a line parallel to the inferior endplate of L5, and a line parallel to the superior surface of the sacrum. The normal range appears to be between 10° and 15°.(Banks, 1983) (Cox, 1990)

3.2.1.3: spinal canal stenosis

was evaluated by the method suggested by (Jones and Thomson, 1968) :

The antero-posterior diameter of the spinal canal in the lateral radiograph from the middle of the back of the vertebral body to the base of the opposing spinous process(B), then measure the interpedicular distance in the antero-posterior radiograph(A),to get a product AB. This product is then compared as a ratio with the product of the antero-posterior and transverse diameters of the middle of the adjacent vertebral body in order to correct for magnification (CD).

A ration of 1:2 or less indicate large canal and eliminate the suspicion of stenosis, and a ratio of 1:4 or higher indicate a small canal and warrant more sophisticated imaging if spinal canal stenosis is suspected, a ration between these two is considered inconclusive in this study. *(Figure 3.1 B)*

3.2.1.4: L5/S1 disc hiegh : Hurxthal's method:

The distance between the opposing endplates at the midpoint between the anterior and the posterior vertebral body margins is measured (HURXTHAL, 1968).

3.2.2. Study duration:

The study extended over a period of two months, from the beginning of September 2016 to the end of October 2016.

3.2.5. Inclusion criteria:

Adult patients, with lower back pain in the previous 8 weeks

3.2.6. Exclusion criteria:

Patients under 18 years, with back pain due to significant trauma (RTA or fall from considerable high), Patient under 16 years of age, those underwent spinal surgery, came for follow up purposes or have gross scoliosis

3.2.7. Statistical analysis: Descriptive statistics, independent sample student's test, Mann Whitney means comparison, spearman and Pearson correlations calculated using the Statistical analysis software package software (release 21. 2012)

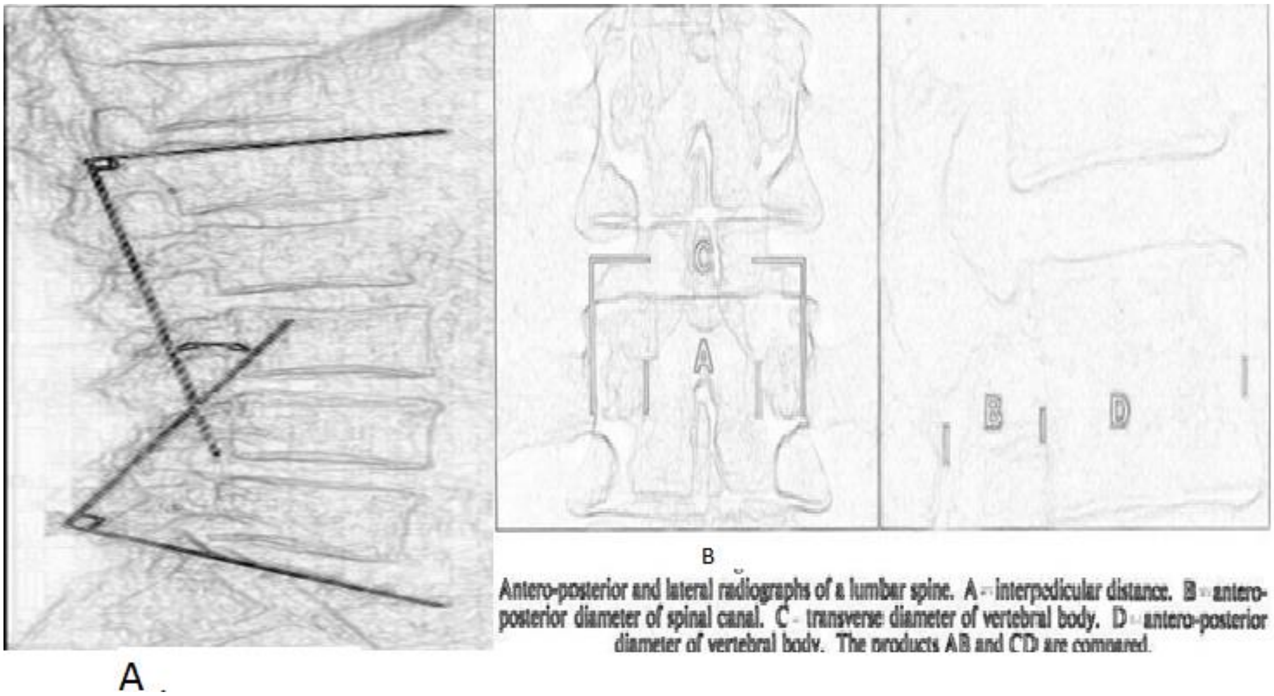

Figure 1:1 measuring methods for (A) lumbar lordosis, and (B) spinal canal

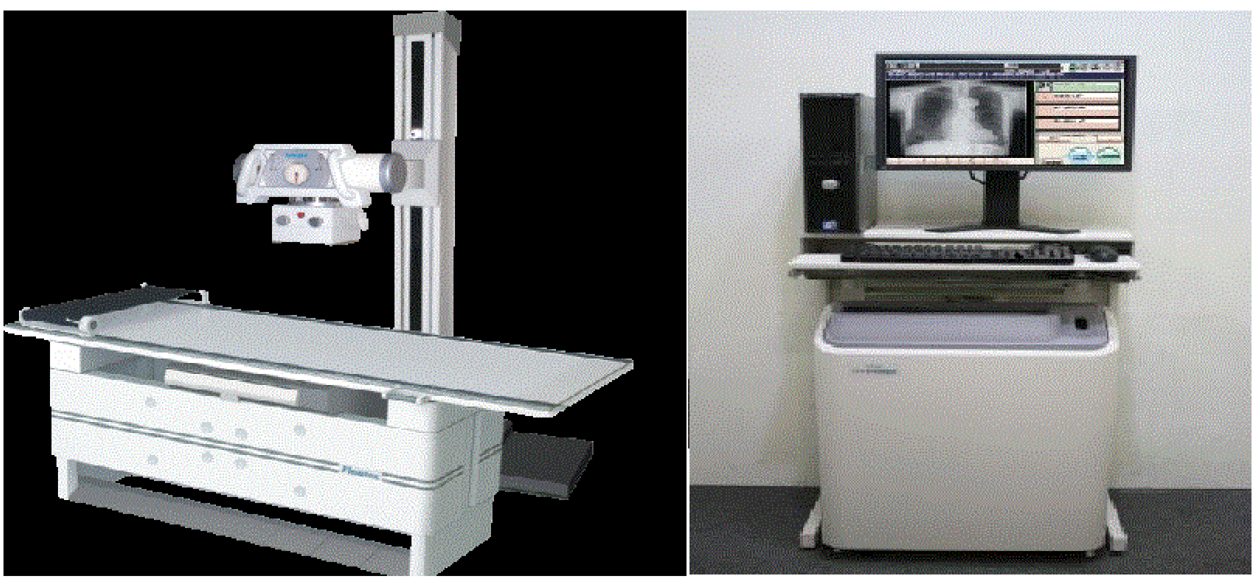

Figure 3:2: x-ray machine and CR unit

Chapter four

4. Results

4.1: Sample characteristics:

The ages of the included subjects ranged from 23 to 81 years. There was 40 males, made up 48.2% of the study sample, with a mean age of 51.9 years (SD=11.8), the age median for females subjects was 49 (IQ range=7 days). See figure (4.1)

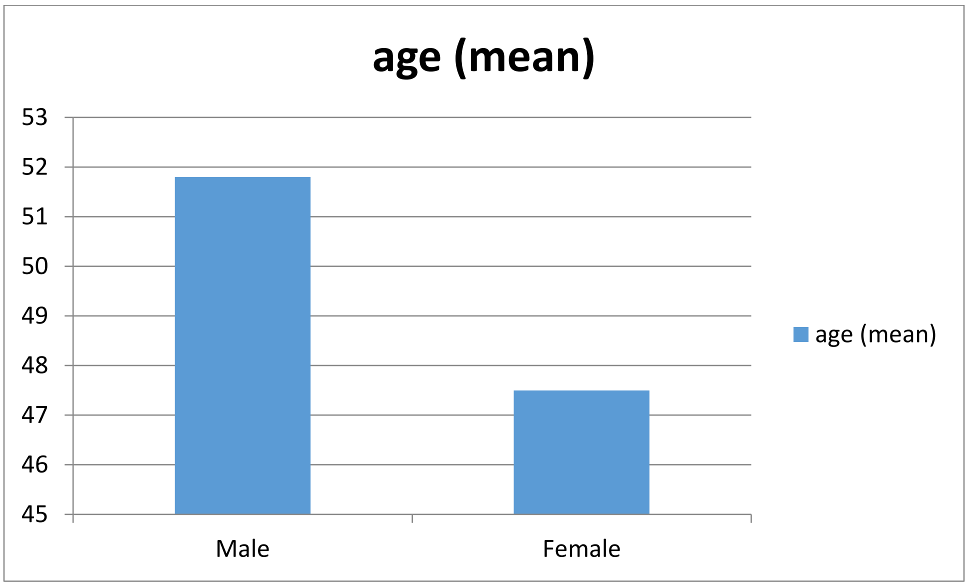

Figure 2:1: age distribution of between genders

Only 15.6% of the sample (7men and 6 women) had no vertebral body anomalies, showed no transitional vertebra, Schmorl's nodes nor narrowed spinal canal, their measurements are summarized in table (4.1)

Table 4.1 carcterestics of the patients with no vertbral abnormalties

	No.	Range	Minimum	Maximum	Mean	Std. Error of Mean	Std. Deviation	Variance
AGE	13	32	33	65	45.69	2.707	9.759	95.231
Intervertebral Disc of S1L5 Height (mm)	13	10.3	5.6	15.9	12.662	.7592	2.7373	7.493
Lumbosacral Lordosis Angle	13	46	30	76	49.15	3.644	13.139	172.641
Lumbosacral Disc Angle	13	18	7	25	14.15	1.613	5.814	33.808

4.2: Lumbar lordosis angle:

As measured by Cobb's method (L1-S1) the sample measurements ranged from 26 to 85 degrees with an mean of 50.7^{o} (SD 11.1 ^{o})

The difference of 6 degrees between the mean of the males versus females showed statistically significant difference between the genders with a p-value of 0.005. Mean difference and 95% CI -6.72 (-11.3, -2, 12).

This angle showed a significant correlation with age in male subjects (r=0.708, p<0.0001 at 0.01 level 2-tailed) but none was detected for females. Spearman's rho was used due to the non-normal distribution of the angle in males

Table 4.2 lumbar lordosis angle carcteristics

Lumbar lordosis angle	n	Distribution in the sample
Male	40	Median =45^o (IQ range=15^o)
female	43	Mean=53.9^o (SD=12.1)

4.3: Lumbosacral disc angle:

Men had a mean angle of 13.7^o (SD=5.05 ^{o}), while females subjects averaged 14.4^o (SD=7.8^o).

In the sample as whole, this angle showed statistically significant correlation with age ($r=0.225$, $p=0.02$) at the 0.05 level, and with the lumbar lordosis angle ($r=0.446$, $p<0.001$) at the 0.01 level.

Between the genders however, as demonstrated by figure (4:2), the angle has a mild correlation with age in men ($R=0.343$, $P=0.03$) at the 0.05 level but not in the female population.

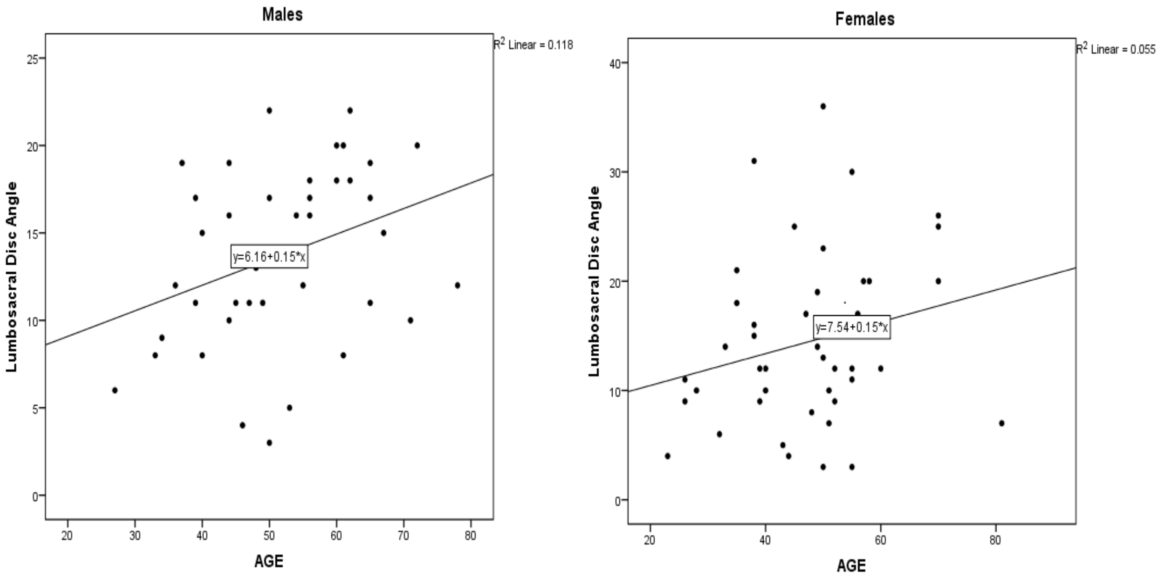

Figure 4.2 lumbsacral disc angle correlation with age

4.4: L5-SI Intervertebral disc height:

The disc space in this study had a median of 12.6 mm (IQ 3.4 mm), and slight skewness to the left with no correlation with the age nor the angles measured.

Men tend to have a slightly overall greater height, mean of 12.8 (SD=1.9) with a fairly normal distribution (Kolmogorov-Smirnova test gave a p value of 0.197 and Shapiro-Wilk a p value of 0.199).

However, women showed greater variability and wide range of 16.9 mm compared to 7 mm in men as demonstrated by figure (4.3)

The height of L5/S1intervertibral disc had no correlation with age, lumbar lordosis or lumbosacral disc angle, neither as a whole nor for just men or women.

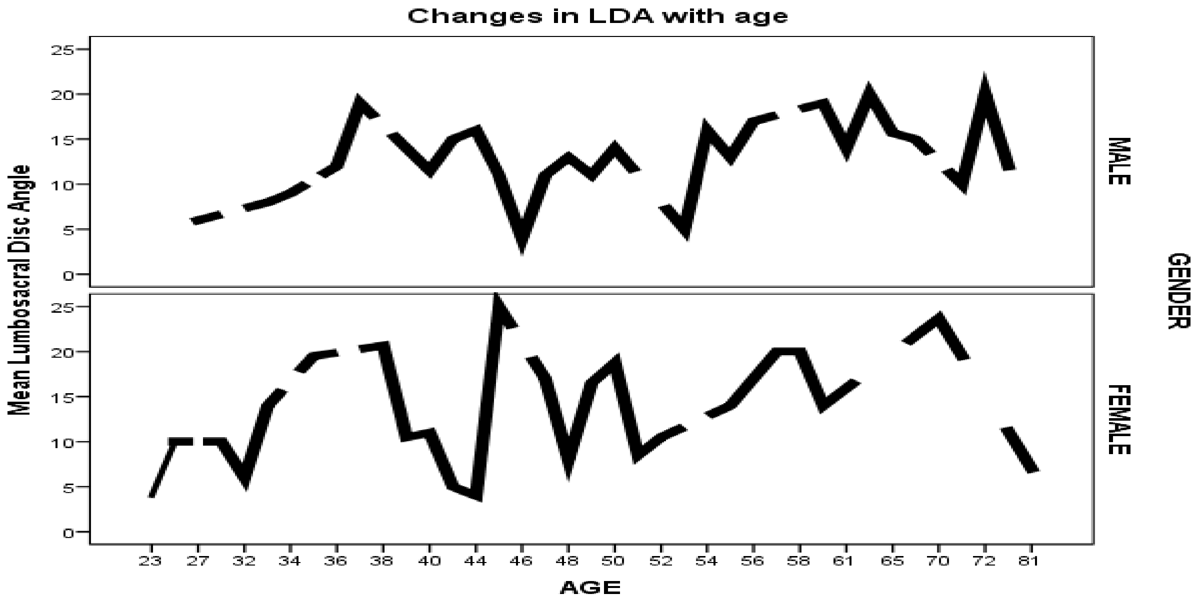

Figure 4.3: fluctuation in lumbosacral disc value with age

4.5: Spondylolisthesis:

No slippage to any degree was found in 54.2% (29 men and 16 women) of this sample, the distribution of the different grades and between the genders is shown in table (4.3) and demonstrated in figure ()

Table 4.3 disturbution of spondylolisthesis

Grade of spondylolisthesis	Males		Females	
	count	% within gender	count	% within gender
Grade 1	11	37.9%	18	41.9%
Grade 2	0	00%	2	4.7%
Grade 3	0	00%	2	4.7%
Grade 4	0	00%	0	00%
Posterior listhesis	0	00%	5	11.6%
Total	11		27	

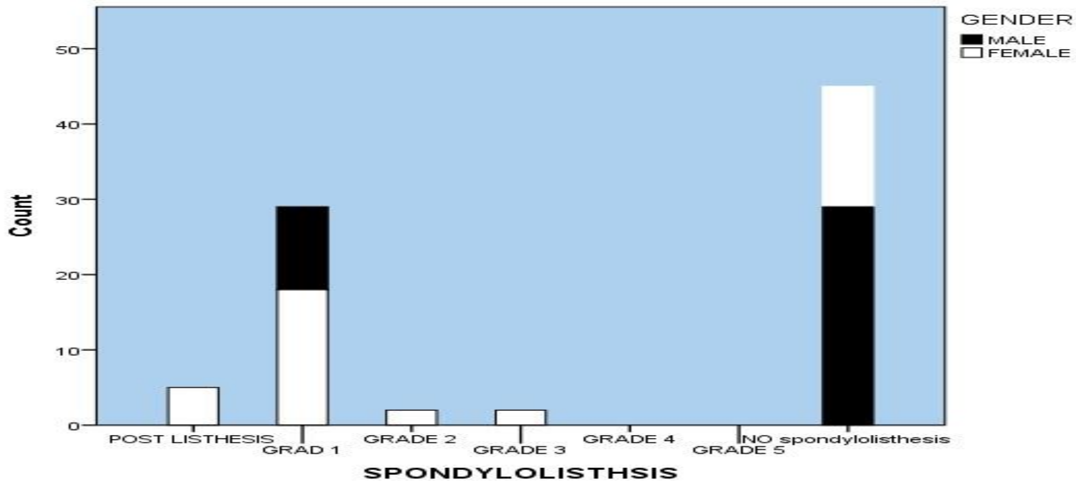

Figure 4:4 distributions of spondylolisthesis

One-way ANOVA test was conducted to evaluate the effect of different grades of spondylolisthesis on the other measurement in and ages this study, the five groups examined (G1, G2, G3, POST and NO SLIPAGE) showed no statistical difference in ages or lumbar lordosis, in the other hand, L1/S1 disc angle and height, had significant variations in the groups, especially grade 3 spondylolisthesis, which is associated with a substantial drop in the disc height.

Table 4.4: correlation of spondylolisthesis with the other parameters in this study

	df	Mean Square	Sig.
Lumbosacral Disc Angle	4	105.220	.042
Intervertebral Disc of S1L5 Height (mm)	4	60.652	.000
AGE	4	44.423	.892
Lumbosacral Lordosis Angle	4	82.932	.620

4.6: Vertebral body abnormalities:

In the studied sample, 30.1% (13 males and 12 females), showed bony spurs at least in two vertebrae, 10 patients (7 males) had osteophytes along with vertebral body compression.

Compression, osteophytes nor other lesions were detected in 58% (20 men and 28 women) of the sample.

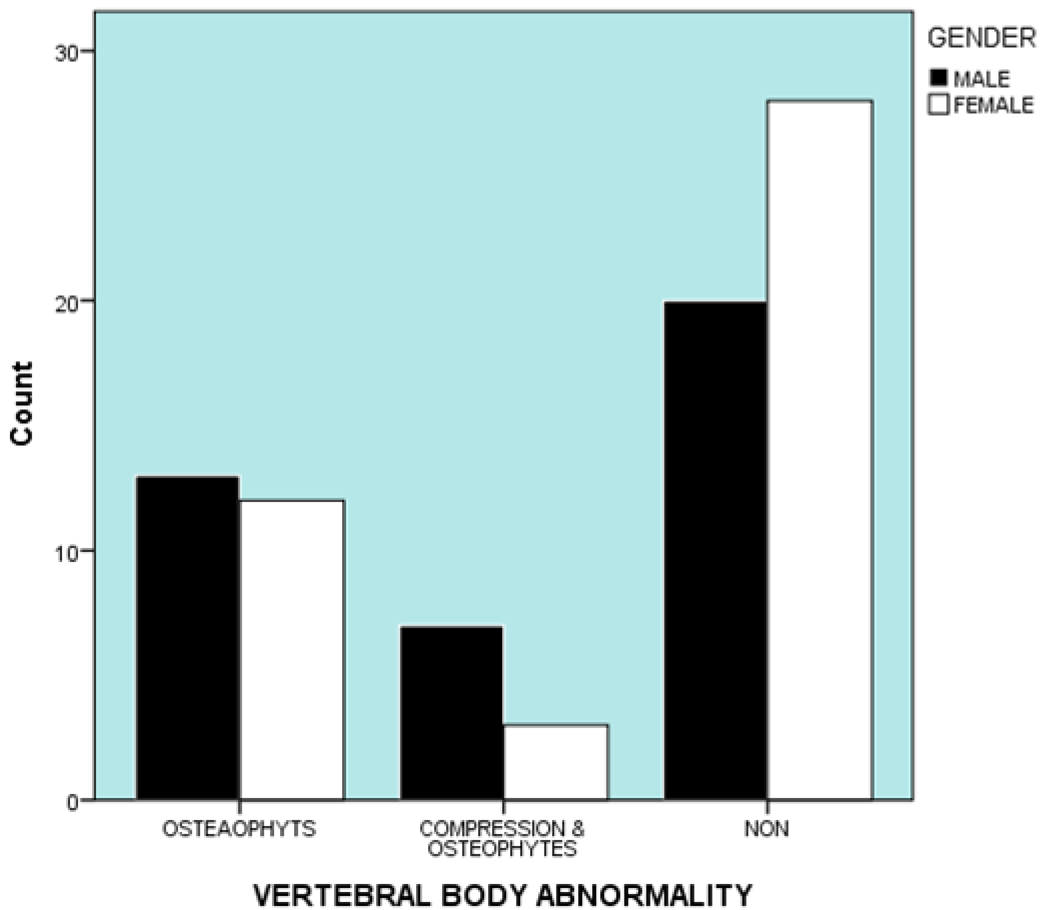

Figure 4:6: vertebral body anomalies

4.7: Schmorl's node:

In a prevalence of a 47%, a total of 76 nodes were found in 39 patient, distributed as follows

Table 4.5 : distribution of SN

Number of nodes	GENDER		Total
	MALE	FEMALE	
PESENT IN 1 vertebrae	4	5	9
PESENT IN 2 vertebrae	12	15	27
PESENT IN 3 vertebrae	0	1	1
PESENT IN 5 vertebrae	2	0	2
NON	22	22	44
Total	40	43	83

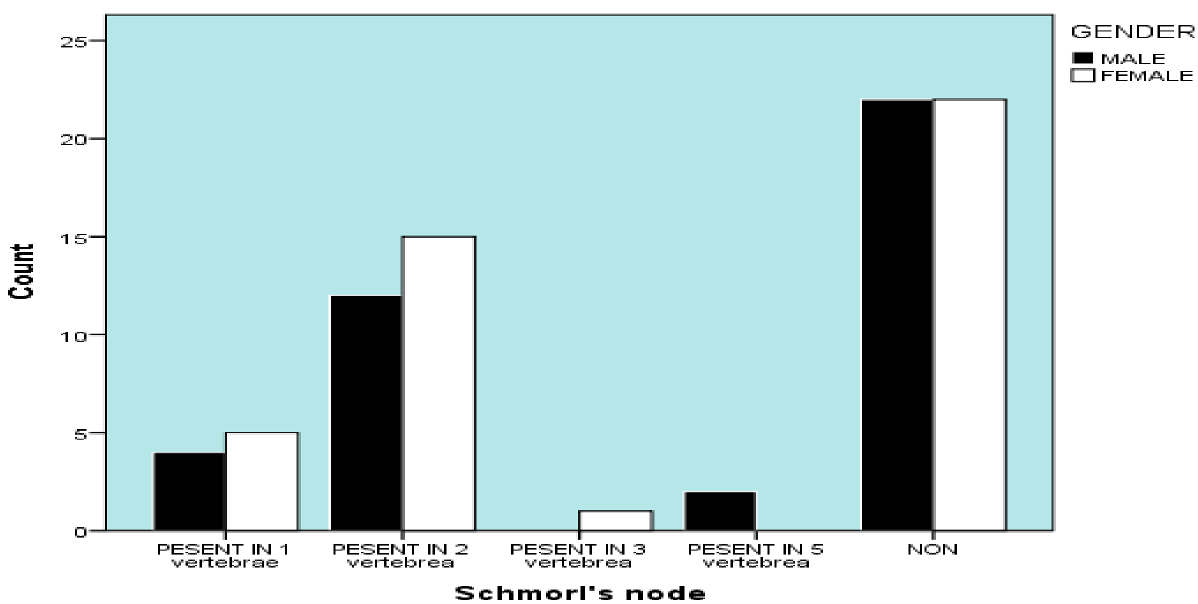

Figure 4:7 SN in males & females

4.8: Transitional vertebra:

From the 83 patients in this sample, eight subjects (9.63%, four men and 4 women) had lumberized first sacral vertebra, no subject had sacralization.

Their measurements are shown below:

Table4. 6 : measurment of patients with transtional vertebra

	Intervertebral Disc of S1L5 Height (mm)	Lumbosacral Lordosis Angle	Lumbosacral Disc Angle	age
Mean	12.738	47.00	8.75	43.6
Std. Error of Mean	1.1580	3.510	1.810	5.1
Median	13.750	49.00	8.00	46.5
Std. Deviation	3.2754	9.928	5.120	14.6
Range	10.2	34	15	42
Minimum	5.8	26	4	23
Maximum	16.0	60	19	65

In addition, none of them had a narrowed spinal canal.

Neither means lumbar lordosis angle nor the intervertebral disc height showed significant change between the group with lumberized S1, and those with normal five vertebrae; however, the lumbosacral disc angle showed significant decrease in the 8 patients, with a spearman’s rho p-value of 0.01 at the 0.05 level.

4.9: Spinal canal:

Using (Jones and Thomson, 1968) evaluation ratios, narrow spinal canal had prevalence of 1.23% (one male), this 60 years Old's angular measurement were lower average.

A ratio that could considered normal was found in 30% (9 males and 15 females), while the rest had a ratio indicating a wide canal.

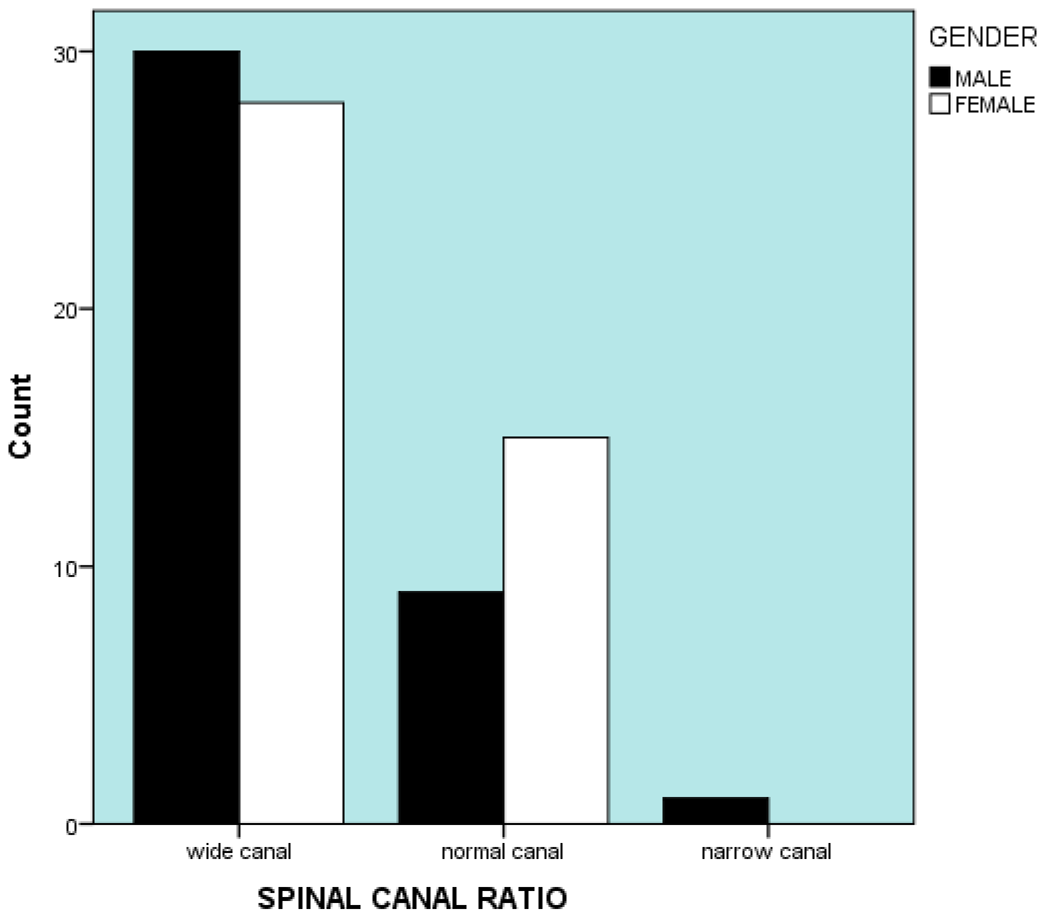

Figure 4:8: spinal canal distribution

Chapter five

5.1: Discussion:

This descriptive, prospective, cross-sectional hospital based study was undertaken to evaluate the role of lumbar x-ray examination in acute and subacute lower back pain diagnosis.

A variety of subtle abnormalities of the spine were evaluate, but the main focus was on the lumbar lordatic curvature and it's angle. it was noted upon reviewing the literature that the term "lumber lordosis angle" referred to more than one concepts, definitions and methods of measurements, this may cause confusion and complicate describing and studying the subject. (Hellems and Keats, 1971) also had these remarks on the subject: "It becomes apparent, after review of the English literature, that the term lumbosacral angle is measured and defined in many different ways." (Amonoo-Kuofi, 1992) also complained from the lack of definition in a medical dictionaries and sources like Nomina anatomica, and called for the standardization of the definitions and nomenclature of these parameters.

In this study, an average angle of 50º in the angle of lumbar lordosis is near the lower end the normal range of lordatic curvature of the lumbar spine, this may indicate loss of lordosis is a common feature in patient with LBP, especially in men where it dips into the middle forties'. This does not seem to be supported by the literature which show variation that go above and below this degree in Asymptomatic subjects, as most notably in the work of (Damasceno et al., 2006) when their measurements averaged -60.9° (-33 to –89). Furthermore, the scientific consensus around the exact significance of altered lumbar lordosis has not been reached, as a wide range of opinions has been expressed, from it being of no consequence on one end, to regarding it as a prime consideration in investigations of LBP.

The lumbosacral disc angle mean of the sample approximate, but under the upper limit of 15^{o} (Yochum and Rowe, 2005) over which increased risks of low back pain and spondylolysis develop. This is close to (Bryner and El Moussali, 1992) measured mean of 15^{o}. However, a significant number of subjects had an angle over 15^{o}, 18 of them are males who scored up to 22^{o}, and 17 women who generally scored higher angles and a maximum of 36^{o}, one possible, and rather intuitive, explanation for this could be that females tend to be more afflicted by osteoporosis and Consequently less robust spine and more pronounced curvatures, but (Papadakis et al., 2009) refuted this, claiming not even females with osteoartheritsi as well as osteoporosis had changes in their spine angles that significantly differ from normal individualls. The overall range of 33^{o} is much heigher than that reported by (Banks, 1983) and (Cox, 1990) of 5 degrees, but not considerably different from (Bryner and El Moussali, 1992) scored range of 22^{o}, both this studies were carried out on normal asymptomatic samples, which may account for the wide difference.

The disc of lumbosacral junction was also evaluated in term of height, a mean of 14.1 (SD 6.5) mm is a peculiar finding, considering the sample of this study are patient with LBP, and taking into account that (Inoue et al., 1999) and (Naidoo, 2008) found the height to average 10.5 and 9.5 mm respectively, in normal asymptomatic individuals, difference in population could also be held accountable for this variation, especially in light of what both (Frymoyer et al., 1984) and (DABBS and DABBS, 1990) consider “ poor correlation between loss of disc height and the focus for low back pain”, another justification could be made from what (Yochum and Rowe, 2005) says is “the most common causes for a decreased disc height are disc degeneration, post-surgery, postchemonucleolysis, infection, and congenital hypoplasia”, this conditions were not encountered in the current study.

A fairly high prevalence of spondylolisthesis of 45.6% was discovered in this study, with a male to female ratio of 1 : 2.5, the most logical explanation is that the sample is somewhat old (mean 49.6 SD=12.4 years), in patients younger than 35 years the percentage drops to 4.8%, this is also supported by the investigation of spondylolisthesis in elderly Chinese by (He et al., 2014), who found an overall prevalence of 25%, although his sample had a higher mean age 72.5 years and lower female to male ratio of 1:1.3. furthermore (Denard et al., 2010) also found a prevalence of 31% in elderly population. However, in the overall population, spondylolisthesis is quiet uncommon, (Jacobsen et al., 2007) found only 254 positive cases in 4151 participants in their epidemiological survey.

Osteophytes were present in at least in vertebral body in 30.1% of the patients in this study, and was complicated by, were it complicated, vertebral body compression in 12%, they may contribute to impingement of spinal nerves and to the narrowing of spinal canal, both are common causes of LBP.

Almost one half of the population with LBP (47%) showed at least one indentation on the endplates “Schmorl's nodes”, with no tangible association with gender (F:M ratio of 1:1.1), (Dar et al., 2010) also did not find significant difference between the genders gender, but (Hilton et al., 1976) disagree, they found a much higher (76%) prevalence and a predominance in men. The higher number they detected is easily explainable by the fact they examined Skelton of deceased subjects, which increase the chance of old age and more pronounced deterioration in the spine structures, including the end-palates that suffer the preach from the intervertebral cartilage.

The percentage of patients afflicted with transitional vertebra in this study is quiet odd, considering that studies at least six studies, published from 1977 through as recent as 2007 put the percentage well above 20%, and some go as high as 37%, one reason to account for his could be the different populations of studies, Sudanese people could be less predisposed to transitioned vertebrae due the different genetic makeup, however, one cannot rule out sampling errors, and sampling differences between studies.

Patient with lumberized vertebrae also showed lower lumbosacral disc angle and no significant change in the disc height, which contradictory, in light of what (Luoma et al., 2004) found to be increased risk of disc degeneration in those subjects, be that as it may, the method of measuring the disc angle in this study is more affected by the posterior edge of the vertebral body, and the height measurement is taken from the midpoint, add to that the tendency of degenerative disc to herniate posteriorly, lowering the acuteness of the angle without much change in the mid-point height.

Being one of the leading preopertaive diagnosis in spinal surgery,lumber spinal canal stenosis is major issue, and its competently evaluated using cross sectional imaging modalties says (Koompairojn et al., 2006), but a general idea about the condition of the canal can be assed in lumber x-rays, argues (Jones and Thomson, 1968), supported by (Nelson, 1973) who suggested that reduced interpedicular distance is one of the cause of primary narrowing of the spinal canal, in this study nonetheless, only one patients complaining of LBP had a compromised canal, almost 70% had “wide” canals, this is fairly lower than expected in random sample of LPB patients.

In the capital of the Sudan republic, a lumbar radiograph cost anywhere between 60 and 300 SDG, with an average around 200 SDG, considering the economic factors, this is not an inexpensive test to say the least, combine that with the wide spread of back pain complaint, and the result is extremely high number of lumbar examinations, moreover, the region require the highest exposure factors in all of routine radiography, and is in close proximity to the radiosensitive gonads, (Wall and Hart, 1997) estimate that a typical lumbar AP & lateral series deliver an effective dose of 100 mRem, a consideration with exceptional importance in young females, several authors agree as stated in chapter three, and a quick revision of the overall result of this study, which indicate a poor Specificity and sensitivity of plain radiograph in the pathologies loosely associated with LBP, and specially with the major causes of it.

The inevitable conclusion to make here, is that lumbar radiographs are grossly over requested, unquestionably over used, without great reward in term of clinical value, with great finical costs, and a problematic radiation exposure

This study will serve, sincerely hopes the author, to advance the efforts to adhere to international guide lines for managing, and above all in using plain radiograph of the lumbar spine in the diagnostic plan, or to at least develop new guidelines in Sudan, to reduce the unnecessary, costly and unrewarding, over use of radiographic procedures.

5.2: Conclusion

This study was carried out on 83 lumber spine radiographs of adults complaining of lower back pain, and evaluated certain angular parameters and lesser obvious contributors to LBP in an effort to determine the value of requesting lumbar x-ray for non-traumatic acute back pain in the preceding two months, in Sudanese patient. The final results point toward the failure of the study to find greater value of lumbar radiographs than those established by international guidelines. Limiting in the use of these radiographic procedures to selected patients, with “the red flags “specifically.

This study faced several limitations, staring with the poor, sometimes unacceptable, quality of lumbar radiographs that being produced, diagnosed and not repeated, also patients records and clinically information’s are unsatisfactorily kept, which severely hinders retrospective research. Furthermore, the number of participants in this study (below 100) is somewhat “below par”.

Future studies could be conducted upon large sample, in extended period of time, with better clinical information, and utilizing control groups to more rigorously defined what is normal in our population.

5.3 Recommendations:

Based on the process of conducting this study, the data obtained and the results produced, the author offer the following recommendations:

1. The technical quality of lumbar radiograph while minimizing the radiation dose should be specially emphasized in training student and closely monitored in radiology departments
2. Lumbar radiograph for non-specific LBP within the first 8 weeks from the last pain episode should be strictly preserved for patients with worrisome history and risk factors.
3. Specific guidelines for practicing evidenced based medicine should be developed and reinforced, as should policies to raise medical awareness, seeing that ignorance and traditional remedies (for LBP and many other illnesses) often exaggerate and complicate many simple disorders.

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Appendix

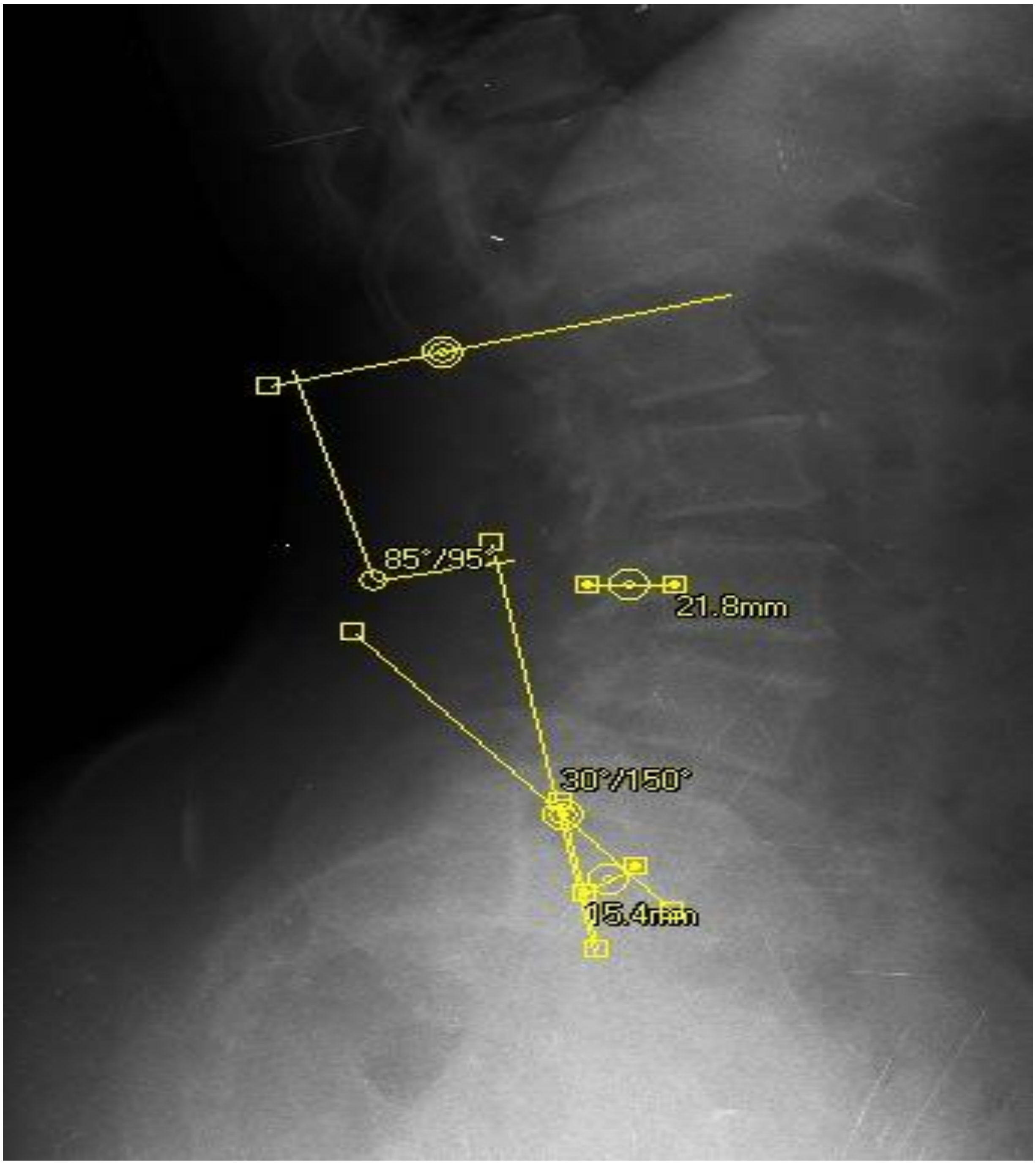


Figure 6-1 angles measurements in lateral radiograph

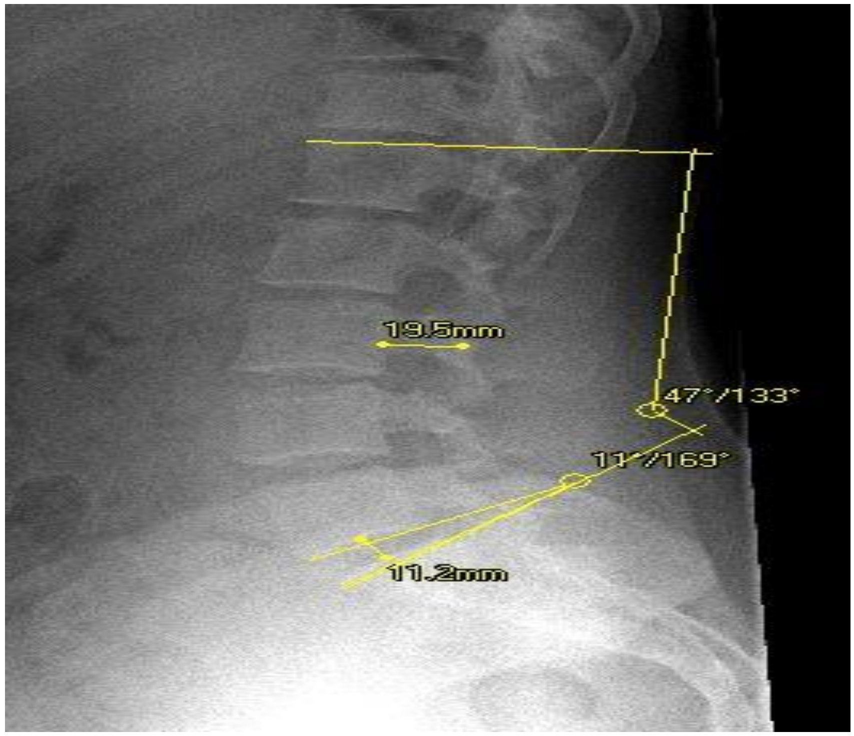


Figure 6-2: angles measurements in lateral radiograph

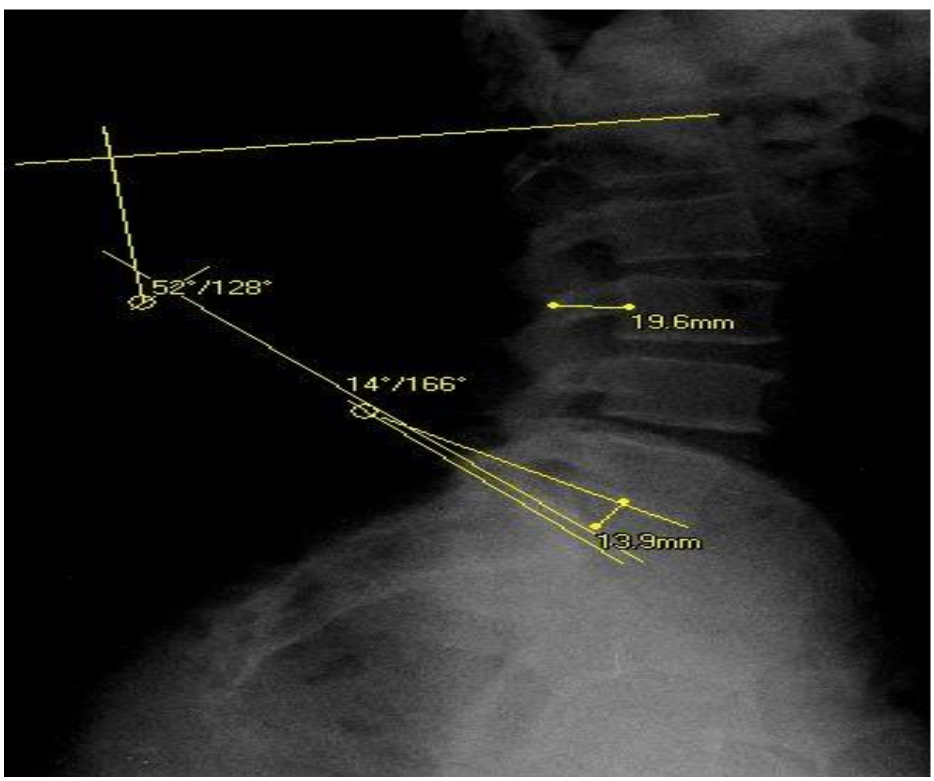
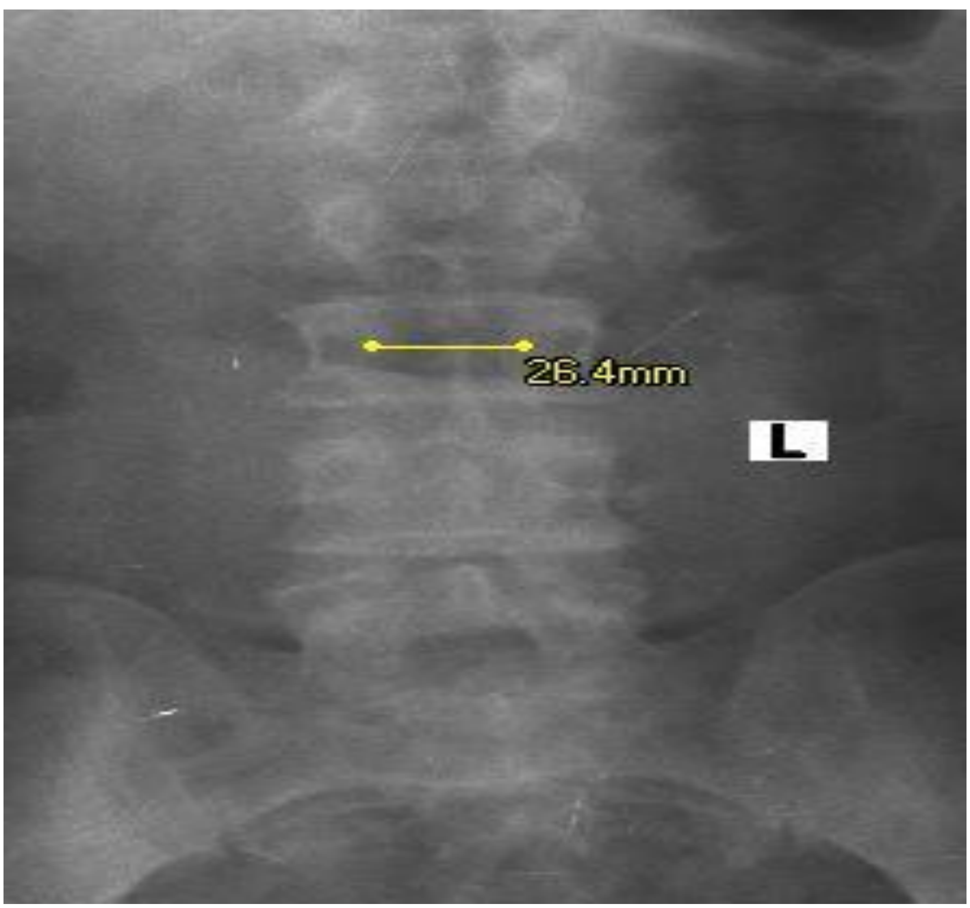


Figure 6-3: angles measurements in lateral radiograph

Figure 6-4: interpedicular distance AP



AGE	GEND	SPN	VERB	IDH	LLA	LDA	Lt_RT_DIM	IPL	AP_DIM	EM	SCMN	TRNS	AGE2	SPNCNRT
23	FEMALE	GRAD 1	NON	16.0	26	4	45.2	24.0	39.2	20.2	PESENT I...	LUMBERIZ...	20 TO 30	Wide cana
27	MALE	NO spondy...	OSTEAOP...	10.3	51	6	45.5	22.9	37.3	20.1	NON	NON	20 TO 30	Wide cana
32	FEMALE	NO spondy...	OSTEAOP...	14.1	51	6	42.0	26.2	36.6	22.4	NON	LUMBERIZ...	30 TO 40	Wide cana
33	MALE	NO spondy...	NON	11.4	30	8	55.0	25.4	40.0	22.6	NON	NON	30 TO 40	Wide cana
33	FEMALE	GRADE 2	NON	13.5	55	14	41.8	22.6	32.2	19.0	PESENT I...	NON	30 TO 40	Wide cana
34	MALE	NO spondy...	NON	12.0	36	9	42.2	24.8	38.0	20.2	NON	NON	30 TO 40	Wide cana
35	FEMALE	NO spondy...	OSTEAOP...	13.2	59	21	41.0	25.5	33.0	18.6	PESENT I...	NON	30 TO 40	Wide cana
35	FEMALE	NO spondy...	NON	14.4	76	18	44.0	25.3	34.0	19.2	NON	NON	30 TO 40	Wide cana
36	MALE	GRAD 1	NON	14.0	36	12	55.0	24.8	44.8	19.2	NON	NON	30 TO 40	Wide cana
37	MALE	GRAD 1	OSTEAOP...	15.4	32	19	50.0	29.2	42.5	20.8	NON	NON	30 TO 40	Wide cana
38	FEMALE	NO spondy...	OSTEAOP...	12.4	40	16	46.4	25.0	38.4	22.3	PESENT I...	NON	30 TO 40	Wide cana
38	FEMALE	POST LIST...	NON	8.0	64	31	42.6	20.6	37.5	17.8	NON	NON	30 TO 40	Wide cana
38	FEMALE	NO spondy...	NON	5.6	52	15	41.0	25.6	40.0	27.0	NON	NON	30 TO 40	Wide cana
39	FEMALE	GRAD 1	NON	10.8	73	12	39.5	26.7	33.4	21.6	NON	NON	30 TO 40	Wide cana
40	MALE	GRAD 1	NON	15.4	37	8	48.5	28.7	37.0	31.5	PESENT I...	NON	40 TO 50	Wide cana
43	MALE	NO spondy...	NON	14.7	45	14	48.0	24.8	38.0	20.2	NON	NON	40 TO 50	Wide cana
43	MALE	NO spondy...	COMPRE...	12.3	48	16	45.0	27.2	37.0	20.0	NON	NON	40 TO 50	Narrow cana
43	FEMALE	GRAD 1	NON	11.5	52	5	45.0	26.8	35.0	23.6	PESENT I...	NON	40 TO 50	Wide cana
44	MALE	NO spondy...	NON	14.7	55	16	42.2	29.2	42.5	20.8	NON	NON	40 TO 50	Wide cana
45	MALE	NO spondy...	COMPRE...	9.0	43	11	51.0	28.1	43.0	23.2	PESENT I...	NON	40 TO 50	Wide cana
46	MALE	NO spondy...	NON	13.9	44	4	51.0	30.1	44.7	23.4	NON	LUMBERIZ...	40 TO 50	Wide cana
47	FEMALE	NO spondy...	NON	11.0	55	17	48.5	27.5	38.3	22.5	NON	NON	40 TO 50	Wide cana
48	MALE	NO spondy...	OSTEAOP...	12.4	54	13	49.0	22.9	37.3	20.1	NON	NON	40 TO 50	Wide cana
48	FEMALE	NO spondy...	NON	11.8	47	8	42.0	22.6	32.0	20.3	NON	NON	40 TO 50	Wide cana