Introduction

The Egyptians were the first to describe the diagnosis and to recommend a treatment for the spine and spinal injuries (2500 BC to 1900 BC) ***(Federico and Vinas, 2011).***

The National Spinal Cord Injury Registry, reported that 40% of spinal injuries were caused by motor vehicle accidents, 20% by falls, and 40% by gunshot wounds, sporting accidents, industrial accidents, and agricultural accidents combined. The spectrum of injury severity related to motor vehicle accidents ranges from minor soft tissue contusions to paraplegia and death. Numerous variables related to the type and severity of the crash, the type of vehicle, and the use of safety restraints have an impact on the frequency and severity of the spinal injury ***(Alanay, 2001).***

Why thoracolumbar junction is more vulnerable to traumatic injury

The transition from the anatomy of the thoracic to lumbar spine occurs over a relatively small area (T10-L2). In this transitional region, the spinal column is uniquely predisposed to injury, as the costovertebral structures no longer serve as a buttress and the spine has not yet transitioned to its full lordosis (shifting more of the load to the larger and more sagitally oriented posterior facets). The mechanics of the spine change from relative constraint in flexion and extension to relative constraint in coronal rotation ***(Stagnara et al., 1982; White and Panjabi, 1990).***

The forces responsible for spinal fractures are compression, flexion, extension, rotation, shear, or distraction forces or a combination of these mechanisms ***(Denis, 1984).***

Indications of spinal fixation

1. To decompress directly or indirectly the neural elements.
2. To realign the spine and spinal canal.
3. To allow mobilization of the patient to prevent bed ridden complications.
4. To relieve pain.

(Stambough, 1997)

Posterior spinal instrumentation is a safe, available, and effective method to achieve these goals. Standard techniques for fixation of the thoraco lumbar spine involve open exposures and extensive muscle dissection. Percutaneous spinal fixation is a minimally invasive spine surgery offers patients the benefits of low infection rate, decreased blood loss, fewer complications, and a more rapid return to daily activity ***(Rechtine 2001).***

There are two percutaneous systems of fixation the first is the **rod** system & the second is the **plate** system.

In rod system there is an extension sleeve that permits remote manipulation of the poly-axial screw heads and remote engagement of the screw-locking mechanism. A unique rod-insertion device was developed that linked to the screw extension sleeves, allowing for a percutaneous screw and contoured rod to be placed through a small stab wounds. Because the insertion device relies on the geometrical constraint of the rod pathway through the screw heads, minimal manipulation is required to place the rods in a standard sub-muscular position, there is essentially no muscle dissection.

However In plate system the screw tracts are made first then the plate is being applied through small stab opening then the screws are applied ***(Foley et al, 2001).***

Indications of percutaneous dorsolumbar fixation

1) Single level spinal vertebral body fracture, the vertebral compression is less than 2/3 of its real height, and the anterior column is compressed.
2) The Cobb‘s angle is less than 30°, with no neuro deficits.
3) The vertebral canal blocked area is less than 1/3 in sagittal diameter, with no neuro deficits.
4) McCormack score must be 6 or less
5) Grade D and Grade E in **American Spinal Injury Association (ASIA)** score, no need for posterior decompression of the vertebral canal.
6) All the type A fractures, especially the A1, A2.1, A2.2 and A3.1 fracture according to the AO fracture classification.
7) Type B.2 fracture (osseous flexion distraction fracture).

(Ni et al., 2010)

Aim of the Work

The aim of this study is to outline the anatomy, diagnosis, treatment modalities of dorsolumbar fracture and overview the percutaneous dorsolumbar fixation its indication, application, effectiveness and complications.

Anatomy

Anatomy of the dorsolumbar junction:

As described by ***Stagnara et al. (1982)*** the transition from the anatomy of the thoracic to lumbar spine occurs over a relatively small area (T10-L2). In this transitional region, the spinal column is uniquely predisposed to injury, as the costovertebral structures no longer serve as a buttress and the spine has not yet transitioned to its full lordosis (shifting more of the load to the larger and more sagitally oriented posterior facets). The mechanics of the spine change from relative constraint in flexion and extension to relative constraint in coronal rotation.

The facet joints of the upper thoracic spine have a coronal orientation and resist flexion and extension. Conversely, the lumbar spine has sagitally oriented facets and subsequently increased motion in flexion and extension. The upper thoracic spine is shielded from injury by the associated costovertebral structures. The ribs and the chest wall musculature serve to protect the spine and dissipate forces, and this buttresses against the significant compressive forces necessary to produce a vertebral body fracture in a normal bone ***(Harvey et al., 2010).***

Thoracic vertebra:

The thoracic vertebral bodies increase in size as the vertebral column descends, each bearing an increasing amount of weight transferred by the vertebra above. Although the characteristics of the superior aspect of vertebra T12 are distinctly thoracic, its inferior aspect has lumbar characteristics for articulation with vertebra L1. The abrupt transition allowing primarily rotational movements with vertebra T11 while disallowing rotational movements with vertebral L1 makes vertebra T12 especially susceptible to fracture.

In the thoracic region the articular processes are thin and more or less triangular, and project almost vertically. The articular surface on the superior processes faces mainly backwards but also slightly upwards and laterally, so that it lies on the circumference of a circle whose centre is in the anterior part of the vertebral body. The inferior process has also circumferential arrangement so that their articular process are directed forwards and slightly downwards and medially. They do not have a marked upward and downward projection (Fig. 1).

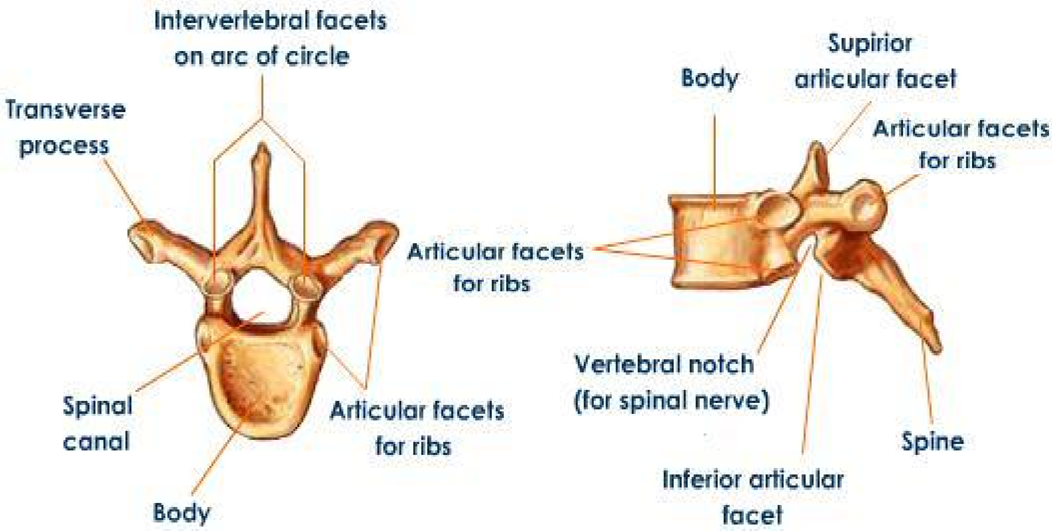


Fig. (1): Showing superior and lateral view of thoracis vertebra ***(Grant's Atlas, 2009).***

Typically, the head of each rib articulates with the bodies of two adjacent vertebrae and vertebral disc between them and the tubercle of the rib articulates with the transverse process of the inferior vertebra (Fig. 2) ***(Dommisse, 1975).***

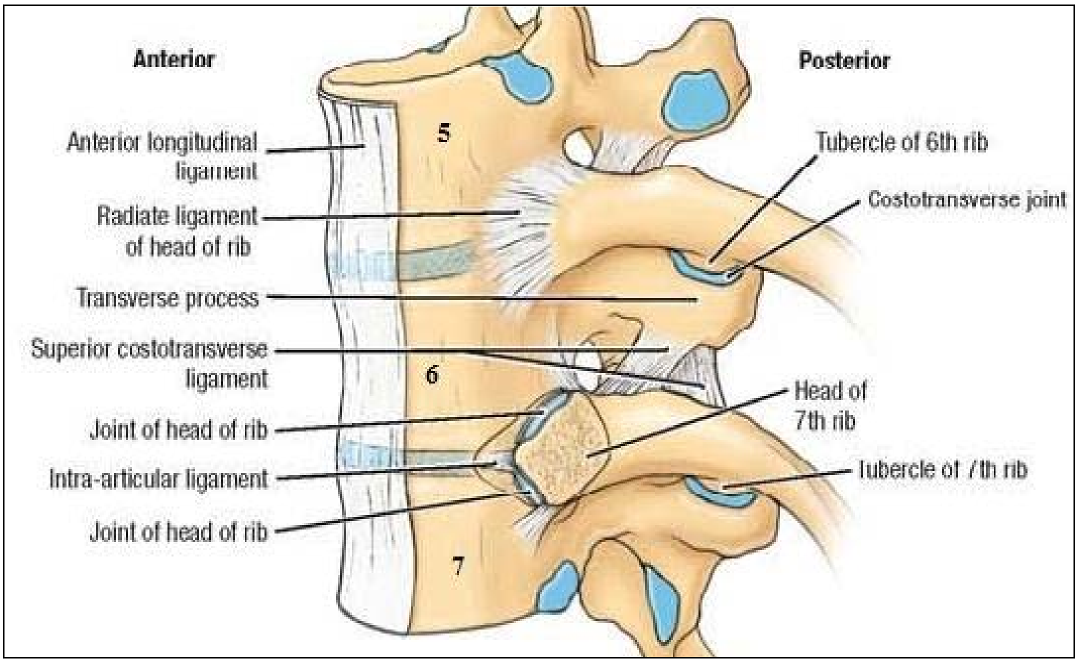


Fig. (2): Lateral view of Thoracic vertebra and its related Joints and ligaments ***(Grant's Atlas, 2009).***

Lumbar Vertebra:

The main function of the lumbar spine is to bear the weight of the body(fig . 3).it has kidney-shaped body when viewed superiorly.

The lumbar articular processes are strong and have marked upward and downward projection in a vertical plane. The facets on the superior processes are concave and face medially and back-wards, while those on the inferior processes are convex, being directed forwards and laterally. ***(Dommisse, 1975).***

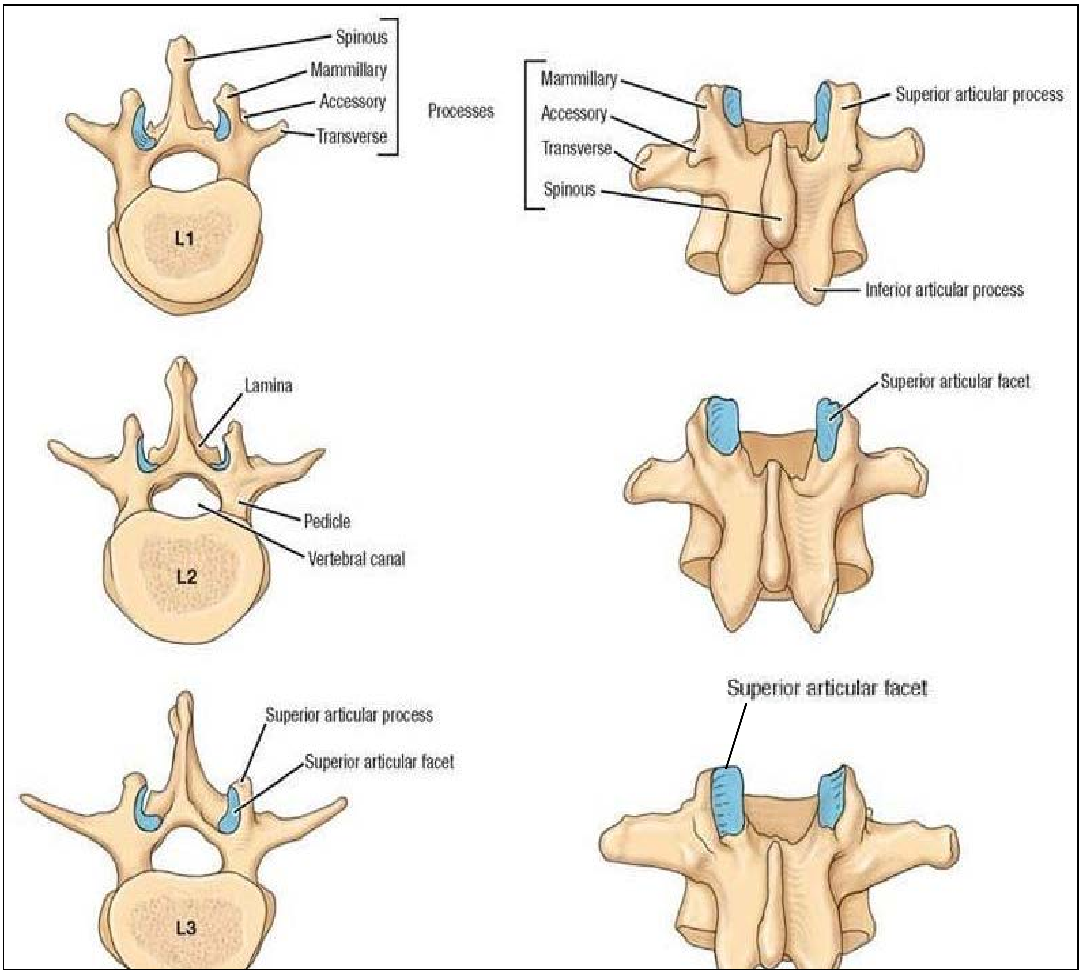


Fig. (3): Superior and posterior views of lumbar vertebra ***(Grant's Atlas, 2009).***

Facet joints:

The zygapophysial (facet) joint is formed between the inferior articular process of one vertebra and the superior articular process of the vertebra below. The facet joint itself is a true synovial joint with hyaline cartilage surfaces and a joint space enclosed in a fibrous capsule, lined with a synovial membrane.

The capsules are thin and lax and are attached to the bases of the engaging superior and inferior articulating processes of opposing vertebrae. The capsule of the facet joint blends with the ligamentum flavum on its medial and superior aspects. The outer portions of the ligamentum flavum may prevent the capsule from being nipped between the two articular surfaces during movement and from protrusion into the spinal foramen ***(McMinn, 1990).***

The synovial membrane is a thin fibrous layer that forms superior and inferior recesses which are filled with small synovial villi or fat pads approximately the size of grains of rice encapsulates the facet joint. These villi contain a rich supply of blood vessels and nerves. It has been postulated that these synovial villi may become inflamed or trapped between the articular process, thereby producing pain ***(McMinn, 1990).***

Facet joint orientation

The orientation of facet joints varies with different vertebral levels. In the thoracic spine they face posteriorly and laterally, the angle of inclination of the thoracic facet joint is 60 degrees in horizontal plane and is 20 degrees in frontal plane. In lumbar spine they face medially and posteriorly, the angle of inclination of the lumbar facet joint is 90 degrees in horizontal plane and is 45 degrees in frontal plane (fig. 4) ***(McMinn, 1990).***

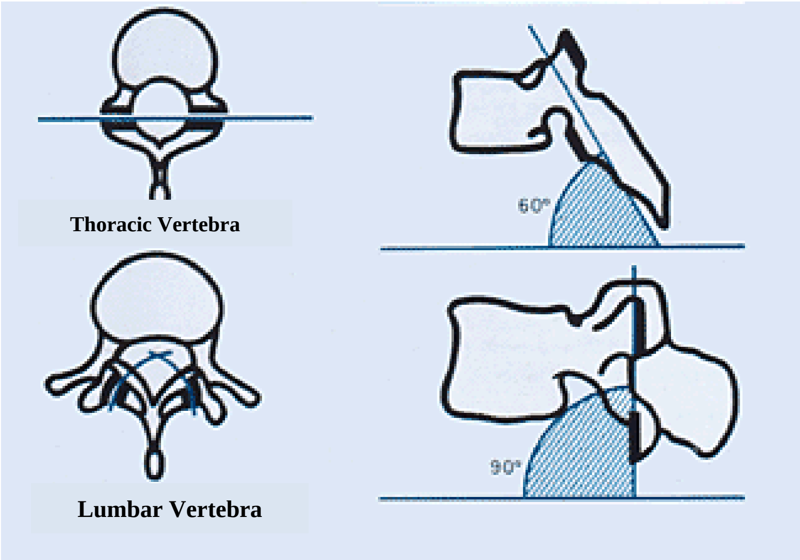


Fig. (4): Showing facet joint orientations in thoracic and lumbar spine ***(McMinn, 1990).***

Ligaments: There are 2 groups:

- Ligaments affixing the vertebral bodies include anterior longitudinal ligament (ALL), posterior longitudinal ligament (PLL) and annulus fibrosus of the intervertebral disc.

- Ligaments of the posterior elements include supraspinous, interspinous and ligamenta flava. The capsules of the facets also serve ligamentous function ***(McMinn, 1990).***

Anterior longitudinal ligaments: The ALL is wide and very strong. Its superficial layer extends over 4 to 5 vertebrae in an overlapping fashion, and its deep layer connects adjacent vertebrae. It is attached to periosteum and thus to bone by Sharpey's fibres ***(Kuner et al., 1994).***

Posterior longitudinal ligaments:

The PLL has superficial and deep layers

The superficial layer is 0.5 to 1 cm wide and extends continuously from the foramen magnum to the L3/4 disc where most of its fibers terminate, some thin bundles however, reach the S1/2 disc.

The deep layer is segmental, it is 1 cm wide in the midline of each vertebral body but spreads to blend with the annulus fibrosus and the periosteum of the upper margin and pedicles of each body.

Intervertebral disc:

The inter vertebral disc, which has many functions, is subjected to a considerable variety of forces and moments. Along with the facet joints, it is responsible for carrying all the compressive loading to which the trunk is subjected ***(Hirsch, 1955).***

The intervertebral disc consists of:

A- Nucleus pulposus:

The nucleus pulposus is a centrally located area composed of a very loose and translucent network of fine fibrous strands that lie in a mucoprotein gel containing various mucopolysaccharides. The water content ranges from 70 - 90%.

B- Annulus fibrosus:

The annulus fibrosus is a portion of the intervertebral disc that gradually becomes differentiated from the periphery of nucleus and forms the outer boundary of the disc. This structure is composed of fibrous tissue in concentric laminated bands. The fibers are arranged in a helicoid manner. They run in about the same direction in a given band but in opposite directions in any two adjacent bands. They are oriented at 30^o to the disc plane and therefore at 120^o to each other in adjacent bands (Fig. 5).

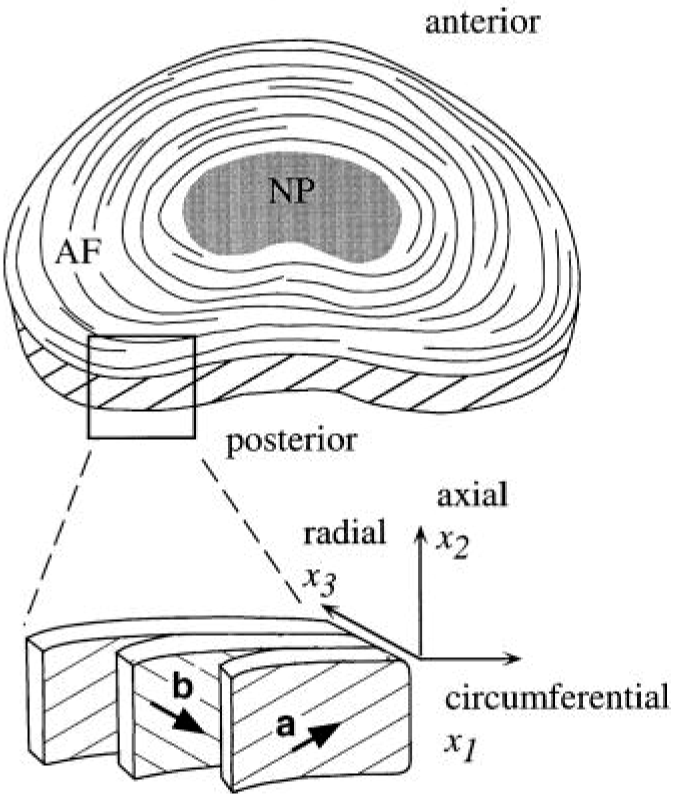


Fig. (5): Orientation of fibers in annulus fibrosus ***(Dawn ME and Lori AS, 1999).***

The annulus fibers are attached to the cartilaginous endplates in the inner zone, while in the more peripheral zone they attach directly into the osseous tissue of the vertebral body and are called Sharpey‘s fibers. ***(White and Pangabi, 1990).***

C- Cartilaginous end-plate: This is composed of hyaline cartilage that separates the other two components of the disc from the vertebral body ***(White and Pangabi, 1990).***

Ligaments of the posterior element

1- **Supraspinous Ligament:**

This is a tough ligament which runs vertically over the apices of the spines of the lumbar and thoracic vertebrae and continues higher up in the cervical region as the ligamentum-nuchae (fig. 6).

2- **Interspinous Ligament:**

This ligament is a very thin one and runs between spines of adjacent vertebrae (fig. 6). The ligament attaches along the length of the spinous processes uniting the upper border of the lower one to the lower border of the more cranial one. Anteriorly the ligament blends in with the ligamentumflavum and posteriorly it blends in with the fibers of the supraspinous ligament. It takes the shape of a rectangle.

3- **Ligamentum Flavum:**

The ligamentum flavum is composed of mainly elastic fibers and is yellow in color (fig. 6), and in name. Flavum is Latin for yellow. It runs from an anterior-inferior surface of a cranial lamina to the posterior-superior border of the lamina below. Laterally the ligament blends with the capsule of the joint between the articular processes and then passes over medially where it will meet its counterpart from the opposite side. ***(Grant's Atlas, 2009).***

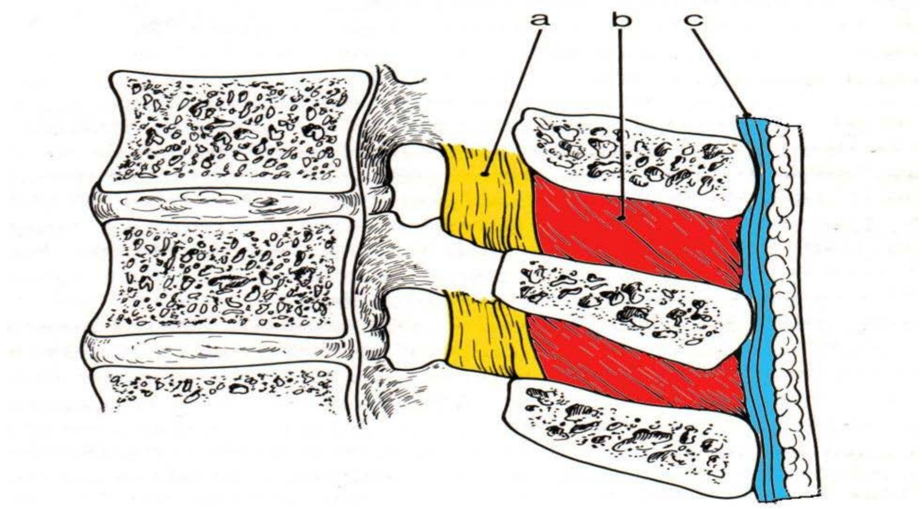


Fig. (6): Lateral view of a-Ligamentum Flavum, b-Inter spinous and c- Supra spinous ligaments ***(Grant's Atlas, 2009).***

<u>Anatomy of the thoracic and lumbar pedicles:</u>

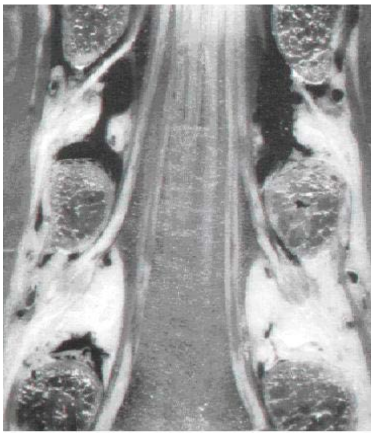
Pedicle is a tube - like structure that connect the anterior and posterior columns of the spine.

The pedicle in cross section is not a circle, as the horizontal diameter is smaller than the vertical diameter ***(Hirano et al., 1997).***

Clinical anatomy of the pedicular relations (Fig. 7):

The pedicles are closely related anatomically to the spinal nerve roots. The pedicle form the lateral borders of the vertebral canal, and also constitutes the superior and inferior margins of the intervertebral foramina. The dural sac is located medial to the pedicle, and the nerve roots pass directly caudal to the pedicles as they course out through the respective intervertebral foramen ***(Cohen et al., 1990).***

The nerve roots (motor and sensory) follow closely the medial aspect of the pedicles and they are located in the anterior superior one third of the intervertebral foramen. Because of these close anatomic relationships, the nerve roots can be injured by violation of the medial or inferior pedicular cortex. It should also be noted that the spinal nerves, after they exit from the neural foramen run close to the lateral cortex of the pedicle below. These anatomic features indicate that the placement of the pedicle screws, with respect to the risk for neural damage, is centrally or slightly toward the superior cortex of the pedicle ***(Rauschning, 1987).***



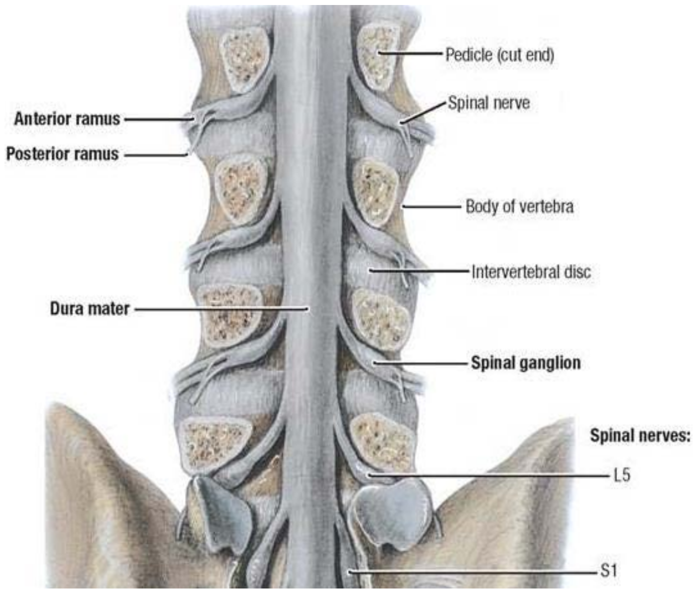


Fig. (7): Pedicle relation and Clinical anatomy of the pedicle ***(Rauschning, 1987).***