Pyogenic spinal infections

An Essay
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The circulation of the spine along with the microscopic and gross anatomy is essential to understand spinal infection and its treatment.

(1)Arterial circulation:

The arterial circulation to the spine is analogous in the cervical, thoracic, and lumbar regions. The vertebral arteries in the cervical spine, the intercostal arteries in the thoracic spine and the lumbar arteries in the lumbar spine supply blood to the vertebrae directly and via branches. Small arterioles penetrate directly into the vertebral body as the artery crosses over the bone.

The second source of arterial blood comes from posterior spinal branches that divide off the main arteries and enter the canal through the intervertebral foramen and separate in to ascending and descending branches. Within the spinal cord, they form an anastomotic network posterior to the vertebral body. This network donates nutrient arteries to each vertebral body via a centrally located nutrient foramen in the posterior wall of the vertebral body **(Marvin R. Leventhal, 2003).**

This general pattern of the vasculature is best demonstrated in the area between the second thoracic and fifth lumbar vertebrae, here the segments are associated with paired arteries that arise directly from the aorta fig. (1).

The cervical, upper thoracic, and sacral regions have different patterns in their segmental supply that affect to various extents the arrangements of the finer vessels. It can be seen that

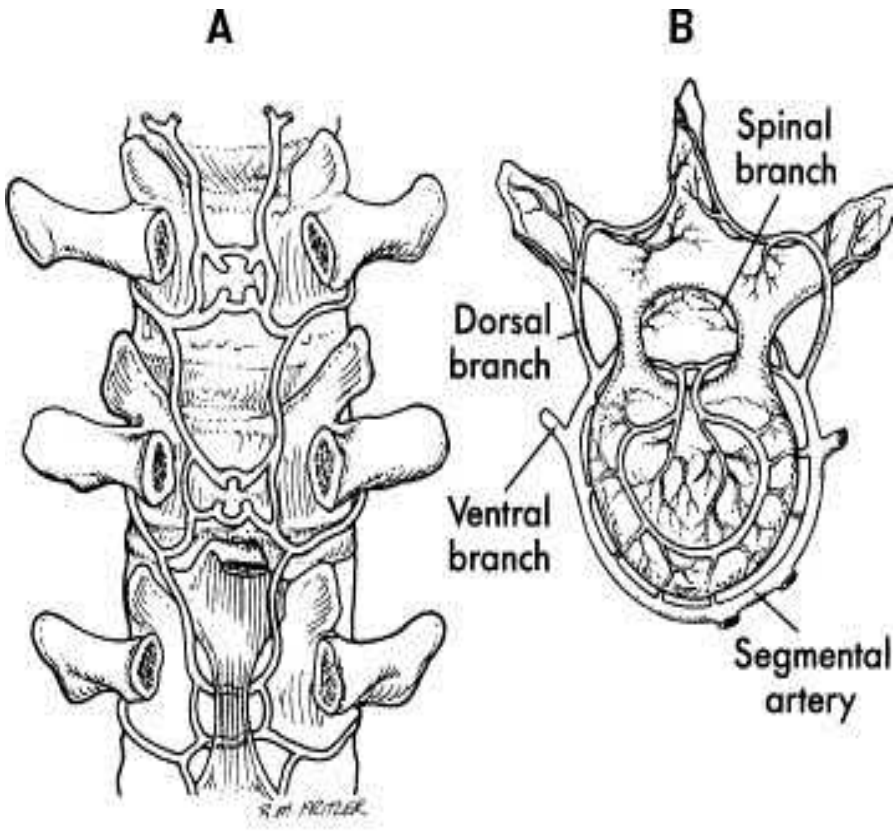

Figure (1): Vertebral blood supply. **A,** Posterior view; laminae removed to show anastomosing spinal branches of segmental arteries. **B,** Cross-sectional view; anastomosing arterial supply of vertebral body, spinal canal, and posterior elements**(Marvin R. Leventhal, 2003).**

the greater part of the cervical arteries are supplied by the vertebral arteries and the deep cervical arteries. An intermediate area that usually includes the lower two cervical and upper two thoracic vertebrae is supplied by costocervical branches of subclavian that are of variable pattern and often bilaterally dissimilar. In the sacral area lateral sacral branches of the hypogasteric artery and branches of middle sacral assume the function of supporting the nutritional vasculature to the vertebral elements **(Wesley, 2001)**.

(2)Venous circulation:

The venous system of the spine forms a valveless plexiform network from the dural sinuses to the sacrum in a longitudinal arrangement. Original accounts describe three main divisions; the venous channels within the vertebral body (basivertebral vein) ; the epidural veins surrounding the dura (anterior and posterior internal vertebral venous plexus)which lies within the spinal canal; and the venous network surrounding the vertebral column(anterior and posterior external vertebral venous plexus) fig. (2).

The internal plexus: the vertebral canal contains a plexus of thin walled valveless veins that surround like a basketwork the dura mater of the spinal cord and the posterior longitudinal ligament, anterior and posterior longitudinal channels(venous sinuses) can be discerned in this plexus, cranially, this plexus

communicates though the foramen magnum with the occipital and basilar sinuses; at each spinal segment ,the plexus receives veins from the spinal cord and a basivertebral vein from the body of vertebra: the plexus, in turn, is drained by intervertebral veins that pass through the intervertebral and sacral foramina to the vertebral, intercostal, lumber and lateral sacral veins.

The external plexus: through the body of each vertebra come veins that form anterior vertebral plexus, and through the ligamenta flava pass veins that form a wall-marked posterior vertebral plexus; in the cervical region, these plexuses communicate freely with the occipital and profanda cervicis veins, which receive from the segmoid sinus, the mastoid and condyloid emissary veins; in the thoracic ,lumbar, and pelvic region the azygos (or hemiazygos), the ascending lumbar, and the lateral sacral veins, respectively, further link segment to segment (fig.3)**(Marvin R. Leventhal, 2003).**

(3) The intervertebral disc:

The intervertebral disc is a fibrocartilaginous complex that forms the articulation between the bodies of vertebrae. Although it provides a strong union, ensuring the degree of intervertebral fixation that is necessary for effective action and the protective alignment of the neural canal. The summation of the limited movements allowed by each disc imparts to the spinal column as a whole its characteristic universal motion. The disc of the various spinal regions may differ considerably in size and in

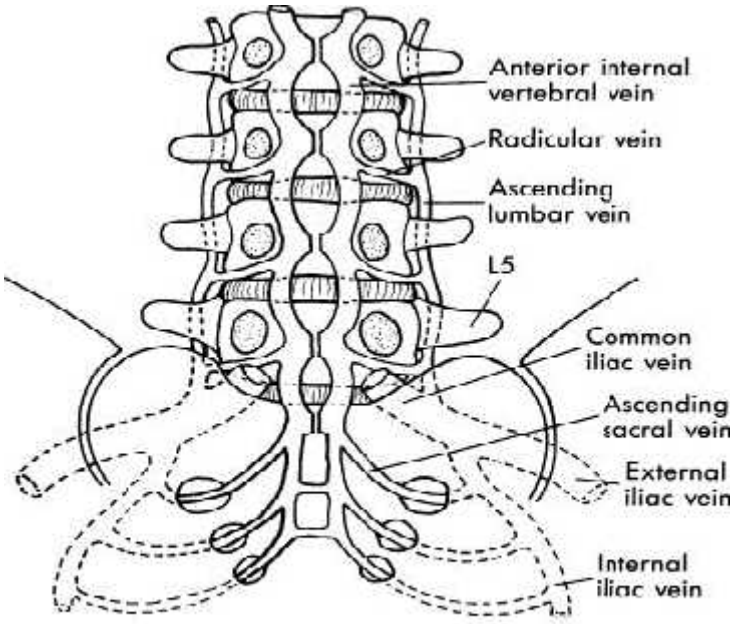

Figure (2): Schematic diagram of vertebral venous system **(Macnab et al, 2003).**

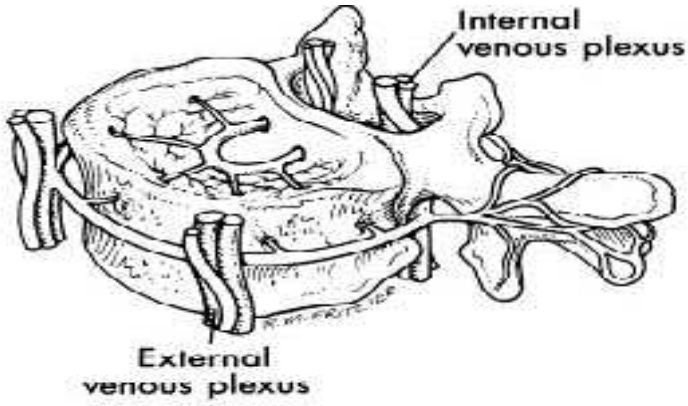

Figure (3): Venous drainage of vertebral bodies and formation of internal and external vertebral venous plexuses **(Bullough et al, 2003).**

some details, but they are basically identical in their structural organization. Each consists of two components: the

internal semifluid mass, the nucleus pulposus and its laminar fibrous container ,the annulus fibrosus(Fig.4) **(Wesley, 2001).**

In adults older than 30 years the intervertebral disc receives its nutrition from tissue fluids rather than from direct blood supply. There are multiple holes in the end plates of the vertebral bodies, which corresponded with the marrow cavities and were arranged in three distinct areas: central zone with numerous small holes, peripheral zone with a few large holes, and an epiphyseal ring surrounding the end plate which overlaps the outer surface of the vertebral body and joins the more concave surface of the central and peripheral zones internally. Next to the bony end plate is the cartilaginous plate, which consists of hyaline cartilage and forms the inner base between the bone and the fibrous disc. The disc was firmly adherent to the vertebral end plate. Blood vessels enter and leave the disc through tiny perforations in the central cartilaginous plate. These vessels obliterate during the first three decades of life; thereafter, nutrition of the disc is supported only by lymphatic channels and extracellular fluid circulation. The atrophy of disc blood vessels during maturation could be the underlying cause of the progressive desiccation, collapse, and degeneration of the discs seen with advancing age. In experimental animals, the permeability of the disc matrix has also been found to increase with aging**(Marvin R. Leventhal, 2003).**

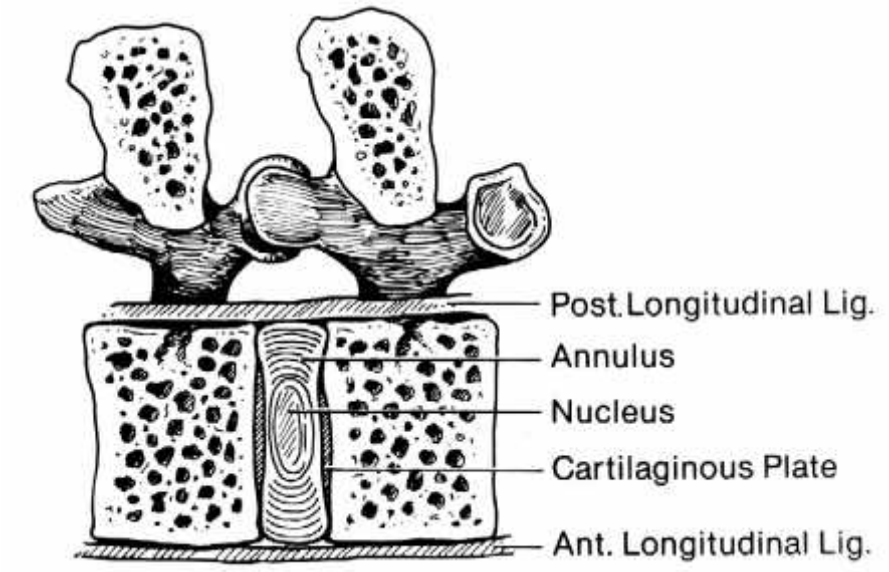

Figure (4): Intervertebral disc and adjacent structures. The posterior longitudinal ligament fuses with the annulus in the midline, while the anterior longitudinal ligament crosses over the disc without firm attachment (**George W. Wood II, 2003).**

Classification of spinal infections by anatomical location:

Classification of disease is important in studying, diagnosing, and treating related disorders. With infections of the spine, it was proposed a classification system according to anatomical location. Describing spinal infections according to the anatomic location of their focus is often helpful. Infections often involve more than one area and multiple contiguous structures; however, the location of their focus can suggest the cause and aid in the determination of treatment and, if needed, surgical approach. Table(1) classifies spinal infections according to location. Included is commonly used terminology. Fig(5) depicts the structures or areas involved. Infections of the spine are characterized into three main divisions: the anterior spine, the posterior spine, and the spinal canal**(Rocco RC and John ML, 2003).**

(1)Anterior spine:

The anterior aspect of the spine includes the vertebral body, and the intervertebral disc, as well as the paravertebral area. Infections of the vertebral body are referred to as vertebral osteomyelitis or spondylitis and are commonly hematogenous in nature. MRI imaging often shows signal change in the vertebral body, the disc space, and the endplate of the next vertebra, justifying the term spondylodiscitis. Discitis, a primary infection of the intervertebral disc, commonly occurs in children because of the immature circulation pattern of the disc. In adults,

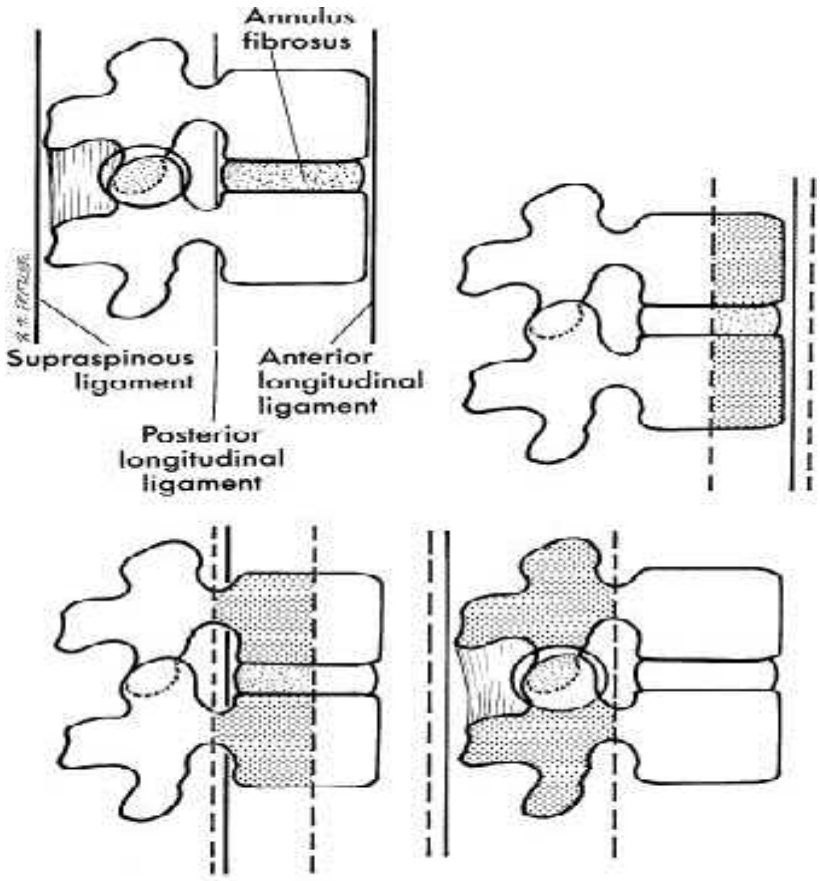

Figure (5): Three-column classification of spinal instability. Illustrations of anterior, middle, and posterior columns **(Denis F, 2003).**

iatrogenic discitis involving adjacent endplates can occur as a postoperative infection after discectomy **(Rocco RC and John ML, 2003).**

The paravertebral area is that potential space that exists anteriorly and laterally to the vertebral body. Vertebral osteomyelitis in the cervical spine can progress anteriorly causing a retropharyngcal abscess and inferiorly causing mediastinitis . Likewise, pharyngeal infection or esophageal perforation can extend posteriorly and involve the cervical spine secondarily. Infections in the thoracic region may progress via the paravertebral space to a mediastinits or mediastinal abscess. Empyema and pericarditis have been reported secondary to vertebral osteomyelitis. Anterior infections in the thoracolumbar and lumbar spine have the potential of causing subdiaphragmatic abscesses, peritonitis, or psoas abscesses that may dissect down the iliopsoas as far as the inguinal ligament. These are all examples of anterior vertebral infections extending into the paravertebral space and involving contiguous structures **(Rocco RC and John ML, 2003).**

(2)Posterior spine:

Infections in the posterior aspect of the spine involve those areas posterior to the plane of the transverse processes. This includes the subcutaneous and subfascial areas, as well as the posterior elements of the spine. Most often, an infection in the posterior aspect of the spine is an acute or chronic postoperative infection. A seroma or a wound dehiscence of the

back may develop into an infection in the subcutaneous space. This is more common when a plane is developed above the fascial layer for a bilateral paraspinous approach to the lumbar spine. A deep postoperative infection manifests in the subfascial area and may lead to formation of a paraspinous abscess or may infect exposed bone of the posterior elements of the spine. Pedicle -screws and other spinal instrumentation may serve as an entrance site for a deep wound infection into the bone. Rarely, a primary vertebral osteomyelitis anteriorly will progress to involve the posterior elements of the spine. More commonly it will progress into the spinal canal**.(Rocco RC and John ML, 2003).**

(3)Spinal canal:

Infections within the spinal canal involve the epidural space, the meninges, the subdural space, and the spinal cord. Commonly, an epidural abscess may form from a hematogenous source. Also, vertebral osteomyelitis can result in an epidural abscess. An epidural abscess from a hematogenous source is often posterior within the canal .

Table (1): Classification of spinal infections**(Rocco RC and John ML, 2003).**

Anatomy	Area involved	Terminology
Anterior spine	-Vertebral body	-Vertebral osteomyelitis =(spondylitis) -Spondylodiscitis -Tuberculous spondylitis -Pott's disease
	-Intervertebral disc	-Discitis
	-Paravertebral space	-Paravertebral abscess -Psoas abscess -Retropharyngeal abscess -Mediastinitis,empyema
Posterior spine	-Subcutaneous space	-Superficial wound infection
	-Subfacial space	-Infected seroma -Superficial wound infection -Deep wound infection -Paraspinous abscess
	-Posterior element	-Osteomyelitis -Deep wound infection
Spinal canal	-Epidural space -Meninges -Subdural space -Spinal cord	-Epidural abscess -Meningitis -Subdural abscess -Intramedullary abscess