

Male Internal Genital Organs

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Introduction

- The **male internal genital organs** include the **ductus deferens (vas deferens)**, **seminal vesicles**, **ejaculatory ducts**, **prostate**, and **bulbourethral glands**.
- These structures lie mainly in the **pelvic cavity**, and their functions are closely coordinated for **sperm transport, maturation, and ejaculation**.
- The **testis and epididymis** (external genital organs) produce and store sperm, while the **internal organs** provide **nutrients, secretions, and passage** for sperm to reach the urethra.

Dissection Overview

- The pelvic dissection for male internal genital organs involves tracing the **ductus deferens** from the **deep inguinal ring** to the **posterior surface of the bladder**, exposing the **seminal vesicles**, **prostate**, and **ejaculatory ducts**.
- The **ductus deferens** can be identified as a **firm, cord-like structure** emerging from the deep inguinal ring and passing posterior to the bladder.
- The **seminal vesicles** appear as lobulated, elongated structures on either side of the midline behind the bladder.

Ductus Deferens (Vas Deferens)

- The **ductus deferens** is a **thick-walled, muscular tube** about **45 cm long**, conveying sperm from the **tail of the epididymis** to the **ejaculatory duct**.
 - It plays a vital role in **sperm transport during ejaculation**, aided by strong **peristaltic contractions** of its muscular wall.
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Course and Relations

1. Scrotal Part:

- Begins at the **tail of the epididymis**, ascends along the **posterior border of testis**, and joins the **spermatic cord**.

2. Inguinal Part:

- Passes through the **inguinal canal** with the spermatic cord and emerges through the **deep inguinal ring**.

3. Pelvic Part:

- Crosses **external iliac vessels** and enters the **pelvic cavity**.
- Runs **medially** and **downward** over the **obliterated umbilical artery** and **ureter**, then descends **posterior to the urinary bladder**.
- The terminal part dilates to form the **ampulla of the ductus deferens**, which joins the **duct of the seminal vesicle** to form the **ejaculatory duct**.

Relations in the Pelvis:

- **Anteriorly:** Urinary bladder.

- **Posteriorly:** Rectum (separated by rectovesical fascia).
 - **Medially:** Seminal vesicle.
 - **Laterally:** Pelvic vessels and peritoneum.
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Arterial Supply

- Supplied mainly by the **artery to the ductus deferens**, a branch of the **superior or inferior vesical artery** (from the internal iliac artery).
 - Also receives collateral branches from the **testicular artery** and **cremasteric artery**.
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Venous Drainage

- The **veins form a plexus** around the ductus deferens that drains into the **pampiniform plexus** and **vesical venous plexus**, ultimately ending in the **internal iliac veins**.
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Histology

- **Mucosa:** Lined by **pseudostratified columnar epithelium** with **stereocilia**; mucosa forms longitudinal folds.
 - **Muscular coat:** Very thick and composed of **three layers** —
 - **Inner longitudinal,**
 - **Middle circular,**
 - **Outer longitudinal.**These layers produce **strong peristaltic contractions** during ejaculation.
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- **Adventitia:** Contains blood vessels, nerves, and connective tissue.
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Development

- The **ductus deferens** develops from the **mesonephric (Wolffian) duct**, under the influence of **testosterone** secreted by fetal Leydig cells.
 - The **cranial end** of the mesonephric duct forms the **epididymis**, the **middle part** forms the **ductus deferens**, and the **caudal part** contributes to the **ejaculatory duct and seminal vesicle**.
 - In females, absence of testosterone leads to regression of this duct, leaving remnants such as **epoophoron and Gartner's duct**.
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Clinical Anatomy

1. Vasectomy:

- A **permanent male sterilization procedure** involving division and ligation of the ductus deferens in the **scrotum**.
- Prevents sperm from entering the ejaculate, though sexual function remains normal.
- Reversal (vasovasostomy) may be attempted but is not always successful.

2. Palpation:

- The ductus deferens is **palpable** as a **firm cord-like structure** in the upper scrotum just medial to the testis.

3. Injury During Inguinal Surgery:

- May occur accidentally during hernia repair or procedures involving the spermatic cord.
- Can result in **obstructive azoospermia** and infertility.

4. **Obstruction:**

- Can result from **infection (epididymitis, prostatitis)** or **congenital atresia**; causes **infertility** due to impaired sperm transport.

5. **Ejaculatory Duct Calculus or Blockage:**

- Blockage leads to **painful ejaculation** and **oligo- or azoospermia**.

6. **Congenital Absence of Vas Deferens:**

- Seen in association with **cystic fibrosis**, leading to **infertility** despite normal spermatogenesis.

7. **Relation to Ureter:**

- In the pelvis, the **ductus deferens crosses the ureter anteriorly** near the base of the bladder — an important landmark during surgery.

Seminal Vesicles

Introduction

- The **seminal vesicles** are a **pair of elongated, sacculated glands** situated **posterior to the urinary bladder** and **anterior to the rectum**.

- They are about **5 cm long** and **lie obliquely**, with their **upper ends diverging** and **lower ends converging** toward the midline.
 - Each seminal vesicle is **not a storage organ for sperm**, but a **secretory gland** producing **seminal fluid**, which nourishes and activates sperm.
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Structure and Relations

- Each vesicle is **coiled and folded**, giving a honeycomb appearance on section.
- The **lumen** communicates inferiorly with the **ductus deferens** to form the **ejaculatory duct**.

Relations:

- **Anteriorly:** Base of urinary bladder.
 - **Posteriorly:** Rectum (separated by rectovesical fascia).
 - **Medially:** Ampulla of ductus deferens.
 - **Superiorly:** Peritoneum of the rectovesical pouch.
 - **Inferiorly:** Prostate gland (ejaculatory ducts enter prostate).
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Duct of the Seminal Vesicle

- The **duct** joins the **ampulla of the ductus deferens** to form the **ejaculatory duct** on each side.
 - The union occurs behind the base of the bladder, above the prostate.
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Arterial Supply

- Branches from the **inferior vesical** and **middle rectal arteries** (from internal iliac artery).
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Venous Drainage

- Veins drain into the **vesical and prostatic venous plexuses**, which communicate with the **internal iliac veins**.
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Nerve Supply

- From the **inferior hypogastric plexus**, containing **sympathetic (T12–L2)** and **parasympathetic (S2–S4)** fibers.
 - Sympathetic stimulation aids **contraction during ejaculation**.
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Histology

- Lined by **pseudostratified columnar epithelium**.
 - The **mucosa** is highly **folded**, forming complex branching pouches that increase secretory surface area.
 - The **wall** has a thin **muscular coat** (inner circular, outer longitudinal).
 - The **secretions** are **alkaline**, rich in **fructose**, **prostaglandins**, **citric acid**, and **fibrinogen**, which provide energy and motility to sperm.
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Development

- Develops from the **lower part of the mesonephric (Wolffian) duct** as a **lateral outgrowth** near its junction with the cloaca.
 - The **duct of the vesicle** becomes the **ejaculatory duct**, while the vesicle itself remains as a **secretory gland**.
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Clinical Anatomy

1. Function:

- Secretes about **60–70% of seminal fluid volume**.
- Fluid is **alkaline**, neutralizing vaginal acidity and enhancing sperm motility.
- **Fructose** acts as an energy source for sperm.

2. Infection (Vesiculitis):

- Commonly spreads from **prostatitis or epididymitis**.
- Causes **painful ejaculation, hematospermia (blood in semen)**, and **fever**.

3. Cyst or Calculus:

- Cysts may compress adjacent structures, causing **urinary difficulty or infertility**.
- Rarely, **seminal vesicle stones** may form due to infection.

4. Tumors:

- Rare; usually secondary from **prostate carcinoma**.

5. Palpation:

- The **seminal vesicle** can be felt **per rectum** as a lobulated structure above the prostate.

Ejaculatory Duct

Introduction

- The **ejaculatory ducts** are two slender tubes, each about **2 cm long**, formed by the **union of the ductus deferens** with the **duct of the seminal vesicle**.
- They pass through the **prostate gland** and open into the **prostatic urethra** at the **seminal colliculus (verumontanum)**.
- They serve to **convey sperm and seminal fluid** into the urethra during ejaculation.

Course and Relations

1. Origin:

- Formed by the **junction of the ductus deferens and the seminal vesicle duct** behind the bladder.

2. Course:

- Pass **anteriorly and inferiorly** through the **posterior part of the prostate**, one on each side of the midline.

3. Termination:

- Each duct opens on the **summit of the seminal colliculus** in the **prostatic urethra**, close to the **prostatic utricle** (homolog of uterus and vagina).
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Arterial Supply

- Branches from the **inferior vesical artery** and **middle rectal artery**.
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Venous Drainage

- Into the **prostatic and vesical venous plexuses**, draining into the **internal iliac veins**.
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Histology

- Lined by **pseudostratified columnar epithelium**.
 - Surrounded by a **thin muscular layer** (inner circular and outer longitudinal).
 - The **lumen** is narrow and may contain **eosinophilic secretions**.
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Development

- Develops from the **caudal part of the mesonephric duct**, distal to the outgrowth forming the seminal vesicle.
 - In females, this portion regresses; remnants may persist as **Gartner's ducts** in the lateral wall of the vagina or broad ligament.
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Clinical Anatomy

1. Ejaculatory Duct Obstruction:

- May result from **inflammation, fibrosis, or calculi** in the prostate or seminal vesicle region.
- Leads to **azoospermia** (absence of sperm in semen) or **painful ejaculation**.

2. Infection:

- Prostatic or vesicular infection may extend into the ducts, producing **ejaculatory pain and tenderness**.

3. Cystic Dilatation:

- Congenital or acquired obstruction causes **cystic swelling**, compressing the urethra and interfering with ejaculation.

4. Surgical Landmark:

- During **transurethral resection of the prostate (TURP)**, care is taken to avoid damage to the **ejaculatory ducts** to prevent retrograde ejaculation.

5. Radiological Visualization:

- Seen during **vasography or seminal vesiculography** to assess patency in cases of infertility.

Prostate

Situation

- The **prostate** is a **fibromusculoglandular organ** that surrounds the **prostatic urethra** at the base of the urinary bladder.
- It lies **below the bladder, in front of the rectum, and behind the pubic symphysis**.
- The **prostate resembles an inverted cone**, with its **base upward** (in contact with bladder neck) and **apex downward**, resting on the **urogenital diaphragm**.

Relations:

- **Anteriorly:** Pubic symphysis (separated by retropubic fat).
 - **Posteriorly:** Rectum (separated by rectovesical fascia).
 - **Inferiorly:** Urogenital diaphragm.
 - **Superiorly:** Neck of urinary bladder.
 - **Laterally:** Levator ani (puboprostaticus fibers).
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Gross Features

- **Shape:** Conical.
- **Size:** About **4 cm wide, 3 cm long, and 2.5 cm thick**.
- **Weight:** Around **18–20 g** in adult males.
- **Base:** Faces upward, surrounding the neck of the bladder.
- **Apex:** Directed downward, rests on the urogenital diaphragm.

- **Surfaces:**

- **Anterior:** Narrow, connected to pubic symphysis by **puboprostatic ligaments**.
 - **Posterior:** Broad, related to rectum — **palpable in rectal examination**.
 - **Inferolateral:** Related to **levator ani muscles**.
- The **urethra** passes vertically through its **anterior part**, and the **ejaculatory ducts** pass obliquely through the **posterior part**.
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Zones of the Prostate (Modern Classification)

The prostate is divided into **four distinct zones** based on **histological and pathological features**:

1. **Peripheral Zone (70%)**

- Posterior and lateral portions.
- Most **common site of carcinoma**.
- Palpable during **digital rectal examination (DRE)**.

2. **Central Zone (25%)**

- Surrounds the **ejaculatory ducts**.
- Resistant to carcinoma but may develop **inflammatory lesions**.

3. **Transitional Zone (5%)**

- Surrounds the **proximal urethra**.

- Site of **benign prostatic hyperplasia (BPH)**.

4. Anterior Fibromuscular Zone

- Contains **fibrous tissue and smooth muscle**, no glands.
 - Provides structural support to prostate.
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Capsules and Ligaments of Prostate

1. True Capsule:

- A **thin fibrous layer** closely adherent to the gland.
- Formed by condensation of connective tissue around the prostate.

2. False Capsule:

- A **sheath of pelvic fascia** enclosing the true capsule.
- Between the two lies the **prostatic venous plexus** (of Santorini).

3. Ligaments of Prostate:

- **Puboprostatic ligaments:** Attach the prostate to pubic symphysis (support anteriorly).
 - **Lateral ligaments:** Condensations of pelvic fascia connecting prostate to pelvic wall.
 - **Posterior fascia (Denonvilliers' fascia):** Separates prostate and bladder from rectum.
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Structures within the Prostate

- **Prostatic Urethra:** Passes vertically through the gland.
- **Ejaculatory Ducts:** Two ducts traverse the posterior part of prostate and open on **seminal colliculus (verumontanum)**.
- **Utricle:** A small blind pouch in the prostatic urethra, homologous to **uterus and vagina** in females.

Seminal Colliculus:

- A ridge in posterior urethral wall within the prostate.
 - Has openings of **ejaculatory ducts** on each side of a small depression — **prostatic utricle**.
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Structural Zones of the Prostate (Classical Lobes)

Although now replaced by zonal classification, the classical division includes:

1. **Anterior lobe (isthmus):** In front of urethra, mostly fibromuscular.
 2. **Posterior lobe:** Behind urethra and below ejaculatory ducts — prone to **carcinoma**.
 3. **Median lobe:** Between urethra and ejaculatory ducts — undergoes **BPH hypertrophy**.
 4. **Two lateral lobes:** On each side of urethra, largest portions.
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Blood Supply

- **Arteries:**

- From **inferior vesical, middle rectal, and internal pudendal arteries** (branches of internal iliac artery).

- **Veins:**

- Form **prostatic venous plexus**, draining into **internal iliac veins**.
 - The **prostatic venous plexus** communicates with **vertebral venous plexus** — pathway for **metastasis of prostate carcinoma to vertebral column**.
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Lymphatic Drainage

- Drains mainly into **internal iliac** and **sacral lymph nodes**.
 - Some lymph may reach **external iliac nodes**.
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Nerve Supply

- **Sympathetic fibers (T11–L2):** Control smooth muscle contraction during ejaculation.
 - **Parasympathetic fibers (S2–S4):** Modulate glandular secretion.
 - Nerves derived from **inferior hypogastric (pelvic) plexus**.
 - **Prostatic plexus** gives **cavernous nerves** to penis, involved in erection — hence injury may cause **impotence** after prostate surgery.
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Age Changes in Prostate

1. **At Birth:** Small and rudimentary.

2. **Puberty:** Rapid growth under **testosterone influence**.
 3. **Adulthood:** Fully developed; secretes seminal plasma contributing to semen volume.
 4. **Old Age:**
 - **Benign hypertrophy** common in transitional zone ? urinary obstruction.
 - May also show **calcification (corpora amylacea)**.
 - Some glandular atrophy and fibrosis occur.
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Histology

- **Glandular Portion:**

- Lined by **pseudostratified columnar epithelium** with basal and secretory cells.
- Lumina contain **corpora amylacea** (hyaline concretions).

- **Stroma:**

- Contains **fibromuscular tissue** with abundant smooth muscle.
- Contracts during ejaculation to expel prostatic secretions into urethra.

- **Secretions:**

- Milky, slightly acidic, rich in **citric acid, acid phosphatase, fibrinolysin, and prostate-specific antigen (PSA)** — liquefy semen and aid sperm motility.
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Development

- Develops from the **endoderm of the urogenital sinus**, as multiple **epithelial buds** that grow into the **surrounding mesenchyme**.
 - The **stroma and capsule** arise from **splanchnic mesoderm**.
 - The **prostatic urethra** develops from the same urogenital sinus region.
 - In females, corresponding structures remain rudimentary as **paraurethral (Skene's) glands**.
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Clinical Anatomy

1. Benign Prostatic Hyperplasia (BPH):

- Common in men over 50 years.
- Involves **transitional and periurethral zones**.
- Causes **urethral compression, frequency, urgency, and difficulty in urination**.
- Treated with **?-adrenergic blockers** or **transurethral resection (TURP)**.

2. Carcinoma Prostate:

- Arises in **peripheral zone**.
- Spreads to **pelvic lymph nodes, vertebrae, and pelvic bones** via **venous plexus**.
- Diagnosed by elevated **PSA levels** and **rectal examination**.

3. Prostatitis:

- Inflammation due to bacterial infection or reflux of urine into ducts.
- Presents with **pelvic pain, dysuria, and fever**.

4. Rectal Examination:

- **Digital rectal examination (DRE)** allows palpation of **posterior lobe**.
- **Normal prostate:** Smooth, firm, and median sulcus palpable.
- **BPH:** Enlarged, firm, and smooth.
- **Carcinoma:** Hard, nodular, irregular, and loss of median sulcus.

5. Prostatectomy:

- Surgical removal of prostate; risk of **erectile dysfunction** due to injury of **cavernous nerves**.

6. Prostatic Calculi:

- Small stones formed due to stagnation of secretions; may block ducts causing inflammation.

7. PSA (Prostate-Specific Antigen):

- A key biomarker for **diagnosis and monitoring** of prostate cancer.

Vertebral System of Veins / Batson's Plexus

Introduction

- The **vertebral venous system**, also known as **Batson's plexus**, is a **network of valveless veins** that provides a **communication route** between the **pelvic and thoracic veins** and the **cranial venous sinuses**.
 - It plays a crucial role in **venous drainage** from the spine, pelvis, and skull, and is clinically significant for the **spread of infections and metastases** without passing through the lungs.
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Components of the Vertebral Venous System

1. Internal Vertebral Venous Plexus:

- Lies within the **vertebral canal**, between the **dura mater** and the **vertebral periosteum** (in the epidural space).
- Divided into **anterior** and **posterior plexuses** that surround the dura mater and spinal cord.
- Extends the full length of the vertebral canal from the **foramen magnum to the sacrum**.

2. External Vertebral Venous Plexus:

- Lies **outside the vertebral column**, on the **anterior and posterior surfaces of the vertebral bodies**.
- Communicates freely with the internal plexus through **intervertebral veins**.

3. Intervertebral Veins:

- Emerge through the **intervertebral foramina**, connecting the **internal** and **external** plexuses.

- They drain into **segmental veins** such as **lumbar, intercostal, and sacral veins**.
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Communications and Connections

- The **vertebral venous plexus** communicates with several important venous systems:

1. **Prostatic Venous Plexus (of Santorini):**

- Surrounds the prostate and base of the urinary bladder.
- Communicates with the **internal vertebral venous plexus** through **vesical and sacral veins**.

2. **Uterovaginal and Vesical Plexuses (in females):**

- Connect to the vertebral venous system via the **sacral veins**.

3. **Internal Iliac Veins:**

- Receive blood from pelvic organs and communicate with the **vertebral venous plexus** through the **lateral sacral veins**.

4. **Azygos and Hemiazygos Systems:**

- Link the **vertebral venous plexus** to the **thoracic venous network**, ensuring free venous communication between pelvis and thorax.

5. **Cranial Dural Venous Sinuses:**

- The **internal vertebral plexus** continues upward to connect with the **occipital, basilar, and marginal sinuses** at the **foramen magnum**, forming a continuous venous channel from skull to pelvis.
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Unique Features

- **Valveless System:**

- Unlike most veins, Batson's plexus lacks valves, allowing **bidirectional flow** of blood depending on posture and pressure gradients.
- This permits **equalization of venous pressure** between the thoracic, abdominal, and pelvic cavities.

- **Epidural Location:**

- The internal plexus lies in the **epidural space**, surrounding the dura — a key consideration in **epidural anesthesia** and **spinal infections**.
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Clinical Implications

1. **Spread of Prostate Carcinoma to Vertebrae:**

- The **prostatic venous plexus** communicates with **Batson's plexus**, allowing **retrograde spread of cancer cells** to the **vertebral column, pelvis, and skull bones**.
- This explains **spinal metastases** in prostate cancer without pulmonary involvement.

2. **Spread of Pelvic and Abdominal Malignancies:**

- Carcinomas of **rectum, bladder, uterus, and cervix** can metastasize to the **vertebrae** through this route.

3. **Transmission of Infections:**

- Infections from the **pelvis or urinary tract** may reach the **spine or cranial cavity**, causing **osteomyelitis or meningitis**.

4. Increased Intra-abdominal Pressure:

- Straining (e.g., coughing, defecation, or lifting) raises abdominal pressure, causing **retrograde flow** in the valveless plexus.
- This may temporarily increase intracranial pressure — significant during **childbirth or Valsalva maneuver**.

5. Epidural Hematoma:

- The internal vertebral venous plexus can rupture due to trauma or surgery, producing **epidural hemorrhage** and **spinal cord compression**.

6. Anesthetic Consideration:

- During **epidural anesthesia**, this venous plexus is at risk of puncture, which may cause **venous bleeding** or improper anesthetic spread.

7. Batson's Pathway in Metastasis:

- It provides a **bypass route around the lungs**, explaining why cancers from **pelvis** can metastasize directly to **brain, skull, or vertebrae**.

Facts to Remember

- The **vertebral venous system**, also called **Batson's plexus**, is a **valveless venous network** that extends from the **pelvis to the skull**, allowing **bidirectional blood flow**.

- It is divided into:
 - **Internal vertebral venous plexus** — located within the **vertebral canal** (epidural space).
 - **External vertebral venous plexus** — located on the **outer surfaces of the vertebrae**.
 - Both plexuses communicate through **intervertebral veins**.
- The **internal vertebral venous plexus** lies **between the dura mater and vertebral periosteum**, running longitudinally along the spinal canal.
- The **external plexus** is subdivided into **anterior** and **posterior groups**, covering the vertebral bodies and arches.
- **Intervertebral veins** act as connectors, passing through **intervertebral foramina** to link the **internal and external plexuses** with **segmental veins** (lumbar, intercostal, and sacral veins).
- The **valveless nature** of the plexus permits **free communication** between **thoracic, abdominal, pelvic, and cranial venous systems**, depending on changes in pressure or posture.
- The **prostatic venous plexus** communicates with the **internal vertebral venous plexus** via **vesical and sacral veins**, providing a **direct route for prostate cancer metastasis** to the **vertebrae and skull**.
- In **females**, the **uterovaginal and vesical plexuses** connect similarly with Batson's plexus, explaining **vertebral metastases from uterine or cervical carcinomas**.
- The **vertebral venous system** also connects with the **cranial dural venous sinuses** (basilar and occipital sinuses) at the **foramen magnum**, forming a **continuous**

craniovertebral channel.

- Because there are **no valves**, venous blood can flow **retrogradely** during increased **intra-abdominal or intrathoracic pressure** (e.g., coughing, sneezing, straining).
- **Clinical significance:**
 - Serves as a **pathway for metastasis** of cancers from **pelvic organs** (prostate, rectum, bladder, uterus) to the **spine, ribs, and skull**.
 - Explains **vertebral metastasis without lung involvement**.
 - Provides a route for **pelvic and spinal infections** to spread intracranially.
 - Source of **epidural venous bleeding** in spinal injuries or during **epidural anesthesia**.
- The **prostatic venous plexus** lies **between the true and false capsules of prostate** and drains into Batson's plexus through the **vesical and sacral veins**.
- **Venous engorgement** in Batson's plexus can occur during **Valsalva maneuver, pregnancy, or pelvic tumors**, sometimes contributing to **vertebral pain or congestion**.
- The **vertebral venous system** acts as a **pressure-regulating channel** for intracranial and intra-abdominal venous systems — a physiological mechanism but one with serious pathological potential.

Clinicoanatomical Problems

Case 1: Prostate Carcinoma with Vertebral Metastasis

A 68-year-old man presents with **low back pain** and difficulty in urination. Digital rectal examination reveals a **hard, irregular prostate**. X-ray and MRI show **osteoblastic lesions in lumbar vertebrae**.

Question: How has the carcinoma of prostate spread to the vertebrae without lung involvement?

Explanation:

- The **prostatic venous plexus** communicates directly with the **internal vertebral venous plexus (Batson's plexus)** via **vesical and sacral veins**.
- Since these veins are **valveless**, tumor cells can travel **retrogradely** to the vertebral column during raised intra-abdominal pressure.
- Thus, **prostate cancer metastasizes to vertebrae** bypassing pulmonary circulation.

Clinical significance:

- Explains **spinal metastases** seen early in prostatic carcinoma.
 - MRI of the spine is routinely done for prostate cancer staging.
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Case 2: Vertebral Metastasis from Uterine Carcinoma

A 55-year-old woman with **carcinoma cervix** develops **pain and weakness in her lower limbs**. MRI shows **lumbar vertebral deposits**.

Question: Through which venous pathway did the metastasis occur?

Explanation:

- The **utero vaginal venous plexus** communicates with the **internal vertebral venous plexus** through **sacral veins**.
 - As these veins are **valveless**, cancer cells may spread retrogradely to the **spinal venous system** and then to **vertebral bodies**.
 - Thus, **vertebral metastasis** from **pelvic carcinomas** occurs through **Batson's plexus**.
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Case 3: Spread of Pelvic Infection to Spine

A young man with **tuberculous prostatitis** later develops **vertebral tuberculosis (Pott's disease)** at the lower thoracic level.

Question: Explain the anatomical basis of this spread.

Explanation:

- Infection from the **pelvic venous plexus** spreads upward through **Batson's valveless venous system**.
 - The communication between **vesical, prostatic, and internal vertebral plexuses** allows bacteria to travel to the **vertebral bodies**.
 - This leads to **osteomyelitis or Pott's disease** of the spine without direct lymphatic involvement.
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Case 4: Epidural Venous Bleeding During Lumbar Puncture

During epidural anesthesia for labor, a patient develops **persistent bleeding** from the needle site.

Question: Which venous structure is most likely punctured?

Explanation:

- The **internal vertebral venous plexus**, lying in the **epidural space**, may be inadvertently damaged.
 - These veins are **thin-walled, valveless, and engorged during pregnancy or increased abdominal pressure**.
 - Accidental puncture causes **venous bleeding** and **hematoma formation**, compressing the spinal cord.
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Case 5: Retrograde Flow during Straining

During heavy lifting, a man experiences transient **headache and fullness in the head**.

Question: What explains this symptom anatomically?

Explanation:

- Straining increases **intra-abdominal pressure**, forcing blood **retrogradely** through the **valveless vertebral venous system** into the **cranial dural sinuses**.
 - This temporarily **raises intracranial venous pressure**, causing **congestion and headache**.
 - The same mechanism can raise **intracranial pressure** during **defecation, coughing, or childbirth**.
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Case 6: Spinal Cord Compression in Prostatic Cancer

A patient with advanced prostate carcinoma develops **paraplegia** due to **compression of the spinal cord** at the thoracolumbar junction.

Question: What is the likely route of spread and mechanism?

Explanation:

- Tumor cells spread via **Batson's plexus** to **vertebral bodies**.
- Secondary deposits erode the **vertebral cortex**, invading the **spinal canal**, compressing the **cord and roots**.
- This results in **neurological deficits (paraplegia)**.

Clinical correlation:

- Emergency **decompression and radiotherapy** are often needed.

- The vertebral venous plexus is thus a **silent pathway for metastatic compression syndromes**.
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Case 7: Skull Metastases from Pelvic Tumor

A 60-year-old man with advanced prostate carcinoma develops **bony swellings over skull vault** detected on bone scan.

Question: How did pelvic cancer cells reach the skull bones?

Explanation:

- The **internal vertebral venous plexus** communicates upward with the **occipital and basilar venous sinuses**.
 - Cancer cells travel cranially via this **valveless channel**, leading to **cranial bone metastasis** without pulmonary spread.
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Case 8: Epidural Abscess Following Pelvic Sepsis

A patient with **rectal abscess** develops **high-grade fever** and **neurological symptoms** of spinal cord compression. MRI reveals an **epidural abscess**.

Question: Explain the anatomical basis of this spread.

Explanation:

- Infection from the **pelvic venous plexuses** (rectal, vesical, or prostatic) can travel via **Batson's plexus** to the **epidural venous space**.
 - The **internal vertebral venous plexus** serves as a conduit for bacteria to reach the **spinal epidural space**, leading to abscess formation.
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Case 9: Vertebral Venous Congestion in Pregnancy

A pregnant woman in her third trimester complains of **backache** and **leg heaviness**.

Question: Why are such symptoms common in late pregnancy?

Explanation:

- The **enlarged uterus** compresses the **inferior vena cava**, redirecting blood through the **vertebral venous plexus**.
 - This causes **congestion of vertebral veins**, resulting in **back pain and leg discomfort**.
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Case 10: Clinical Significance during Epidural Anesthesia

During epidural anesthesia, a practitioner must avoid piercing **Batson's plexus** to prevent complications.

Question: Why is knowledge of this venous system crucial in this procedure?

Explanation:

- The **internal vertebral venous plexus** lies in the **epidural space**, especially enlarged in **pregnant women** or **patients with high abdominal pressure**.
 - Puncturing these veins can lead to **hematoma**, **inadequate anesthesia**, or **spinal cord compression**.
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Summary Insight:

The **vertebral venous system (Batson's plexus)** is an **anatomical highway without valves**, linking the **pelvis, vertebral column, and skull**.

While it ensures **pressure equalization**, it also becomes a **pathological corridor** for the **silent spread of infections and metastases**, particularly from the **prostate, uterus, bladder, and rectum**.

Its understanding is essential in **oncology, neurosurgery, obstetrics, and anesthesiology**, where this venous web often determines the outcome of both disease progression and intervention.

Frequently Asked Questions

Q1. What is Batson's plexus?

A. Batson's plexus, or the **vertebral venous system**, is a **valveless network of veins** that extends from the **pelvis to the skull**, connecting the **pelvic venous plexuses, thoracic veins**, and **cranial dural sinuses**. It provides an alternate route for venous return when normal flow is obstructed.

Q2. What are the main components of the vertebral venous system?

A.

1. **Internal vertebral venous plexus** — within the **vertebral canal** (in epidural space).
 2. **External vertebral venous plexus** — outside the vertebral column (anterior and posterior).
 3. **Intervertebral veins** — connect the internal and external plexuses through **intervertebral foramina**.
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Q3. Why is the vertebral venous system valveless?

A. The veins lack valves to permit **bidirectional blood flow**, helping maintain **equal venous pressure** between the **thoracic, abdominal, and pelvic cavities**, especially during changes in posture or pressure.

Q4. What is the functional importance of the valveless nature of Batson's plexus?

A.

- Allows **pressure equalization** across different body cavities.
 - Provides an **alternative venous route** during obstruction of the vena cava.
 - However, this same property facilitates **retrograde spread of infection and tumor cells**.
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Q5. With which venous systems does Batson's plexus communicate?

A.

- **Prostatic venous plexus (Santorini's plexus)**
 - **Vesical and uterovaginal plexuses**
 - **Internal and external iliac veins**
 - **Azygos and hemiazygos systems**
 - **Cranial dural sinuses** (via occipital and basilar sinuses)
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Q6. What is the anatomical location of the internal vertebral venous plexus?

A. It lies within the **epidural space** between the **dura mater** and **vertebral periosteum**, surrounding the spinal cord throughout its length.

Q7. What is the anatomical location of the external vertebral venous plexus?

A. It lies on the **outer surfaces of the vertebral bodies and arches**, divided into **anterior** and **posterior** groups, and communicates with the internal plexus through intervertebral veins.

Q8. What is the clinical significance of Batson's plexus?

A. It acts as a **route for the spread of malignancy or infection** between the **pelvis**, **vertebral column**, and **brain**, especially because it is **valveless**.

Q9. How does prostate cancer spread to the vertebral column?

A. Through **retrograde flow** from the **prostatic venous plexus** into the **internal vertebral venous plexus (Batson's plexus)**, bypassing the lungs.

Q10. What other pelvic cancers can spread through Batson's plexus?

A. **Carcinomas of rectum, bladder, uterus, and cervix** can metastasize to the **vertebral column or cranial bones** through this venous pathway.

Q11. What is the relation between Batson's plexus and intracranial venous sinuses?

A. The **internal vertebral venous plexus** communicates superiorly with the **occipital, basilar, and marginal dural venous sinuses** at the **foramen magnum**, forming a continuous **craniospinal venous channel**.

Q12. How does raised intra-abdominal pressure affect the vertebral venous system?

A. It causes **retrograde venous flow** through the valveless plexus, leading to **engorgement of vertebral veins** and **temporary rise in intracranial pressure** (e.g., during coughing, straining, or labor).

Q13. Why do vertebral metastases occur without lung involvement?

A. Because **Batson's plexus provides a direct route** from pelvic organs to vertebrae, **bypassing pulmonary circulation**.

Q14. How can pelvic infections spread to the vertebral column or brain?

A. Infections from the **pelvic venous plexuses** can travel **retrogradely** through Batson's plexus to the **vertebral venous channels** and **cranial sinuses**, leading to **osteomyelitis, epidural abscess, or meningitis**.

Q15. What is the clinical importance of Batson's plexus during epidural anesthesia?

A. The **internal vertebral venous plexus** may be punctured if the needle is inserted too deeply, especially in **pregnant women** (due to engorged veins), causing **bleeding or epidural hematoma**.

Q16. What is the relation of Batson's plexus to epidural hemorrhage?

A. Trauma or sudden pressure changes can **rupture the veins** of the **internal plexus**, leading to **epidural hematoma** and **spinal cord compression**.

Q17. What explains back pain in pregnancy?

A. The **gravid uterus** compresses the **inferior vena cava**, forcing blood through Batson's plexus ? **congestion of vertebral veins** ? **backache**.

Q18. Why is Batson's plexus important in neurosurgery and oncology?

A. Because it serves as a **direct venous link** between the **pelvis, vertebral column, and**

cranium, knowledge of its pathways helps in understanding **metastatic patterns**, planning **spinal surgeries**, and interpreting **spinal imaging**.

Q19. Which structures communicate via the lateral sacral veins?

A. The **lateral sacral veins** connect the **internal iliac veins** with the **internal vertebral venous plexus**, forming part of Batson's network.

Q20. What is the importance of the vertebral venous plexus in pressure regulation?

A. It serves as a **pressure-relief system** between the **cranial and pelvic cavities**, equalizing venous pressure during respiration and posture changes.

Q21. What is the difference between Batson's plexus and the azygos system?

- A.**
- **Batson's plexus:** Valveless, epidural, connects pelvis to skull.
 - **Azygos system:** Valved, paravertebral, connects thoracic wall veins to superior vena cava.
- However, both **communicate freely** and can serve as alternate venous channels.
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Q22. What happens to Batson's plexus in advanced prostate carcinoma?

A. It becomes a **conduit for metastatic spread** to **lumbar vertebrae, sacrum, and skull**, often presenting as **bone pain or paraplegia** due to spinal cord compression.

Q23. How can Batson's plexus lead to cranial metastasis?

A. Through **retrograde venous flow** to the **basilar and occipital sinuses**, allowing tumor cells from **pelvis** to reach **cranial bones or brain**.

Q24. Why are epidural veins more prone to rupture during surgery?

A. Because they are **valveless, thin-walled**, and **tethered within the epidural space**, especially when **engorged** during raised abdominal pressure or pregnancy.

Q25. How can Batson's plexus explain simultaneous spinal and brain metastases?

A. The **continuous valveless channel** permits tumor emboli to spread **both upward (to skull and brain)** and **downward (to spine)** without passing through the lungs.

Q26. What are the main clinical disorders associated with Batson's plexus?

A.

- **Spinal metastases** (prostate, uterine, rectal cancers)
 - **Epidural hematoma**
 - **Epidural abscess**
 - **Vertebral congestion in pregnancy**
 - **Retrograde cranial metastasis**
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Q27. How does Batson's plexus relate to the spread of tuberculosis?

A. Tuberculous infection from **pelvic or genitourinary organs** can spread through Batson's plexus, resulting in **Pott's disease (spinal tuberculosis)**.

Q28. Why is Batson's plexus called a "silent pathway"?

A. Because **disease spread** through it (like metastasis or infection) often occurs **without symptoms** until advanced, due to its **deep location and lack of valves**.

Q29. What is the role of the vertebral venous system during respiration?

A. Acts as a **pressure buffer**, accommodating venous blood shifts between **thorax and abdomen** during respiratory movements.

Q30. What is the practical surgical importance of Batson's plexus?

A. Knowledge of its location and communications helps **avoid venous injury** during **spinal and pelvic surgeries** and explains **unusual metastatic routes** seen in imaging and autopsy.

Multiple Choice Questions

1. The vertebral venous system (Batson's plexus) is characterized by:

- A. Presence of valves
- B. Absence of valves
- C. Lymphatic communications only
- D. Connection only with the azygos system

? Answer: B. Absence of valves

2. The internal vertebral venous plexus lies in which space?

- A. Subdural space
- B. Subarachnoid space
- C. Epidural space
- D. Subpial space

? Answer: C. Epidural space

3. The internal vertebral venous plexus is located between:

- A. Dura mater and arachnoid mater
- B. Arachnoid mater and pia mater
- C. Dura mater and vertebral periosteum
- D. Pia mater and spinal cord

? Answer: C. Dura mater and vertebral periosteum

4. The external vertebral venous plexus lies:

- A. Inside the vertebral canal
- B. On the outer surfaces of vertebral bodies and arches
- C. Within the dura mater
- D. In the subarachnoid space

? Answer: B. On the outer surfaces of vertebral bodies and arches

5. Which of the following veins connect the internal and external vertebral venous plexuses?

- A. Basilar veins

- B. Intervertebral veins
- C. Sacral veins
- D. Lumbar veins

? Answer: B. Intervertebral veins

6. The vertebral venous system communicates with which pelvic venous plexus in males?

- A. Rectal venous plexus
- B. Prostatic venous plexus
- C. Pampiniform plexus
- D. Inferior mesenteric venous plexus

? Answer: B. Prostatic venous plexus

7. In females, the vertebral venous system communicates with which plexus?

- A. Pampiniform plexus
- B. Uterovaginal venous plexus
- C. Ovarian venous plexus
- D. Vesical venous plexus only

? Answer: B. Uterovaginal venous plexus

8. The vertebral venous system connects superiorly with:

- A. Cavernous sinus
- B. Inferior sagittal sinus
- C. Basilar and occipital sinuses
- D. Straight sinus

? Answer: C. Basilar and occipital sinuses

9. Which of the following is *not* a feature of Batson's plexus?

- A. It is valveless
- B. It connects pelvic and cranial venous systems
- C. It lies within the subarachnoid space
- D. It can serve as a route for metastasis

? Answer: C. It lies within the subarachnoid space

10. The vertebral venous plexus communicates inferiorly with:

- A. Common iliac veins
- B. External iliac veins
- C. Internal iliac veins
- D. Hepatic veins

? Answer: C. Internal iliac veins

11. Why is the vertebral venous system clinically important?

- A. It provides oxygen to spinal cord
- B. It allows retrograde spread of infection and cancer
- C. It drains cerebrospinal fluid
- D. It regulates lymphatic flow

? Answer: B. It allows retrograde spread of infection and cancer

12. The main reason prostate carcinoma spreads to vertebrae is:

- A. Lymphatic drainage to lumbar nodes
- B. Arterial embolism
- C. Communication between prostatic and vertebral venous plexuses
- D. Direct extension through rectum

? Answer: C. Communication between prostatic and vertebral venous plexuses

13. The vertebral venous plexus lacks valves, hence blood can flow:

- A. Only upward
- B. Only downward
- C. In both directions
- D. Only toward azygos vein

? Answer: C. In both directions

14. The vertebral venous plexus communicates with the cranial cavity via:

- A. Sigmoid sinus
- B. Basilar venous plexus
- C. Superior sagittal sinus
- D. Inferior petrosal sinus

? Answer: B. Basilar venous plexus

15. During epidural anesthesia, bleeding may occur due to injury to:

- A. Azygos vein
- B. Internal vertebral venous plexus
- C. Basilar venous plexus
- D. Superior sagittal sinus

? Answer: B. Internal vertebral venous plexus

16. Which of the following statements about Batson's plexus is **true**?

- A. It contains valves that prevent backflow
- B. It connects pelvic veins to vertebral and cranial veins
- C. It drains only thoracic organs
- D. It has no connection with internal iliac veins

? Answer: B. It connects pelvic veins to vertebral and cranial veins

17. Increased intra-abdominal pressure causes:

- A. Collapse of Batson's plexus
- B. Retrograde flow through Batson's plexus
- C. Cessation of venous return
- D. Spasm of vertebral veins

? Answer: B. Retrograde flow through Batson's plexus

18. Vertebral metastases without lung involvement occur due to:

- A. Azygos venous route
- B. Vertebral arterial spread
- C. Vertebral venous (Batson's) plexus
- D. Lymphatic spread

? Answer: C. Vertebral venous (Batson's) plexus

19. Which of the following best describes the function of Batson's plexus?

- A. Drains cerebrospinal fluid
- B. Equalizes venous pressure between cavities
- C. Prevents spread of infection
- D. Contains lymph nodes for filtration

?

Answer:

B.

Equalizes

venous

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20. The vertebral venous plexus is directly related to which potential complication during spinal surgery?

- A. Damage to sympathetic chain
- B. Epidural hematoma formation
- C. Lymphatic blockage
- D. Arterial spasm

? Answer: **B. Epidural hematoma formation**

Viva Voce

Q1. What is Batson's plexus?

A. It is a **valveless vertebral venous network** extending from the **pelvis to the skull**, connecting **pelvic veins, thoracic veins, and cranial dural sinuses**.

Q2. Why is Batson's plexus clinically important?

A. Because it provides a **pathway for the spread of infection and metastasis** from pelvic organs (like prostate and uterus) to the **vertebral column and skull**, bypassing the lungs.

Q3. Where is the internal vertebral venous plexus located?

A. In the **epidural space**, between the **dura mater and vertebral periosteum**.

Q4. What are the components of the vertebral venous system?

A.

1. **Internal vertebral venous plexus**
 2. **External vertebral venous plexus**
 3. **Intervertebral veins** connecting the two
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Q5. What is the main difference between the internal and external vertebral venous plexuses?
A. The **internal plexus** lies within the **vertebral canal**, while the **external plexus** lies **outside the vertebral column** on the vertebral bodies and arches.

Q6. Why are veins of Batson's plexus valveless?
A. To allow **free bidirectional flow of blood**, ensuring **pressure equalization** between thoracic, abdominal, and pelvic cavities.

Q7. Which pelvic venous plexus communicates with Batson's plexus in males?
A. The **prostatic venous plexus (Santorini's plexus)**.

Q8. Which pelvic venous plexus communicates with Batson's plexus in females?
A. The **uterovaginal venous plexus**.

Q9. Which sinuses in the cranial cavity communicate with Batson's plexus?
A. The **basilar, occipital, and marginal sinuses**.

Q10. Through which veins does Batson's plexus connect to pelvic veins?
A. Through the **lateral sacral veins** which link the **internal iliac veins** to the vertebral venous plexus.

Q11. What are the clinical implications of its valveless nature?
A. Allows **retrograde flow of tumor cells or infections**, explaining **vertebral and cranial metastases** from pelvic malignancies.

Q12. How does prostate cancer reach the vertebral column?
A. By **retrograde spread** through the **prostatic venous plexus** into the **internal vertebral venous plexus (Batson's plexus)**.

Q13. Why can metastasis occur without pulmonary involvement?
A. Because Batson's plexus provides a **direct venous route** from the pelvis to the vertebral and cranial veins, **bypassing the lungs**.

Q14. How does Batson's plexus contribute to epidural hematoma?

A. The **internal vertebral venous plexus** lies in the **epidural space** and may rupture due to trauma or surgical injury, causing **venous bleeding and hematoma**.

Q15. Why does backache occur in late pregnancy?

A. The **enlarged uterus** compresses the **inferior vena cava**, redirecting blood through Batson's plexus ? **venous congestion** of the vertebral veins ? **back pain**.

Q16. What happens to intracranial pressure during straining or coughing?

A. It **risks temporarily** because blood is forced **retrogradely through Batson's plexus** to the cranial venous sinuses.

Q17. What is the relation of Batson's plexus to Pott's disease?

A. **Tuberculous infection** from the genitourinary tract can spread via Batson's plexus to the **vertebral bodies**, producing **spinal tuberculosis**.

Q18. Why is Batson's plexus called a "silent pathway"?

A. Because it allows **disease spread** (like metastasis or infection) **without obvious symptoms**, due to its deep and valveless structure.

Q19. What is the difference between Batson's plexus and the azygos system?

A.

- **Batson's plexus:** Valveless, epidural, connects pelvis to skull.
 - **Azygos system:** Valved, paravertebral, drains thoracic wall into superior vena cava.
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Q20. What is the functional role of Batson's plexus during respiration?

A. Acts as a **pressure buffer**, accommodating venous blood shifts between the **thoracic and abdominal cavities**.

Q21. Why must care be taken during epidural anesthesia?

A. Because **engorged internal vertebral veins** may be injured, leading to **bleeding or**

hematoma formation.

Q22. What type of blood flow occurs in Batson's plexus?

A. Bidirectional flow, depending on changes in intra-abdominal or intrathoracic pressure.

Q23. What structures are drained by Batson's plexus?

A. Vertebral bodies, meninges, and spinal cord, with communications to **pelvic and cranial veins**.

Q24. How does Batson's plexus aid in pressure regulation?

A. It helps equalize venous pressure between **cranial, thoracic, and abdominal cavities**, especially during posture changes.

Q25. Why is understanding Batson's plexus essential in oncology?

A. Because it explains vertebral and cranial metastases from pelvic malignancies like **prostate, rectal, and uterine cancers**, even when lungs are free of metastasis.

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