Introduction & Rationale

Degenerative lumbar scoliosis is a coronal deviation of the spine that is prevalent in the elderly population. Although the etiology is unclear, it is associated with progressive and asymmetric degeneration of the disc, facet joints, and other structural spinal elements typically leading to neural element compression ***(Kotwal et al., 2011).***

Patients with degenerative lumbar scoliosis present with complaints ranging from debilitating back and lower extremity pain with spinal imbalance to incidental findings on lumbar radiographs. The other symptoms in lower extremity include; numbness, cramping, tingling, burning sensation or weakness ***(Tribus, 2003).***

Various specialized committees dealing with the diagnosis of spinal diseases have made efforts within the last years to develop diagnostic standards. Our study provides an overview of radiologic measurements and classification systems that are currently used for the diagnosis of scoliosis and degenerative diseases of the lumbar spine. Imaging are radiological X-ray Anteroposterior (AP) and lateral flexion and extension views), Computer Tomography (CT scan), Magnetic Resonance Imaging (MRI) and Bone Marrow Density (BMD) ***(Waldt et al., 2014).***

The selection of appropriate treatment for degenerative scoliosis is challenging because the condition is heterogeneous with diverse presentation of symptoms, and the results are variable. Several factors, such as medical co-morbidities, social, and environmental factors, play significant roles in the outcome and the need for thorough evaluation ***(Kotwal et al., 2011).***

The treatment options of degenerative lumbar scoliosis include; (1) Nonsurgical interventions, often selected empirically, such as pharmacologic agents (such as non-steroidal anti-inflammatory medication, narcotic analgesics, muscle relaxants, Epidural and facet injections, selective nerve root blocks and trigger point injections), physical therapy and exercises. (2) The surgical options include; decompression alone, decompression and limited short fusion and decompression and long fusion with correction of deformity ***(Kotwal et al., 2011).***

Aim of the Work

The aim of work is to review essay about the etiology and the recent management of degenerative lumbar scoliosis.

Chapter (1): Anatomy and Biomechanics of Lumbar Spine

Spinal Anatomy

The study of spine biomechanics requires an understanding of spinal anatomy. The human spine consists of a series of 29 bones called “vertebrae”. As a vital part of the human skeleton, it functions as the support of the body structure, gives the body flexibility and protects nerves in the spinal cord ***(Dai, 2009).***

The normal spine has an “S”-like curve (Figure 1) in the sagittal plane that allows for an even distribution of weight and makes room for the organs. There are four regions in the spine (Figure 2): the cervical spine, the thoracic spine, the lumbar spine and the sacrum. The cervical spine is made up of the superior seven vertebrae, which connect and support the skull and follow a lordotic (convex anteriorly) curve. The following 12 vertebrae form the thoracic spine and express a kyphotic (convex posteriorly) curve. The shape of the thoracic spine enables support for the ribcage and provides space for the heart and lungs. The lumbar region, made up of five vertebrae and follows a lordotic curve, is responsible for bearing the body weight and load. Below the lumbar spine is the sacrum, which consists of five specialized and fused vertebrae that connect the spine to the pelvis. A typical vertebra consists of two parts that are connected by a pair of pedicles. The anterior segment is the vertebral body, and the posterior part - the posterior elements - encloses the vertebral canal. The vertebral canal for the protection of the spinal cord and nerve roots. The posterior elements contain seven processes, four articular, two transverse, and one spinous. The articular processes from the lower and upper vertebrae join together as facet joints ***(Dai, 2009).***

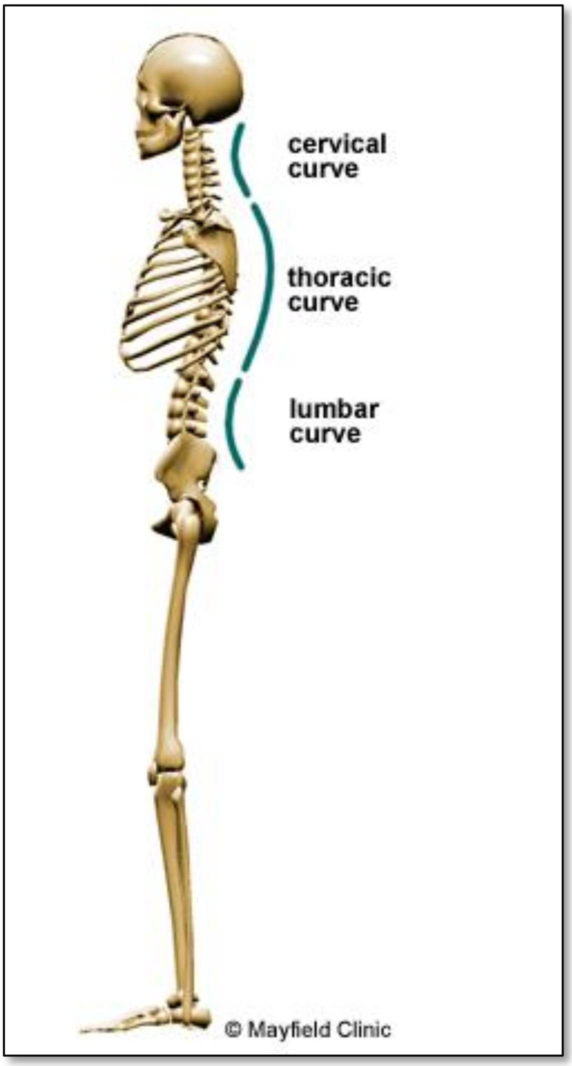

Figure (1): The spine has three natural curves that form an S-shape; strong muscles keep our spine in alignment ***(Hines, 2013).***

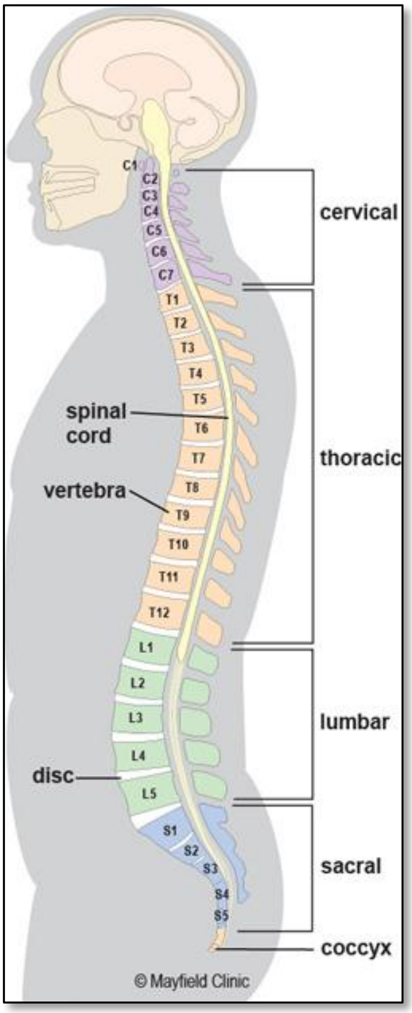

Figure (2): The five regions of the spinal column ***(Hines, 2013).***

The vertebral body consists of a trabecular core surrounded by a thin dense cortical shell (Figure 3). Adjacent vertebrae are separated by flat, round "cushions" called intervertebral discs. The disc consists of an outer area called the annulus fibrosus which is primarily made up of collagen fibers. The inner region of the disc, called the nucleus pulposus, is gelatinous. The intervertebral disc functions with facet joints at each level to form a motion segment, allowing for multiple degrees of motion in the spine (Figure 4). The other function of the discs is to resist compressive loading and act as shock absorbers ***(Dai, 2009).***

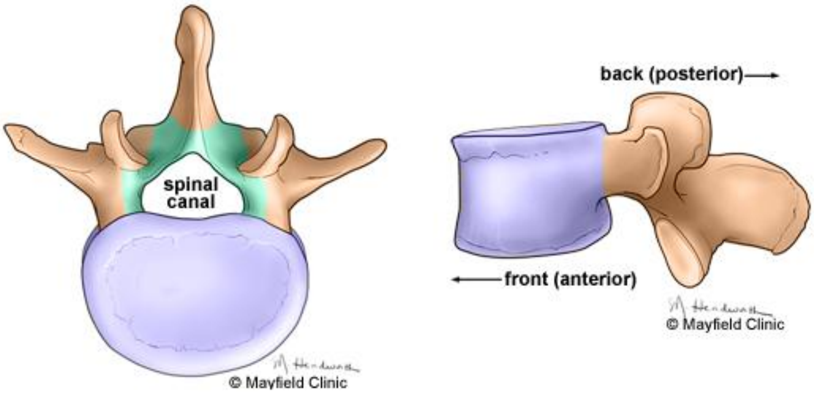

Figure (3): Vertebral Structure ***(Hines, 2013).***While vertebrae have unique regional features, every vertebra has three main parts: body (purple), vertebral arch (green), and processes for muscle attachment (tan).

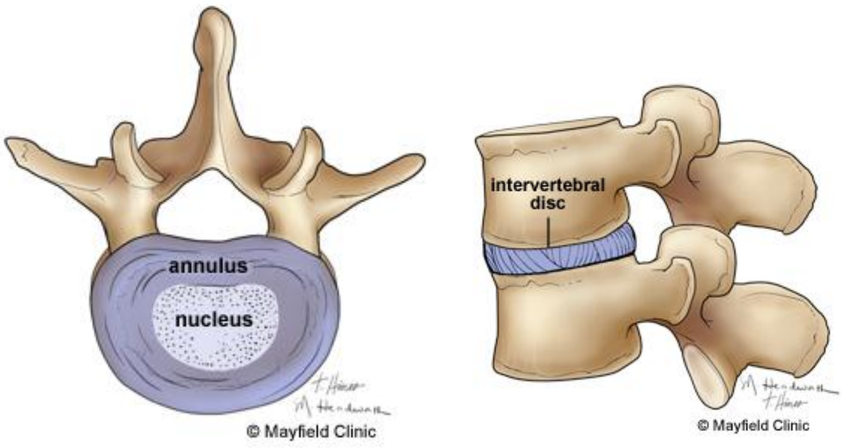

Figure (4): Structure of Intervertebral discs ***(Hines, 2013).***Intervertebral discs (purple) are made of a gel-filled center called the nucleus and a tough fibrous outer ring called the annulus. The annulus pulls the vertebral bodies together against the resistance of the gel-filled nucleus.

I) Bony components

The lumbar spine is composed of 5 vertebrae composing a lordotic curve that connects the thoracic rib cage region with the pelvis. It functions to transfer the loads of the upper body, to provide the stability needed for the attached large muscles, and to allow its owner to position the body in space in order to carry out desired tasks. Each vertebra is typically divided into three functional components: The vertebral body (1), the pedicles (2), and the posterior elements (3) ***(Gagnon and Horvath, 2005).***

The vertebral body is designed for weight bearing, promoting stability in the vertical direction, especially with its larger size in the lumbar spine. It has a shell of cortical bone that surrounds cancellous bone that is composed of vertical and transverse trabeculae. The compressive load is transferred from vertical pressure to transverse tension due to the architecture of the trabecular bone. Because of this structure, the vertebrae are resilient but yet light ***(Bogduk, 1997).***

The pedicles connect the body and the posterior elements. The pedicles transmit forces, both tension and bending, through the posterior elements. Tension in the pedicles arises from the locking of a superior vertebral body sliding on an inferior one, with the locking of the inferior articular processes of the superior vertebrae with the superior articular processes of the inferior vertebrae.

These articulations are typically called facet joints. Bending forces occur because the pedicles act as levers. Since muscles are attached to the posterior elements of the vertebra, the transfer of the muscular action or pull is through the pedicles to the vertebral bodies. As previously described, the posterior portion of the vertebrae includes the facet joints. These joints are load bearing, especially in extension, lordotic postures, and with decreased disc height as in degenerative disc disease ***(Goel et al., 1993).***

The facets also restrict anterior glide of the superior vertebrae on its inferior one and thus resists shearing forces, as well as forces that would create rotatory instability. As intervertebral flexion occurs the inferior articular facet slides upward 5-8 mm along the superior articular facet ***(Bogduk, 1997).***

The facets vary in angulation throughout the spine and there can be variation between individuals. However, in the lumbar spine they are oriented closer to 90° from the coronal and transverse planes, thus they can limit rotation and promote stability. The smallest functional unit of the spine is considered to be a motion segment comprised of two vertebrae and their intervening disc (Figure 5). The joints associated with this motion segment are the anterior joint between vertebral bodies at the disc, and the paired posterior facet or zygapophysial joints. **The term 'neutral zone'** describes motion range occurring at this level, primarily between the two vertebral bodies, restrained by the facets and associated soft tissue ***(Gagnon and Horvath, 2005).***

Neutral Zone (NZ): "is that part of the range of physiological intervertebral motion, measure from the neutral position, within which the spinal motion is produced with a minimal internal resistance". There is a high correlation between increased NZ and spinal pathology ***(Knutsson in Panjabi 1992b).***

The neutral zone concept is based on the observation that the load-displacement curve of the typical spinal motion segment is nonlinear, with high flexibility for motion occurring around the neutral position of the spine and with increased passive resistance to motion nearer the end range of spinal motion. An increase in the neutral zone may lead to higher probability of overstretching of ligaments and be a source of instability ***(Sharma et al., 1995).***

Elastic Zone (EZ): "is that of the physiological intervertebral motion, measured from the end of the neutral zone up to the physiological limit". Within the EZ spinal motion is produced against resistance. "It is the zone of high stiffness" ***(Panjabi 1992b).***

Range Of Motion (ROM): "is the entire range of intervertebral motion measured from the NP". It is the summation of NZ and EZ (Figure 5 and 6) ***(Panjabi 1992b).***

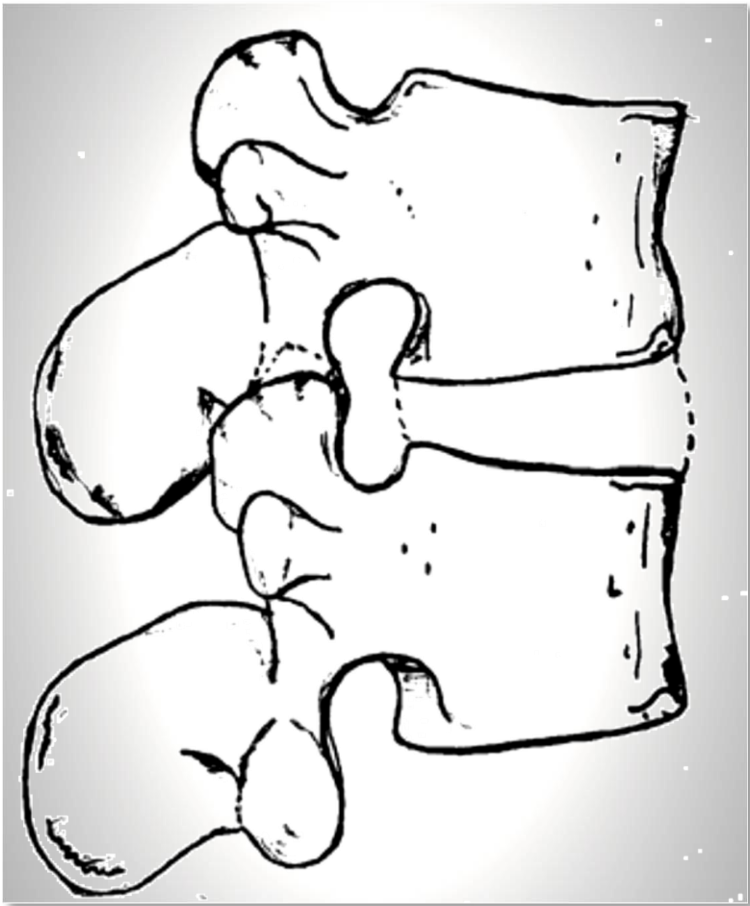

Figure (5): A lumbar spine motion segment
(Gagnon and Horvath, 2005).

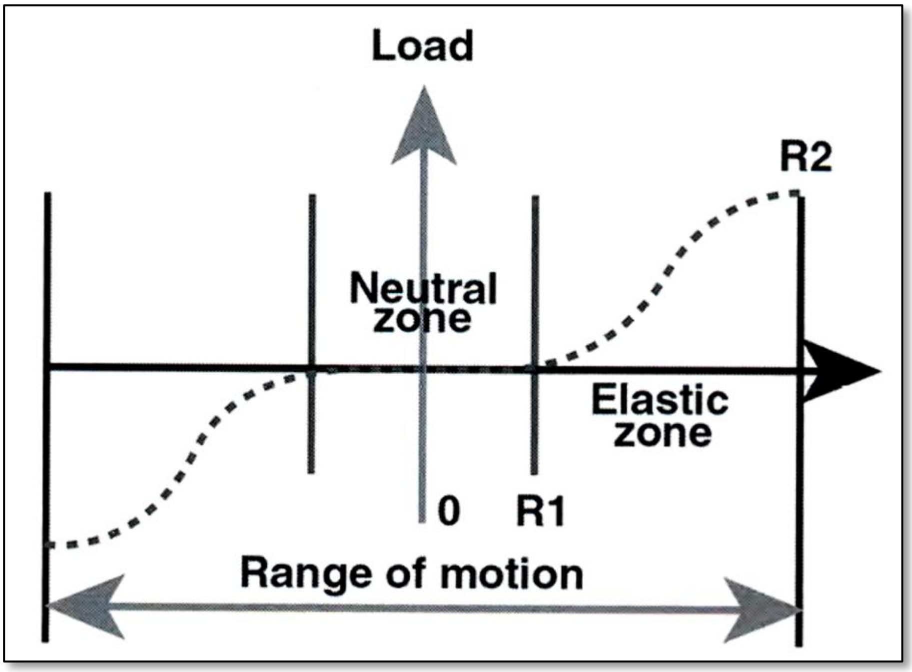

Figure (6): Neutral zone and elastic zone within ROM
(Panjabi 1992b)

II) Soft Tissue Components

The associated soft tissue structures of the vertebral motion segment are the intervertebral disc, joints capsules, ligamentous supports, and the muscular components. The intervertebral disc is composed of a nucleus pulposus and an annulus fibrosus. In a healthy individual the nucleus pulposus is a semi-fluid mass that can be deformed under pressure but not compressed, therefore transmitting any applied pressure in all directions. The annulus fibrosus is composed of highly ordered collagen fibers in concentrically arranged lamella. Under loads the radial expansion of the disc exerts a pressure on the annulus ***(Bogduk, 1997).***

The facet joints have a double layer capsule that is composed of collagen fibers and houses an adipose tissue pad and a meniscoid. These meniscoids have similar functions as the meniscus of the knee (protective, increase the contact surface area, and fill space), the structures in the thickening of the joint capsule range from a small connective tissue rim to an adipose tissue pad to a larger fibroadipose projection ***(Gagnon and Horvath, 2005).***

The facets and capsule help restrain and control motion. The spine has six primary ligaments: anterior longitudinal ligament, posterior longitudinal ligament, ligamentum flavum, interspinous ligament, supraspinous ligament, and iliolumbar ligament. Both the anterior and posterior longitudinal ligaments run the length of the lumbar spine and resist separation of the vertebral bodies, especially the anterior longitudinal ligament. The ligamentum flavum is composed of a high amount of elastin and runs between lamellae of consecutive vertebrae. This ligament differs from all others in the lumbar spine in its fibirous makeup of 80% elastin and 20% collagen. Due to its high elastin content, the normal ligament can stretch with flexion. The interspinous and supraspinous ligaments (Figure 7) (named for their positions) oppose separation of the spinousprocesses and restrain flexion along with the facet joint capsules. The iliolumbar ligament connects the transverse process of the fifth lumbar vertebra with the ilium bilaterally. It restrains motion of L5 on the sacrum in twisting, bending, and in particular with anterior movement or shear of L5 on the sacrum ***(Bogduk, 1997).***

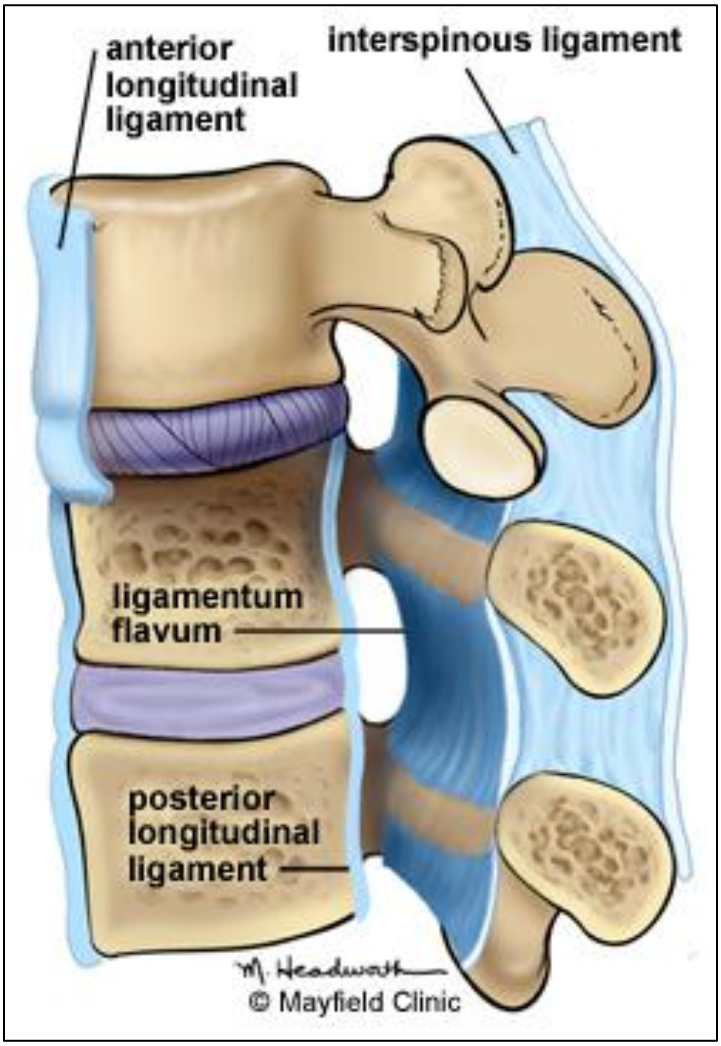

Figure (7): The ligaments of the spinal region ***(Hines, 2013).*** Ligamentum flavum, anterior longitudinal ligament (ALL), and posterior longitudinal ligament (PLL) allow the flexion and extension of the spine while keeping the vertebrae in alignment.

The sacroiliac joint is at the base of the spine where the loads through the lumbar spine are subsequently transferred to the iliae. The sacroiliac joint is an irregular joint between the sacrum and the ilium, it is a load bearing joint but it also permits slight movement in gliding and rotation. The irregular surfaces which interlock, the wedge-like shape to the sacrum, and the network of ligaments anterior and posterior to the joint, all work together to keep the iliae locked against the sacrum and ensure stability. Mobility dysfunction at the sacroiliac joint affects the lumbar spine; similarly, mobility dysfunction at the lumbar spine affects the sacroiliac joint ***(Gagnon and Horvath, 2005).***

Spinal Motion

The physiologic movements occurring in the lumbar spine are described in the three planes of flexion/extension, rotation, and lateral bending. This motion is described as range of motion (ROM) and is typically in degrees. Wong et al. showed that the average terminal flexion was 53.0° ± 10.2° and that the average terminal extension was 23.4° ± 8.3° with a linear like pattern of the IVFE (intervertebral flexion-extension) curve, at all levels, with no significant differences between genders. This means that the motion recruited was more from L1/2 and decreased sequentially to L5/S1 (Figure 8). This seems to show a nice smooth recruitment of motion with the most at L1/L2 decreasing to the least at L5/S1 during flexion. However, in extension, the slope of the IVFE curves in different vertebral levels was found to be about the same. Thus, all levels seem to be contributing to the extension curve similarly ***(Wong et al., 2004).***