The Rectum & anal canal

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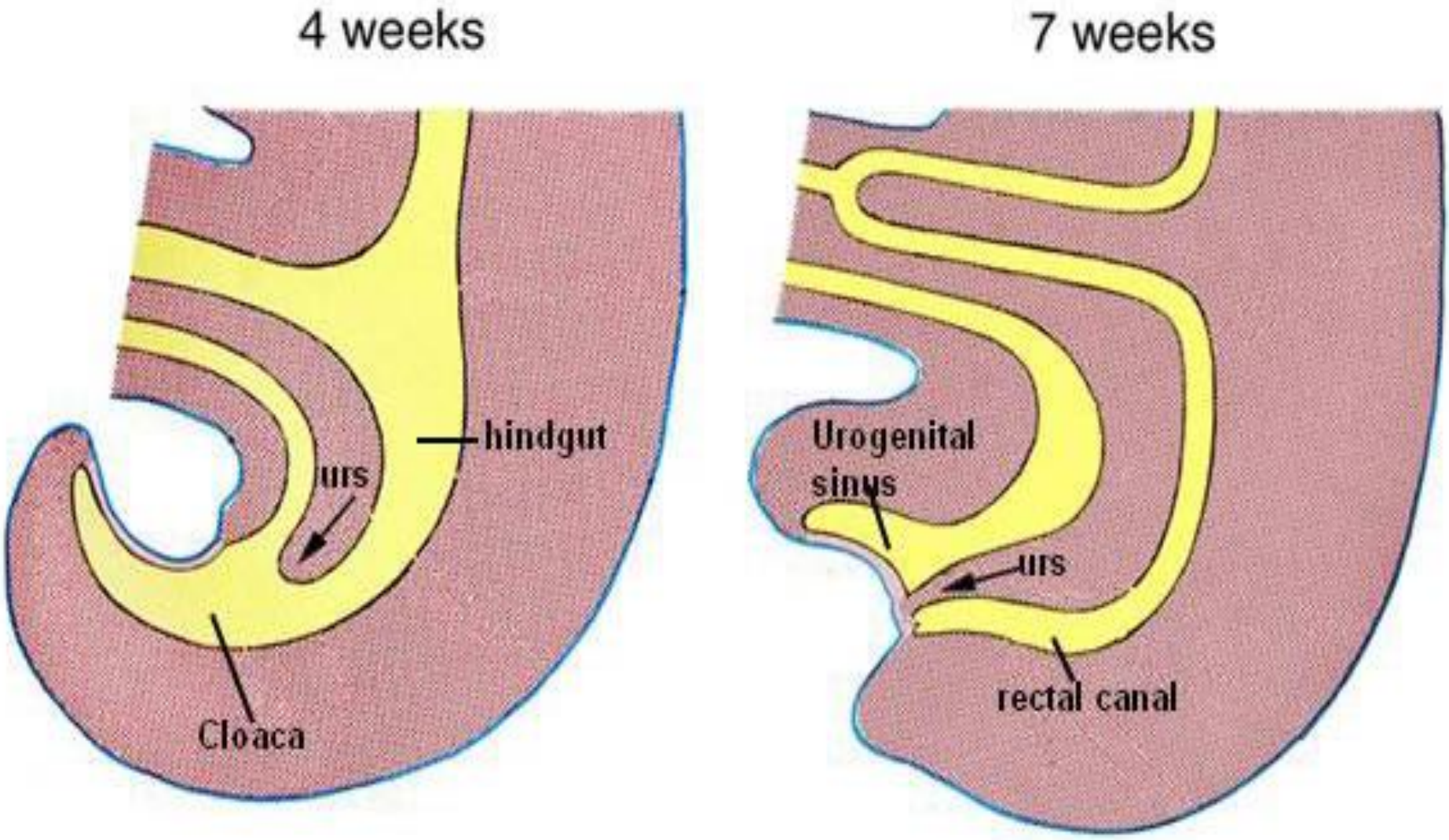
DEVELOPMENT OF RECTUM

Primitive gut- from endodermal roof of yolk sac at beginning of 3rd week.

- **foregut.**
- **midgut.**
- **hindgut.**

- The upper and middle thirds of the rectum which are related to peritoneum develop from the hindgut.
- The lower third which is devoid of peritoneum develops from cloaca.

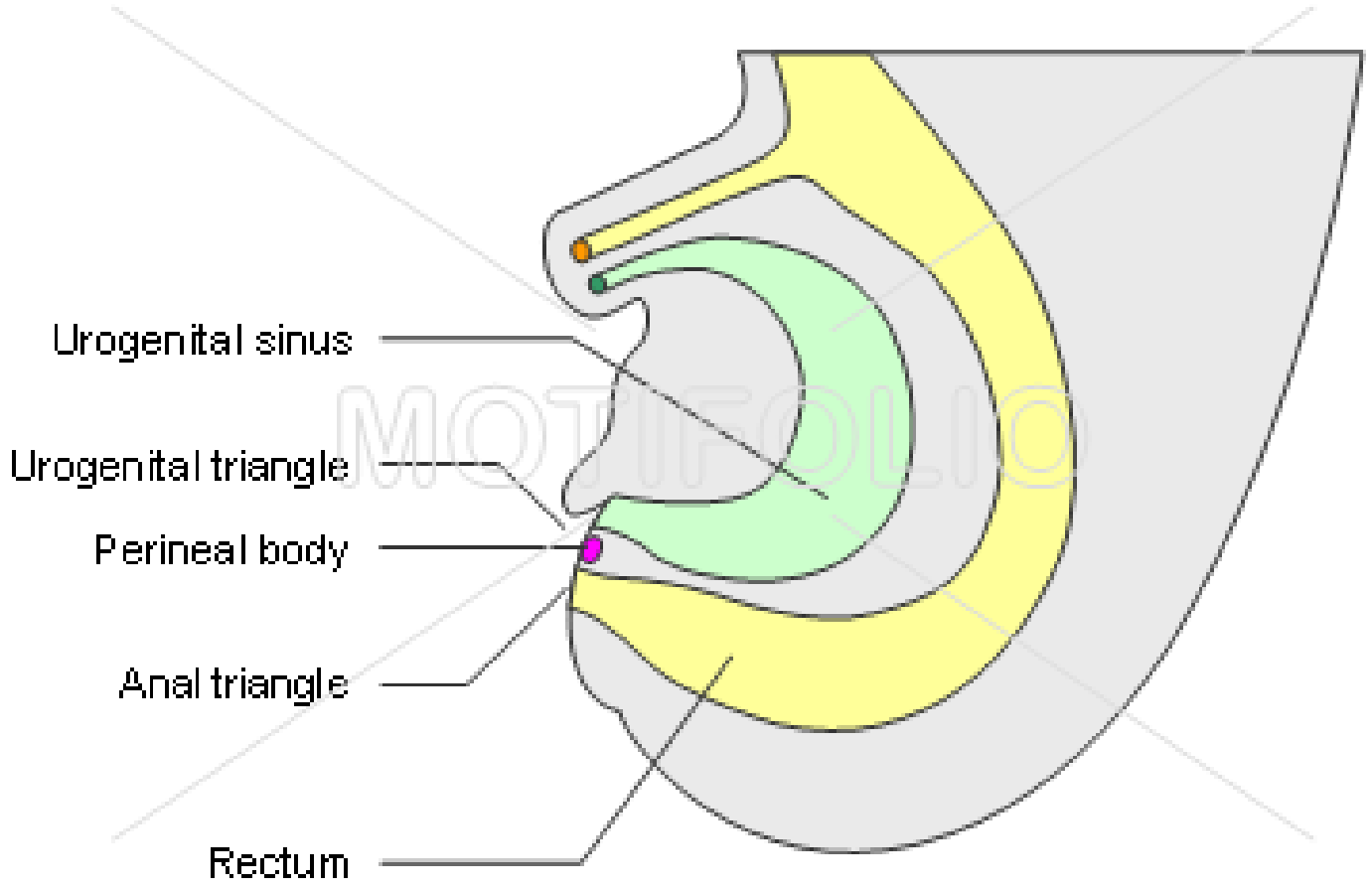
Embryology


4 weeks
7 weeks
hindgut
urs
Cloaca
Urogenital sinus
urs
rectal canal

Cloaca

- Common chamber into which hindgut & allantois open.
- Lined by endoderm & separated from surface ectoderm by cloacal membrane.
- Urorectal septum divides it into dorsal(rectum) & ventral (urogenital sinus).
- Dorsal part of cloacal membrane-⟹ anal membrane-outer ectoderm,inner endoderm.-resorption of anal mem. By 8th wk-anal canal.
- Lower part of urorectal septum- perineal body.

Subdivisions of the cloaca and formation of the anorectal canal – 8 weeks



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Anatomy of the Rectum

General

- The rectum is the distal part of the large gut placed between the sigmoid colon above and the anal canal below.

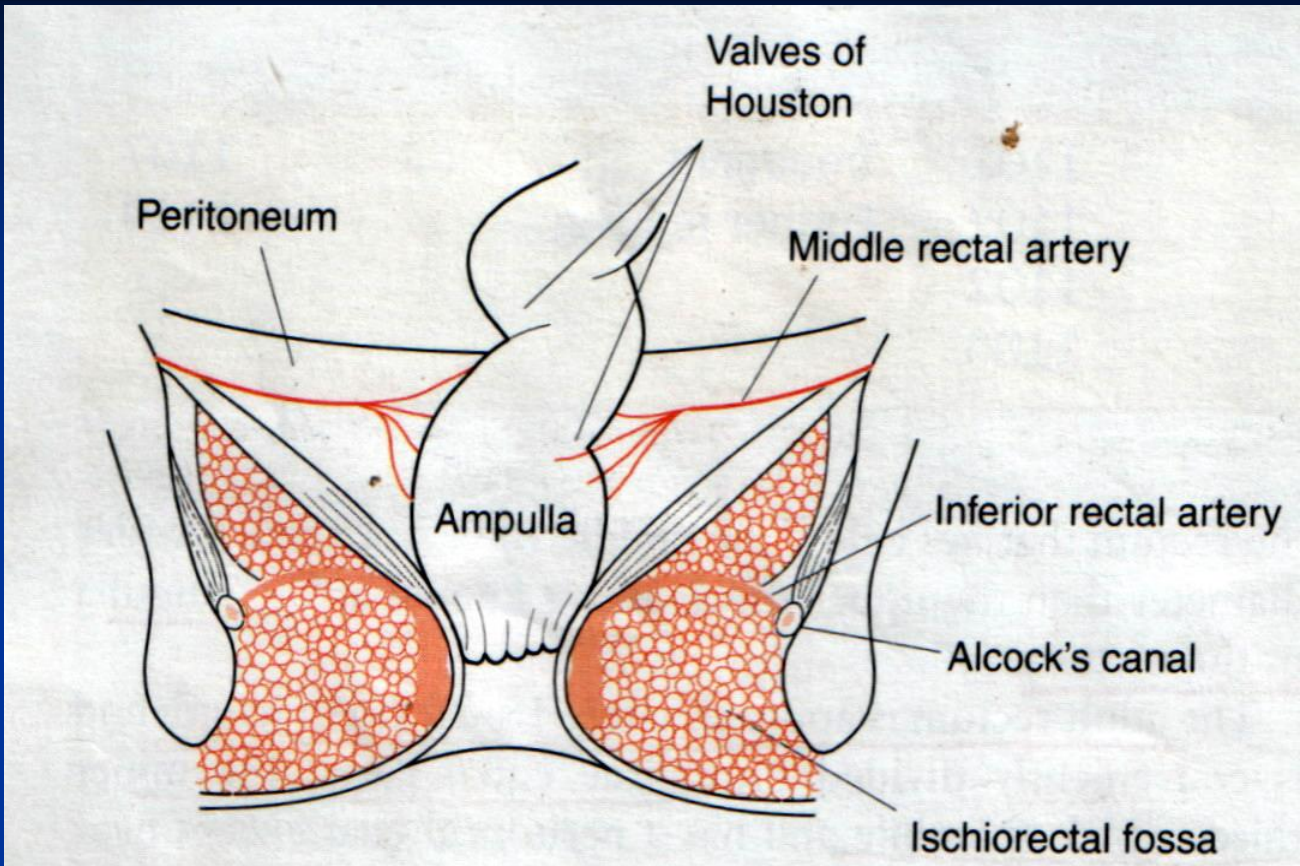


Fig. 60.2 Diagram showing the rectum lying in the pelvis (coronal view). Note the curvatures corresponding to Houston's valves.

- Surgically the rectosigmoid junction lies opposite the sacral promontory to end at the anorectal junction.
- Adult rectum is approximately 12-15 cm long.

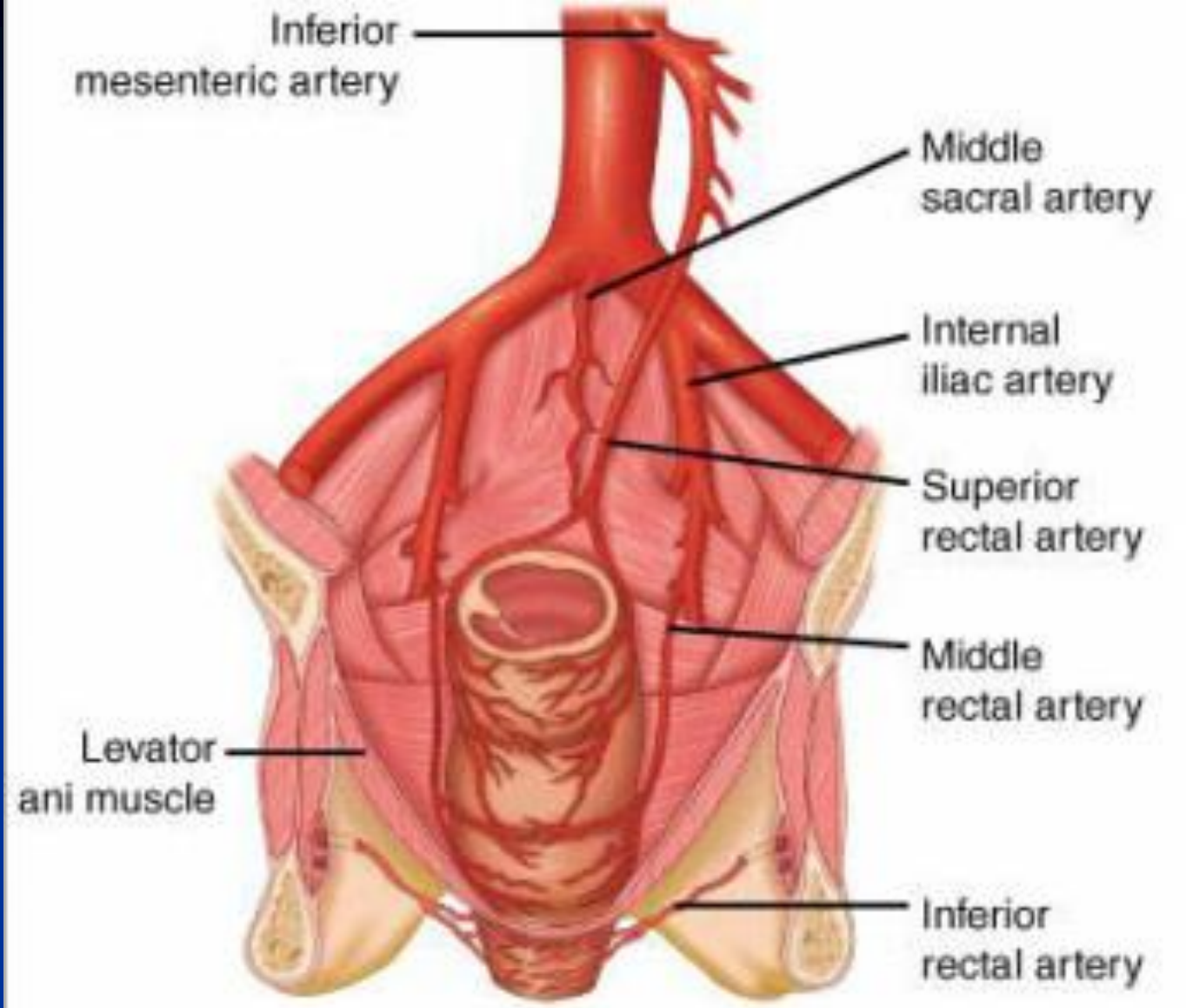
General

- The rectum has 3 lateral curvatures. Upper and lower are convex to the right and the middle is convex to the left.
- The curvatures are marked internally by semicircular folds of mucosa (Houston's valves).
  - Left 2 at 7-8 cm & 12-13 cm from anal verge.
  - Right 1 at 9-11cm from anal verge-most prominent & consistent.
- The dilated part of rectum below the middle valve is known as the rectal ampulla.
- From the anal verge, these three parts are **defined** as follows: the lower **rectum**, 0 to 6 cm; the **middle rectum**, 7 to 11 cm; and the upper **rectum**, 12 to 15 cm

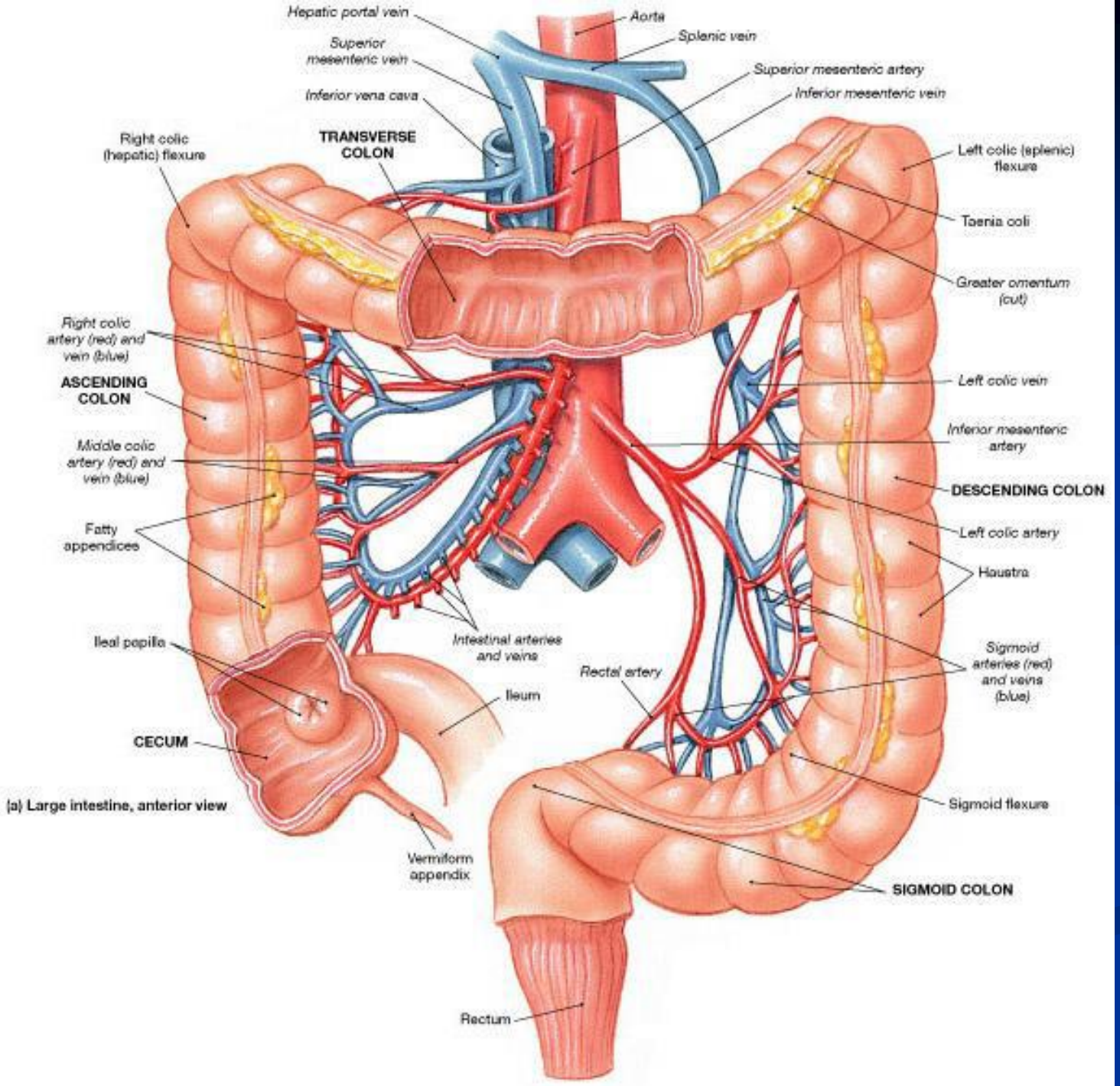
- Rectum is divided into 3 equal parts.
  1. Upper 1/3rd is covered with peritoneum in front and on the sides.

  2. Middle 1/3rd is covered by peritoneum only in the front.

  3. The lower 1/3rd is devoid of peritoneum. It is separated from the prostate in front by *Denonvillier's fascia* and from the coccyx and last 2 pieces of sacrum behind by *Waldeyer's fascia*.



Arterial supply to the rectum and anal canal.

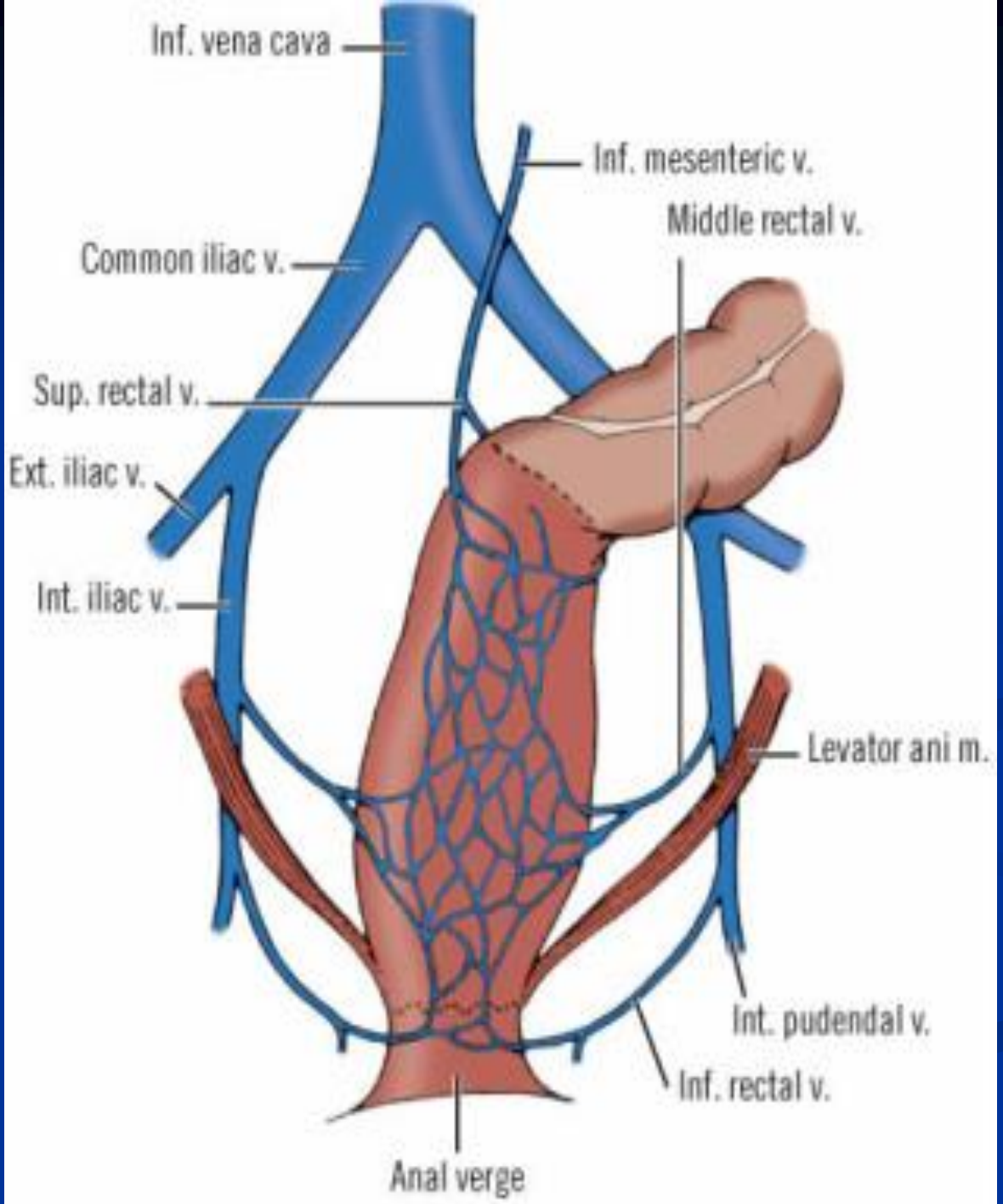

Hepatic portal vein
Aorta
Superior mesenteric vein
Splenic vein
Superior mesenteric artery
Inferior vena cava
Inferior mesenteric vein
Right colic (hepatic) flexure
TRANSVERSE COLON
Left colic (splenic) flexure
Taenia coli
Greater omentum (cut)
Right colic artery (red) and vein (blue)
ASCENDING COLON
Left colic vein
Inferior mesenteric artery
Middle colic artery (red) and vein (blue)
DESCENDING COLON
Fatty appendices
Left colic artery
Haustra
Ileal papilla
Intestinal arteries and veins
Sigmoid arteries (red) and veins (blue)
Rectal artery
Ileum
CECUM
Sigmoid flexure
(a) Large intestine, anterior view
Vermiform appendix
SIGMOID COLON
Rectum

Arterial supply

- The *Superior Rectal Artery* (continuation of the IMA) is the main arterial supply. Opposite S3 vertebrae it divides into rt & lt br in 80% cases, multiple br. in 17% cases.

- The *Middle Rectal Artery* arises from the internal iliac artery.

- The *Inferior Rectal Artery* arises from internal pudendal artery as it enter Alcock's canal.


Inf. vena cava
Inf. mesenteric v.
Middle rectal v.
Common iliac v.
Sup. rectal v.
Ext. iliac v.
Int. iliac v.
Levator ani m.
Int. pudendal v.
Inf. rectal v.
Anal verge

Anatomy of the Rectum

Venous drainage

- *Superior Rectal Vein*: Formed by the union of about 6 tributaries from the internal rectal venous plexus in the anal canal. The superior rectal vein which continues upwards as the inferior mesenteric vein forming part of the portal system.

- *Middle rectal vein*: drain into the internal iliac veins and only become important when normal paths are blocked.

Lymphatic drainage

- Lymphatics from >upper half of the rectum pass along the superior rectal vessels to the inferior mesenteric nodes through the paratrectal (Gerota) and sigmoid nodes.

- Lymphatics from the lower half of rectum pass along the middle rectal vessels to the internal iliac nodes.

- The usual drainage flow is upwards. For this reason, surgical ablation of malignant disease involve mainly wide clearance of the proximal lymph nodes.

Lymphatic Drainage

The submucous and subserous lymphatic plexuses drain into an extramural lymph channels follow their vascular supply.

Colorectal lymph nodes are classically divided into 4 groups:

- epiploic,
- paracolic,
- intermediate, and
- principal.

- The epiploic group
  - lies on the bowel wall under the peritoneum and in the appendices epiploicae;
  - more numerous in the sigmoid and
  - in the rectum- nodules of Gerota.

- The paracolic nodes-
  - along the marginal artery and on the arcades.

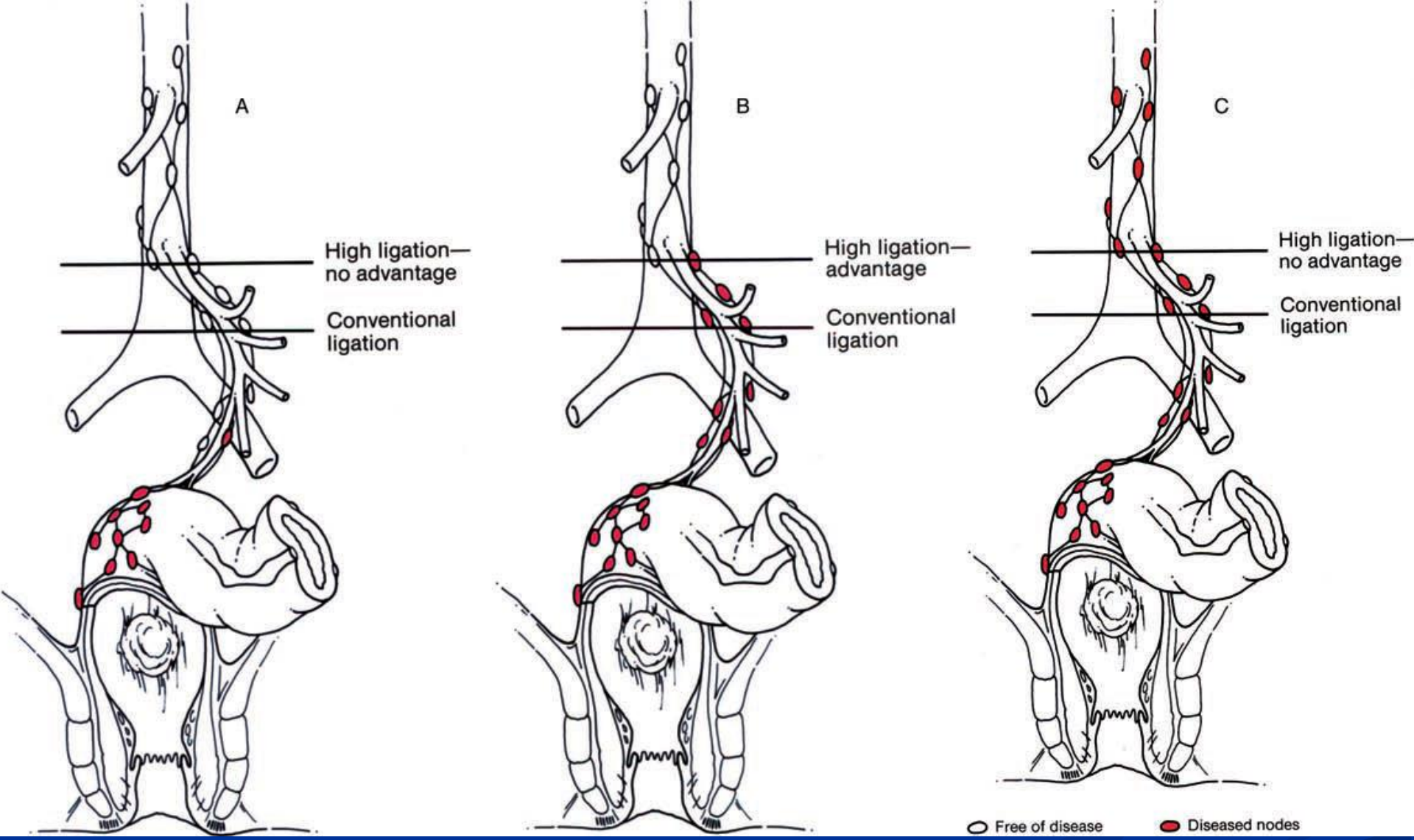
- The intermediate nodes
  - on the primary colic vessels.

- The main or principal nodes
  - on the superior and inferior mesenteric vessels.

The lymph then drains to the cisterna chyli via the paraaortic chain of nodes.

Ligation of IMA

- Flush –at its origin at the root of aorta-not done to preserve sympathetic plexus.
- High-1-2 cm distal to its origin.
  - If palpable nodes at the base of the vessels
  - When max. length of left colon is required.
- Low –below the origin of the left colic artery.



Potential value of high ligation of IMA. (A) Conventional low ligation would be sufficient. (B) High ligation provides potential benefit. (C) Proximal lymphatic spread is beyond confines of even high ligation.

Dukes' staging –

A- Invasion of but not breaching the muscularis propria

B- Breaching the muscularis propria but not involving lymph nodes

C-Lymph nodes involved

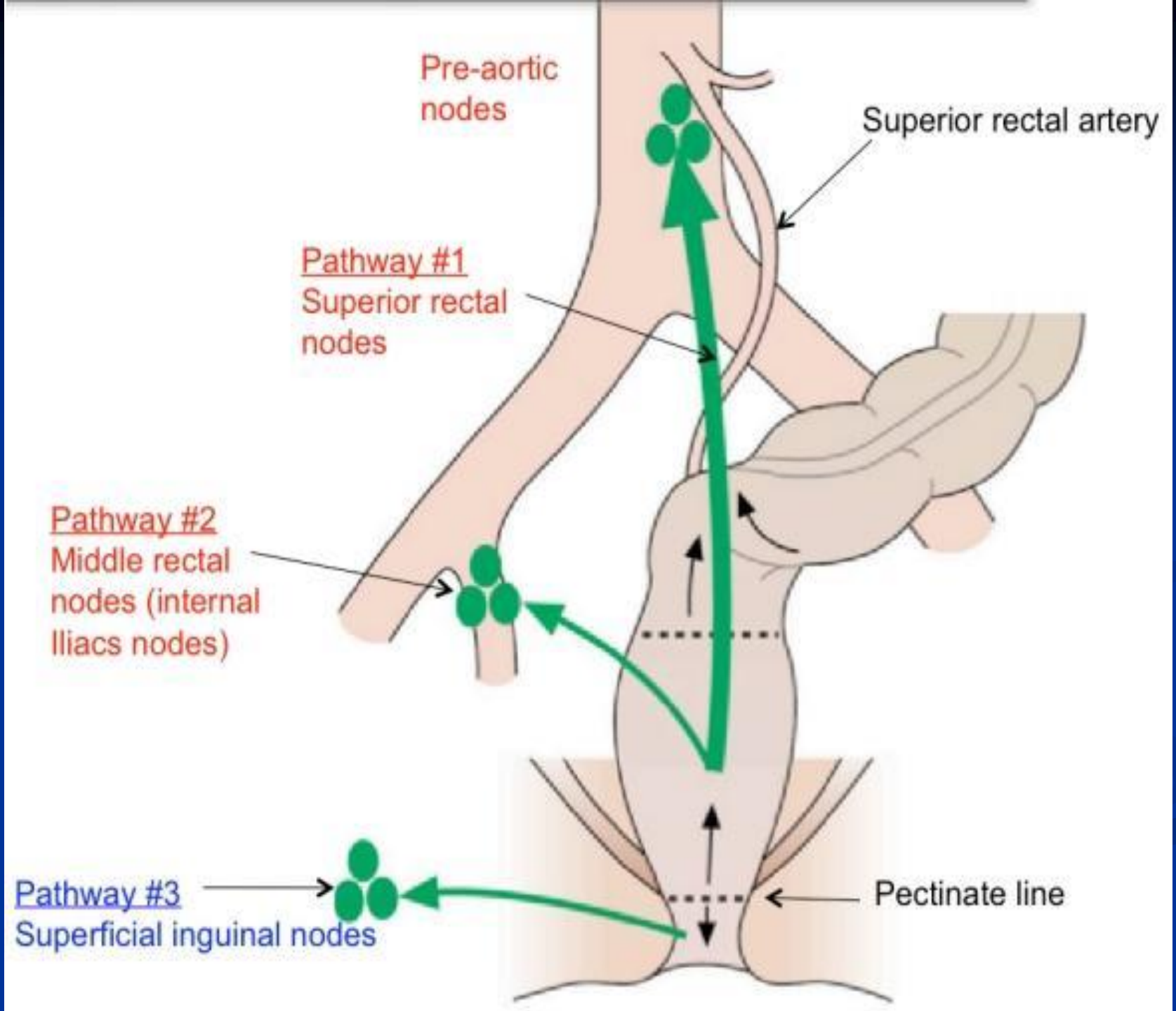
Dukes himself never described a stage D, but this is often used to describe metastatic disease

High ligation is of no value-

- in the treatment of Dukes' A and B lesions,
- in metastases.

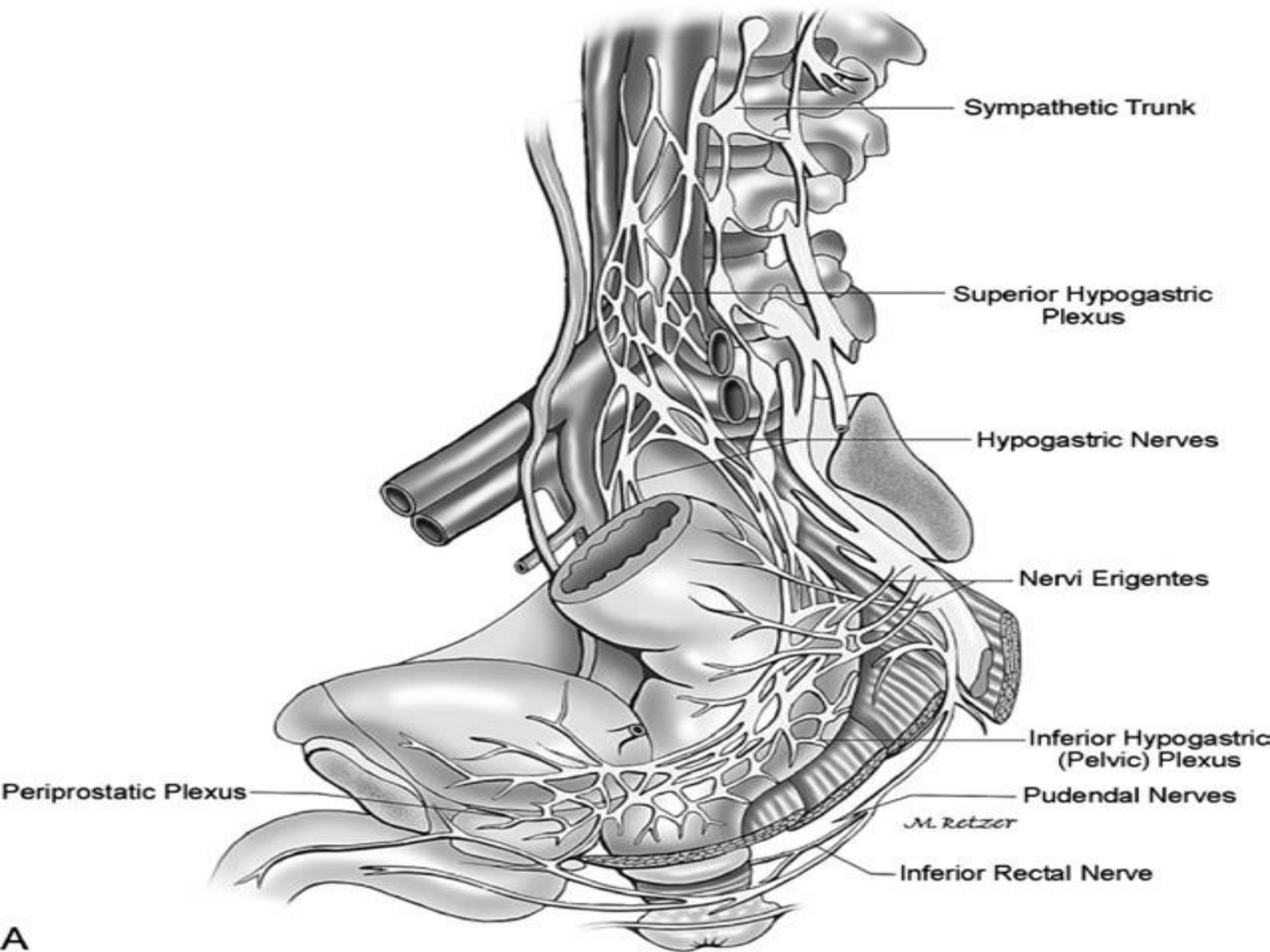
High ligation is of potential benefit-

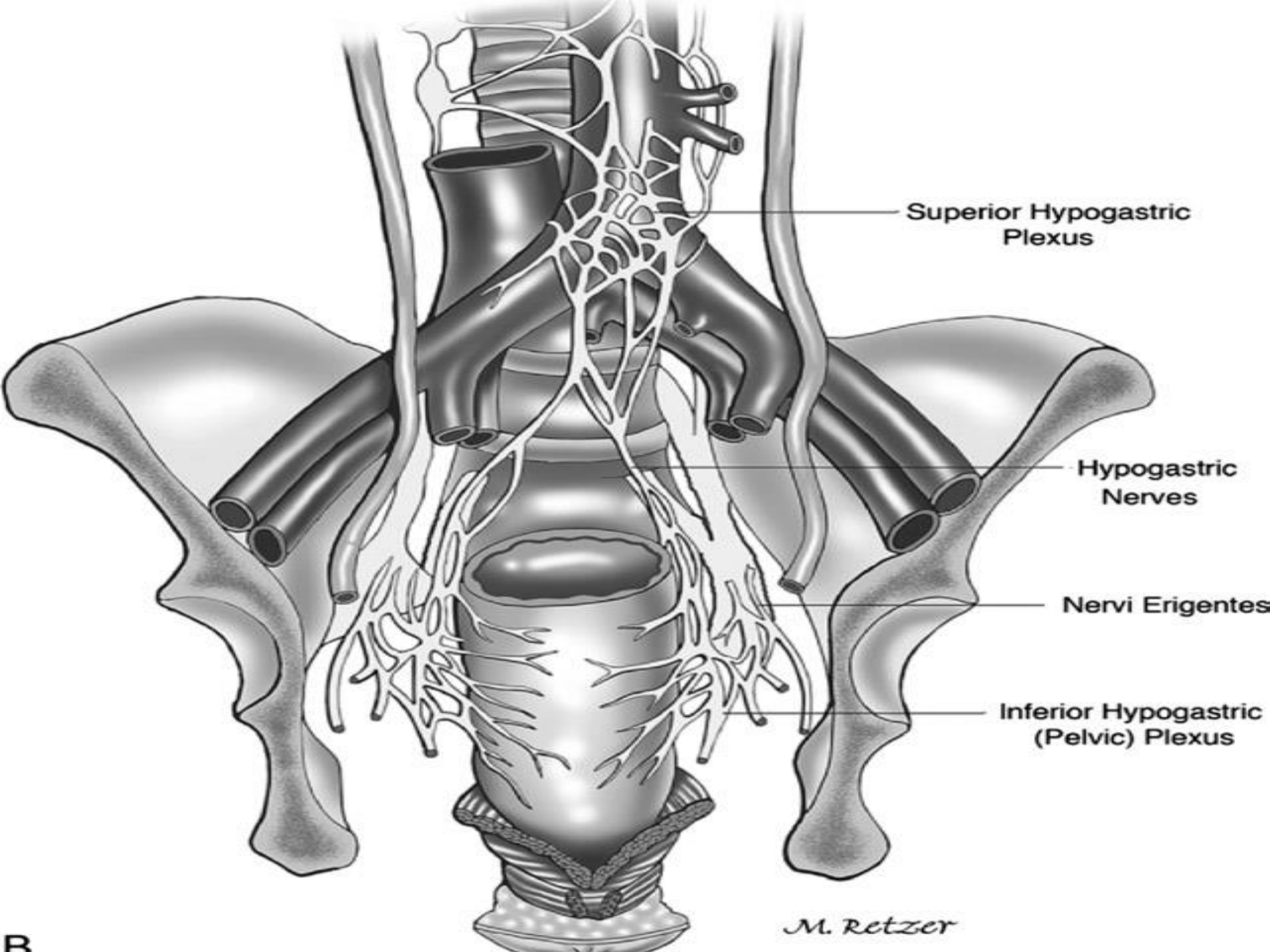
- to Dukes' C lesion only when nodal metastases have spread to a level proximal to the left colic artery but have not spread to the origin of the inferior mesenteric artery.


Pre-aortic nodes
Superior rectal artery
Pathway #1
Superior rectal nodes
Pathway #2
Middle rectal nodes (internal Iliacs nodes)
Pathway #3
Superficial inguinal nodes
Pectinate line

Nerve supply

- The rectum is supplied by both sympathetic (L1,L2) and parasympathetic (S2,S3,S4)-nervi eregentes.
- *Sympathetic-* vasoconstrictor, motor to internal sphincter, inhibitory to musculature.
- *Parasympathetic-* motor to musculature, inhibitory to internal sphincter, carries sensation of distension.


Sympathetic Trunk
Superior Hypogastric Plexus
Hypogastric Nerves
Nervi Erigentes
Inferior Hypogastric (Pelvic) Plexus
Periprostatic Plexus
Pudendal Nerves
M. Retzer
Inferior Rectal Nerve
A


Superior Hypogastric Plexus
Hypogastric Nerves
Nervi Erigentes
Inferior Hypogastric (Pelvic) Plexus
M. Retzer
B

- During high ligation of the IMA-
  - close to the aorta, the sympathetic preaortic nerves may be injured.
- During dissection at the level of sacral promontory or in the presacral region
  - Division of both superior hypogastric plexus and hypogastric nerves- sympathetic denervation with intact nervi erigentes - retrograde ejaculation and bladder dysfunction.

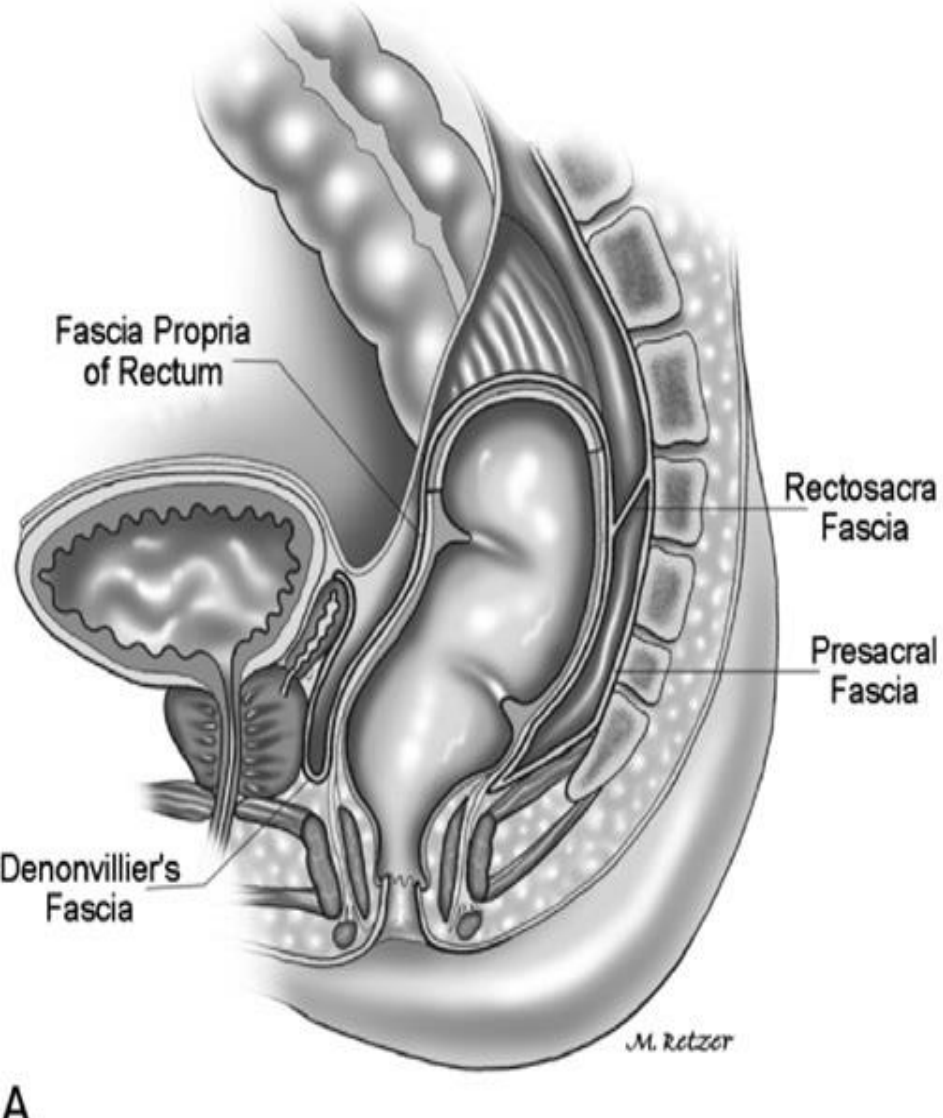
- During dissection of posterolateral aspect of pelvis-
  - The nervi erigentes are located in the posterolateral aspect of the pelvis, Injury to these nerves completely abolishes erectile function.

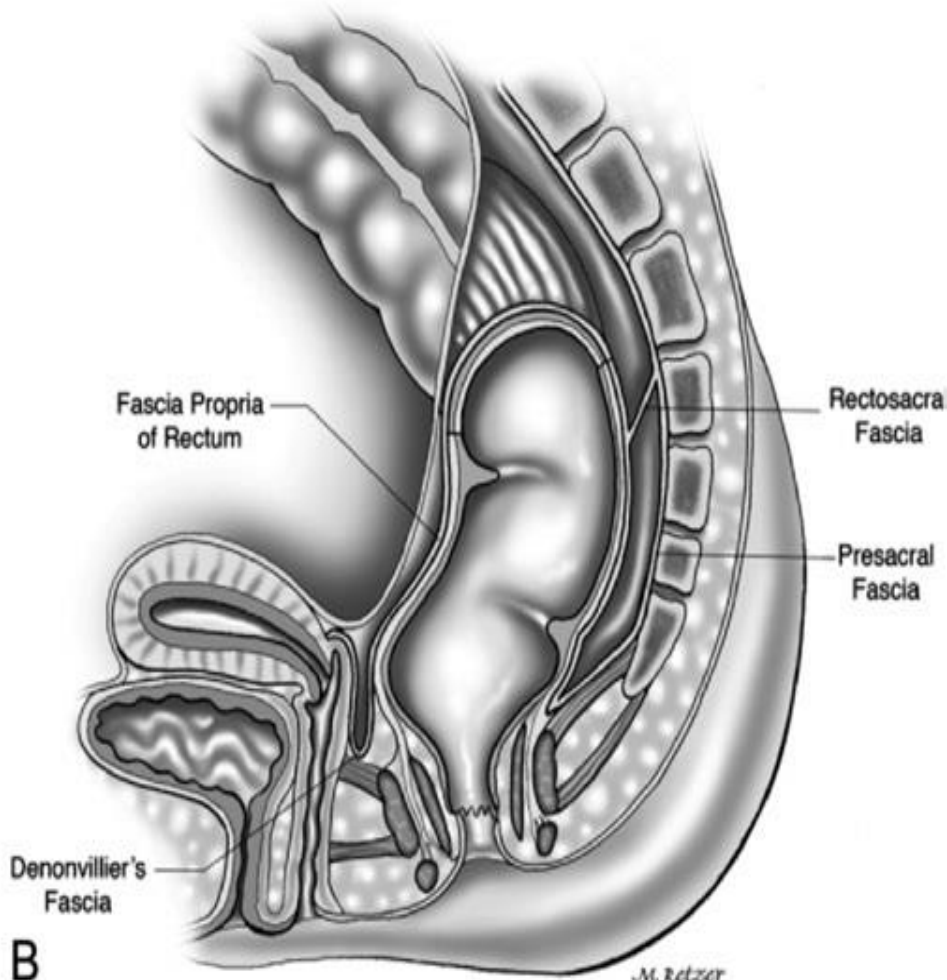
- The pelvic plexus may be damaged
  - either by excessive traction on the rectum, particularly laterally, or
  - during division of the lateral stalks when this is performed close to the lateral pelvic wall.

Relations of the Rectum

	Male	Female
Anterior	1. Bladder 2. Seminal Vesicle 3. Ureters 4. Prostate 5. Urethra	1. Pouch of Douglas 2. Uterus 3. Cervix 4. Posterior vaginal wall
Lateral	1. Lateral ligaments 2. Middle rectal artery 3. Obturator internus muscle 4. Side wall of pelvis 5. Levator ani muscle	1. Lateral ligaments 2. Middle rectal artery 3. Obturator internus muscle 4. Side wall of pelvis 5. Levator ani muscle
Posterior	1. Sacrum & coccyx 2. Loose areolar tissue 3. Fascial condensation 4. Superior rectal artery 5. Lymphatics	1. Sacrum & coccyx 2. Loose areolar tissue 3. Fascial Condensation 4. Superior rectal artery 5. Lymphatics

Fascial relationships of the rectum:





Supports of the Rectum

1. Pelvic floor: formed by the levator ani muscle

2. Fascia of Waldeyer: extension of presacral fascia –from 4th sacral vertebrae to just above anorectal ring- attaches the lower part of the rectal ampulla to the sacrum.

3. Lateral ligaments of the Rectum: condensation of pelvic fascia. Apex to the rectum and triangular base to the posterolateral walls of the lesser pelvis. Contains middle rectal artery-25% cases.

4. Rectovesical fascia of Denonviliers: extends from the rectum to the seminal vesicles and prostate in front

5. Pelvic peritoneum, sacral curvature,fat.

6. Perineal body with its muscles

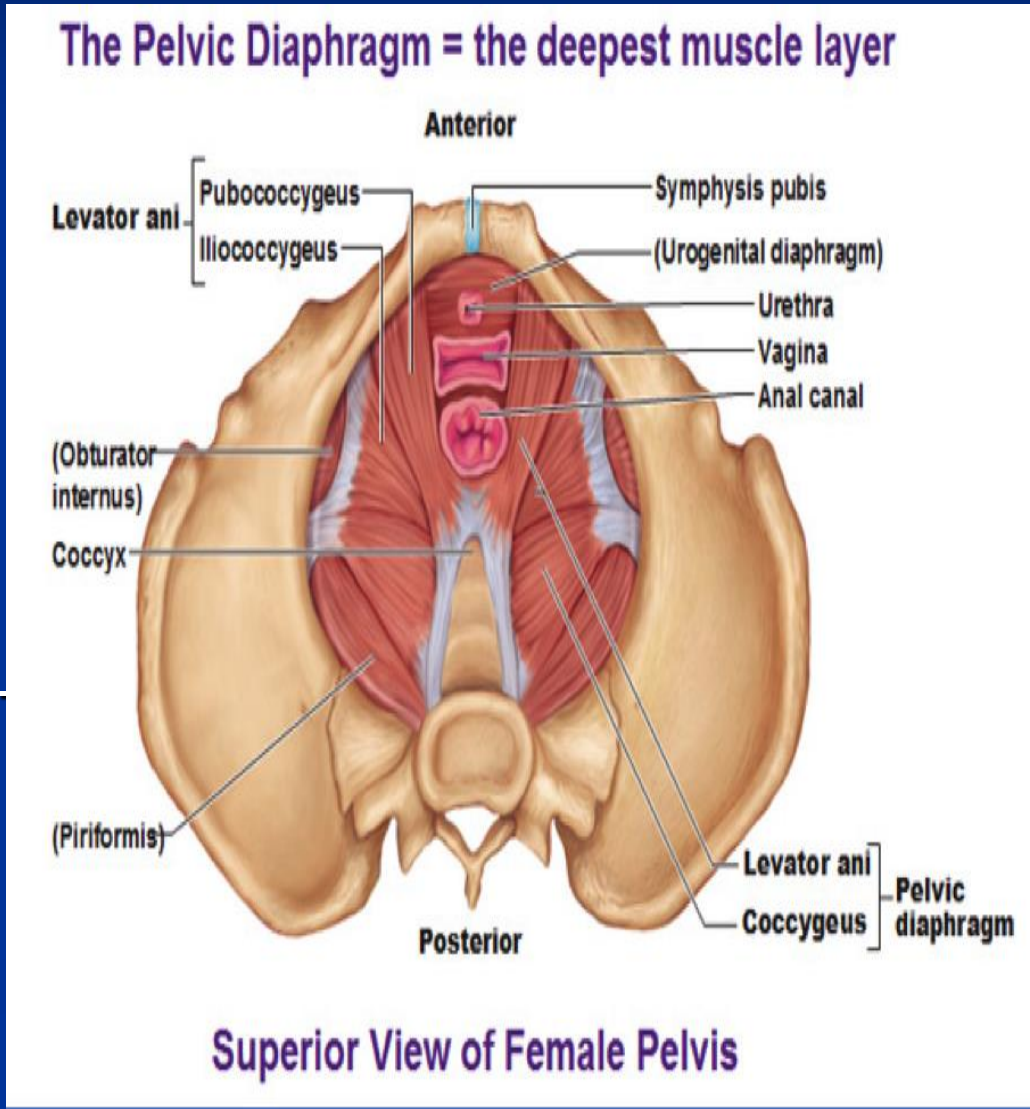
Clinical importance

- Prolapse is thought to commence as an intususception of rectum starts with anterior wall where supporting tissues are weakest specially in woman.

Pelvic diaphragm

- Pelvic diaghragm/ levator ani muscle-3 striated muscle-
  - Ileococcygeus.
  - Pubococcygeus
  - Puborectalis.

  Levator hiatus- space btw 2 pubococcygeus-
  - Lower rectum
  - Urethrae
  - Dorsal v. of penis
  - Vagina.



A line connecting the ischial tuberosities divides perineum into 2 triangles:

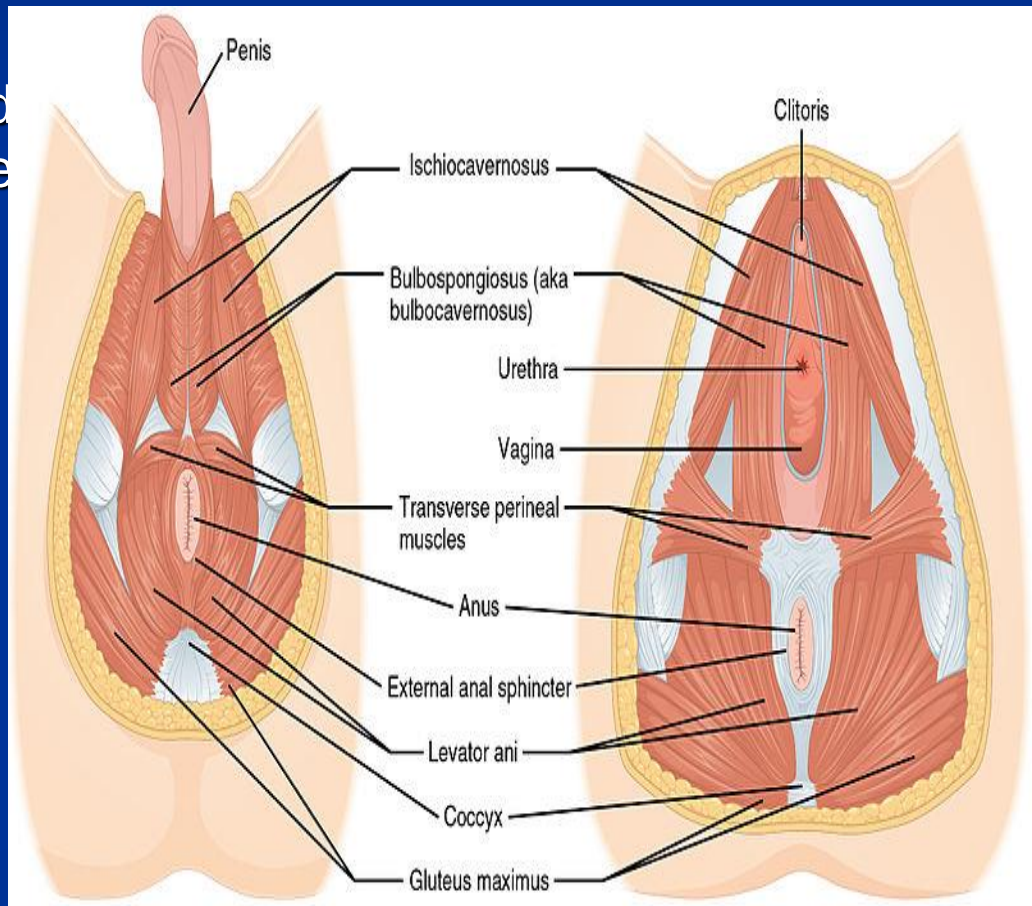
Anterior urogenital triangle-- contains the penis or vagina.

Posterior Anal triangle containing the anus

-

Anatomical boundaries-

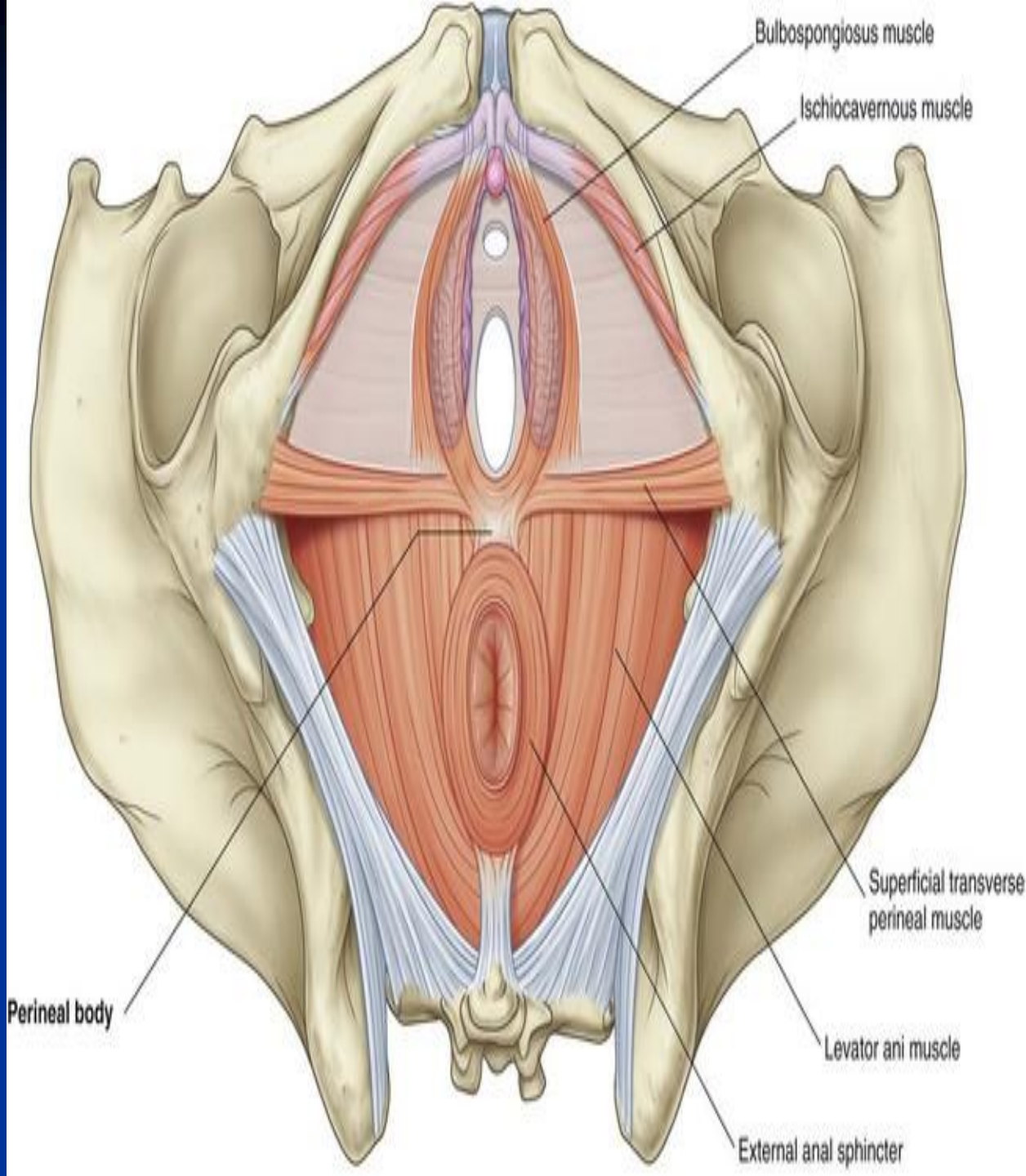
- in front: the pubic arch and the arcuate ligament of the pubis
- behind: the tip of the coccyx
- on either side: the inferior rami of the pubis and ischial tuberosity, and the sacrotuberous ligament
- superiorly: pelvic floor
- inferiorly: skin and fascia



Male perineal muscles: inferior view

Female perineal muscles: inferior view

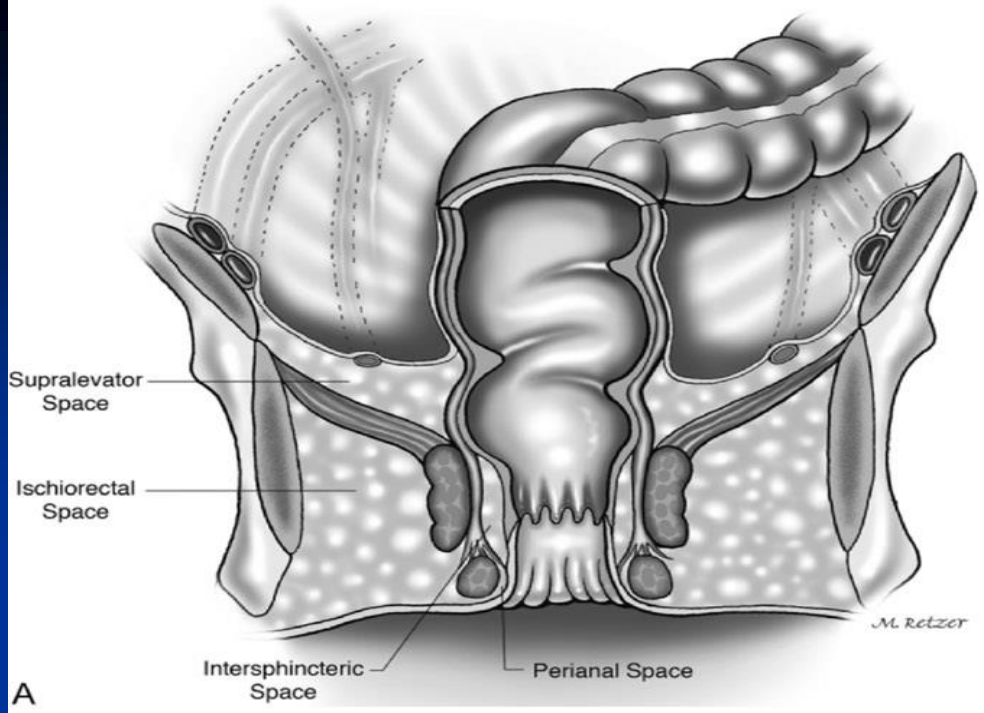
- EAS muscle
- Bulbospongiosus muscle
- Superficial transverse perinei.
- Levator ani muscle (anterior fibers)
- External urinary sphincter
- Deep transverse perineal muscle

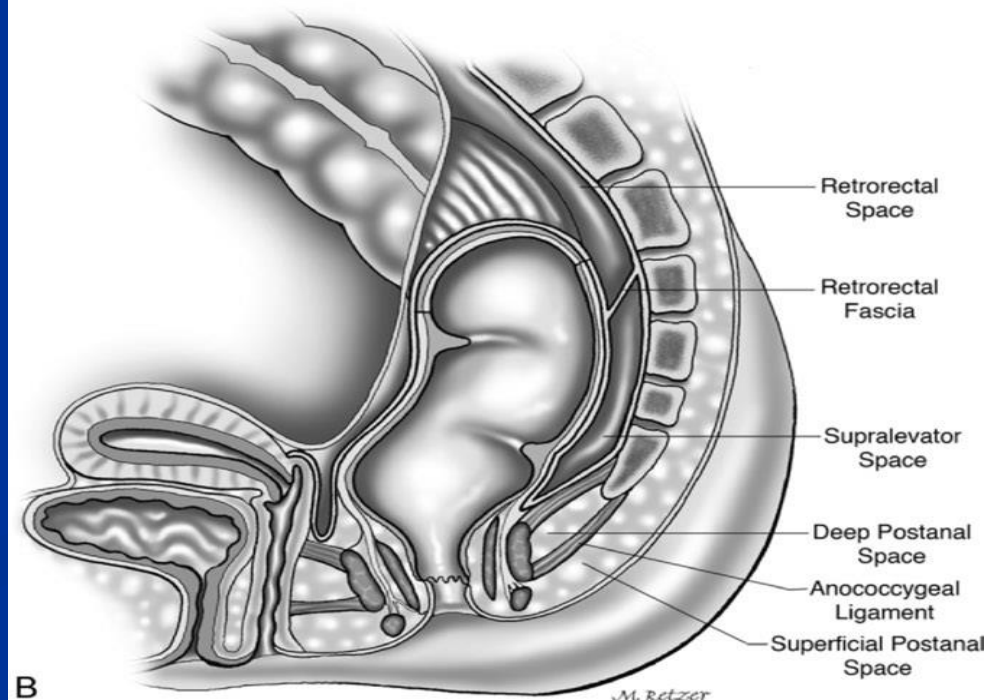


Paraanal and pararectal spaces.

A. Frontal view.

B .Lateral view.





Anorectal Spaces

- ischiorectal,
- perianal,
- intersphincteric,
- submucosal,
- superficial postanal,
- deep postanal,
- supralevator, and
- retrorectal spaces.

Anatomy of the Anal Canal

- The anal canal starts where the rectum passes through the pelvic diaphragm and ends at the anal verge. It is about 3.8cm long.
- The anorectal ring is the muscular junction between the rectum and anal canal.
- The anal canal can be divided into 3 parts. Each part is lined by a characteristic epithelium.

1) Upper mucous part (15mm):

- lined by columnar epithelium and is of endodermal origin.
- The mucous membrane shows 8 to 12 vertical folds *(anal columns of Morgagni)* the lower ends of which are united to each other by short transverse folds called anal valves.
- The anal valves together form a circular line called the *Dentate line*.

2) Middle part or Transitional Zone (15mm):

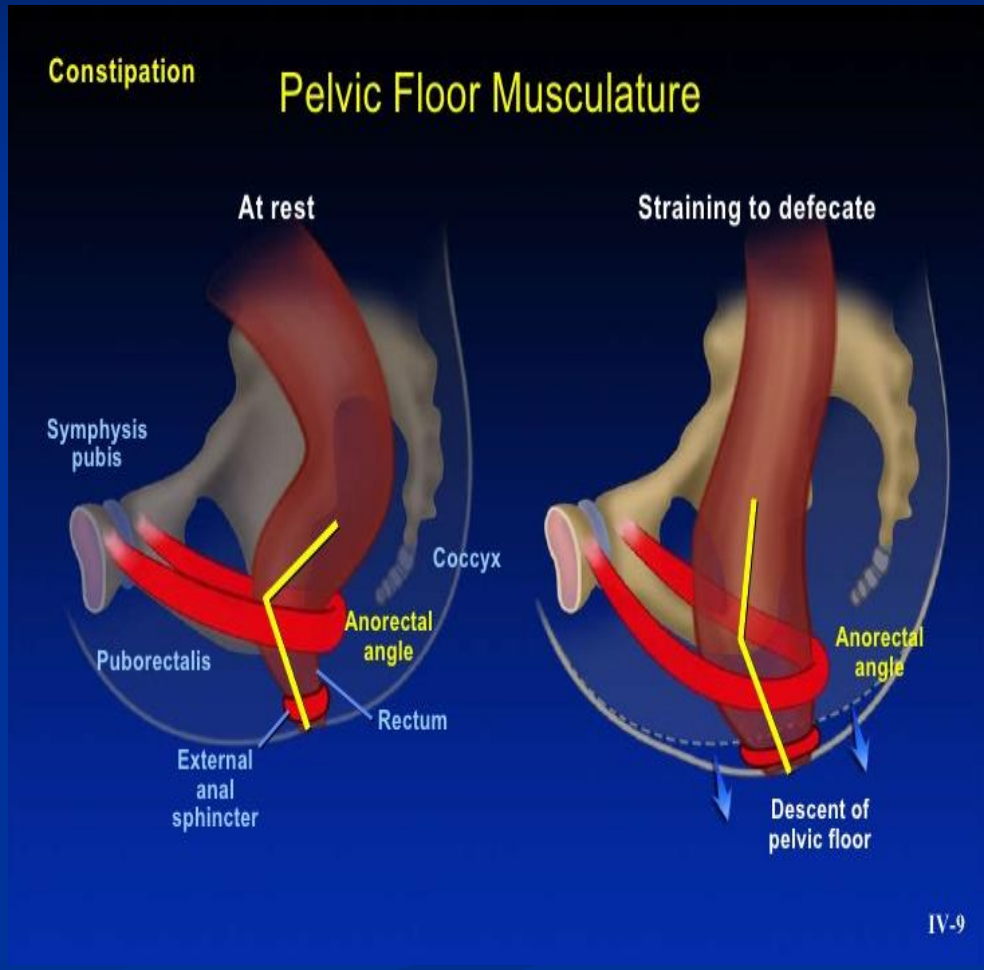
- Lined by non-keratinized stratified squamous epithelium which is devoid of sweat glands.
- Anal columns are not present here and the mucosa has a bluish appearance because of a dense venous plexus that lies between it and the muscle coat.
- The lower limit of this part often has a white appearance and is referred to as the *White line of Hilton.* This line is situated at the interval between the subcutaenous part of external and the lower border of internal anal sphincter.

3) Lower cutaneous part (8mm):

- This part is lined by true skin containing sweat and sebaceous glands.

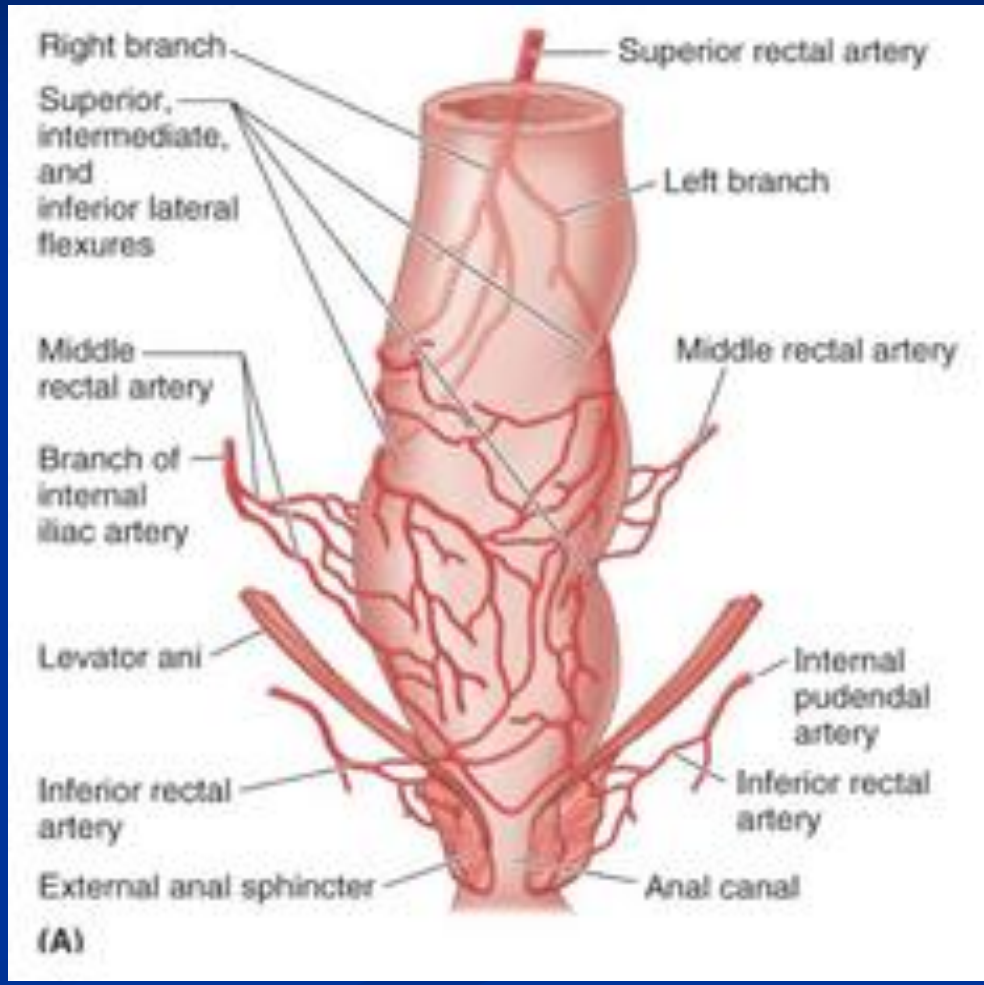
Anorectal angle

- 108-127.



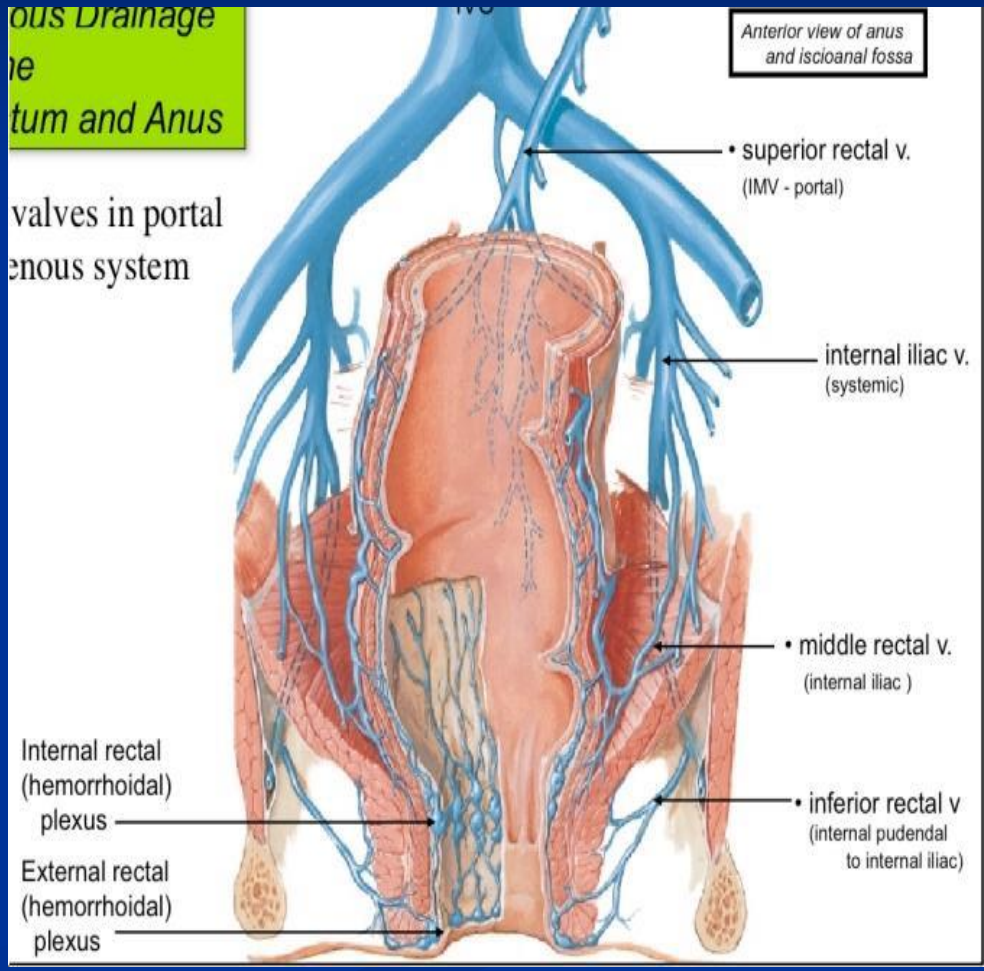
Blood Supply

- Above the Dentate line is supplied by the *superior rectal artery*
- The part below the Dentate line is supplied by the *inferior rectal artery*



Venous Drainage

- The *Internal Rectal Venous* plexus lies in the submucosa and drains mainly into the superior rectal vein but communicates freely with the external plexus and thus with middle and inferior rectal veins.
- Veins present in the three anal columns situated at 3, 7 and 11 O'clock positions are large and constitute potential sites for formation of primary internal haemorrhoids.

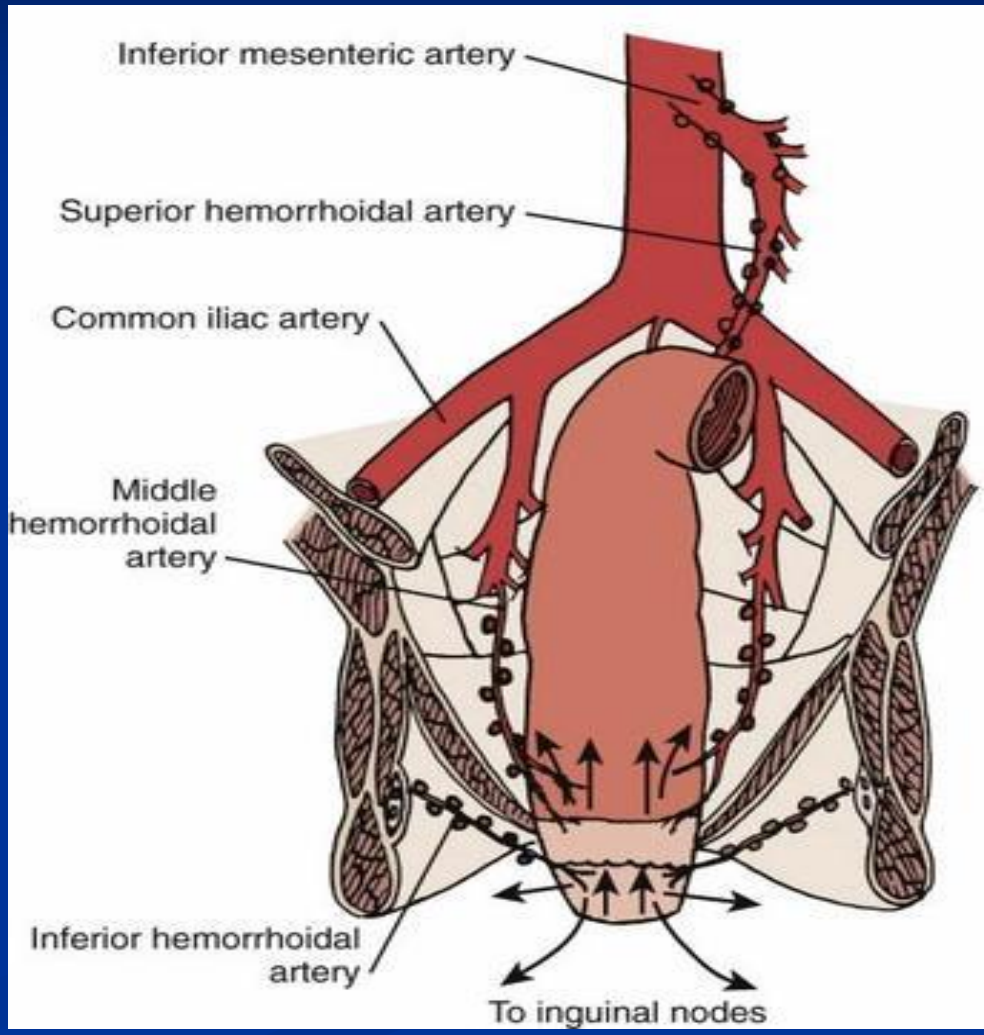


- **The** *External Rectal Venous Plexus* lies outside the muscular coat of the rectum and anal canal.
  - Its lower part is drained by the inferior rectal vein into the internal pudendal vein
  - Middle part by the middle rectal vein into the internal iliac vein.
  - Upper part by the superior rectal vein that continues as inferior mesenteric vein.

- Anal veins are arranged radially around the anal margin. Excessive straining during defaecation may rupture one of these veins, forming subcutaneous perianal haematoma known as External haemorrhoids.

Lymphatic Drainage

- Above the Dentate line goes to the para-aortic nodes via the inferior mesenteric chain.
- At the dentate line into the obturator or internal iliac node.
- Below dentate line drains into the superficial and deep inguinal group of lymph nodes.



Nerve supply

- Above the Dentate line: the anal canal is supplied by autonomic nerves both sympathetic (inferior hypogastric plexus- L1,L2) and parasympathetic (pelvic splanchnic- S2,S3,S4). Pain sensations are carried by both.

- Sphincters: the IAS is contracted by the sympathetic and relaxed by the parasympathetic supply.

- The EAS is under voluntary control via the inferior rectal and by the 4^{th} sacral nerve.

Nerve Supply of Anal Canal

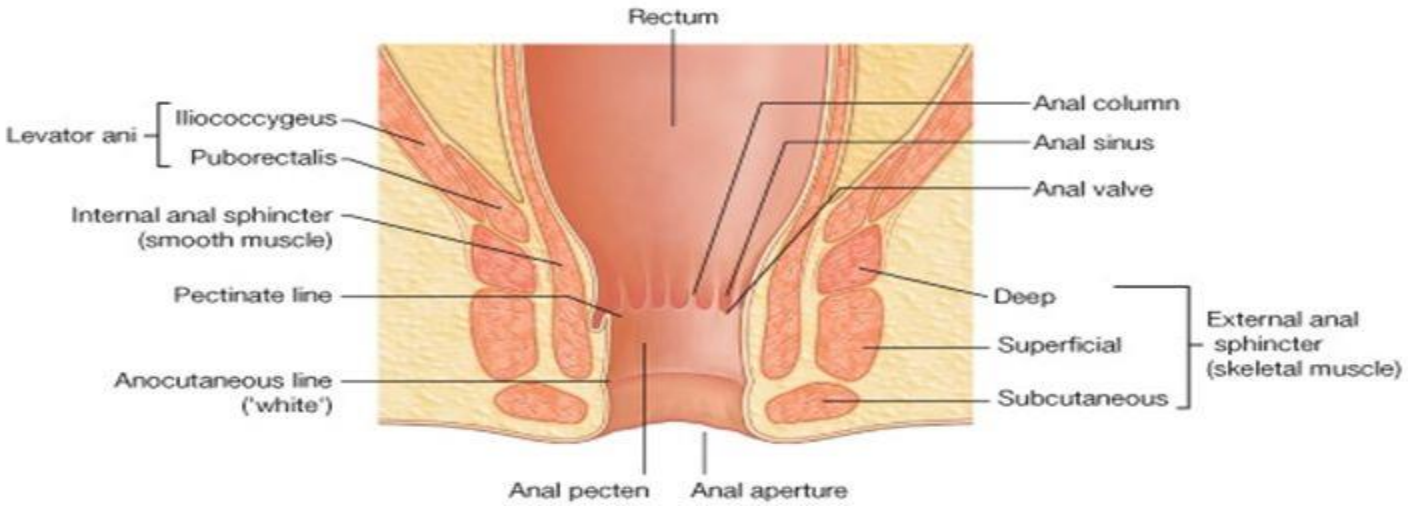
Mucous membranes:

upper ½ is sensitive to stretch and is innervated by **hypogastric plexuses**

Lower ½ is sensitive to pain, temperature, touch, and pressure and is innervated by **inferior rectal nerves**.

Involuntary internal sphincter is supplied by sympathetic fibers from **inferior hypogastric plexuse**.

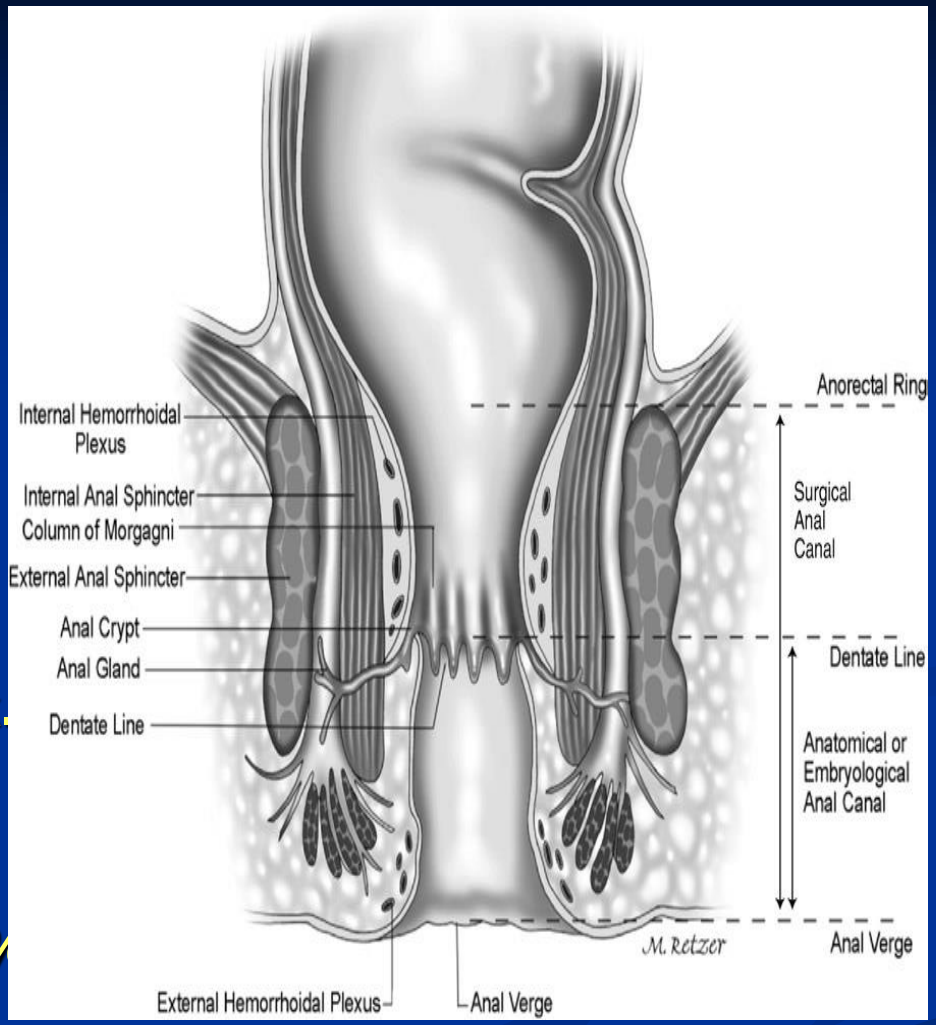
Voluntary external sphincter is supplied by **inferior rectal nerve**, a branch of pudendal nerve, and **perineal branch** of 4th sacral nerve.



Below the Dentate line: it is supplied by somatic (inferior rectal- S2,S3,S4) nerve.

Anal Sphincters

- The IAS
  - Thickened continuation of the circular muscle coat of the rectum.
  - Involuntary and starts Where rectum passes through the pelvic diaphragm and ends at the anal orifice.
  - 2.5-4cm long and 2-3mm thick.
  - Ends 1 cm above EAS.
  - 60-85% of resting anal tone. ASCRS-IAS-55%, Cushion-15% 30%-EAS.

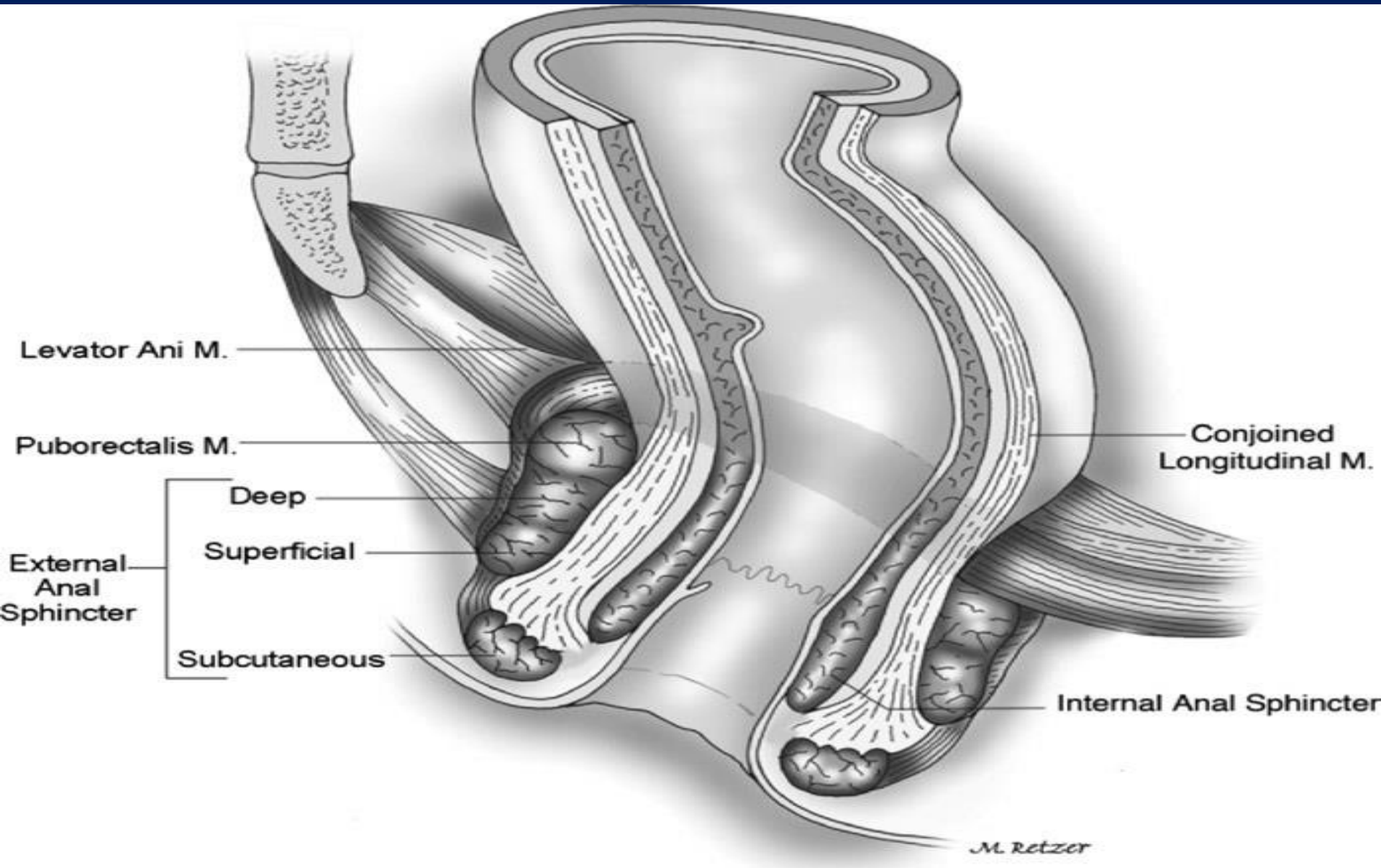


- The EAS is under voluntary control. It is made up of striated muscle and is divided anatomically into 3 portions-
  - Deep
  - Superficial &
  - Subcutaneous

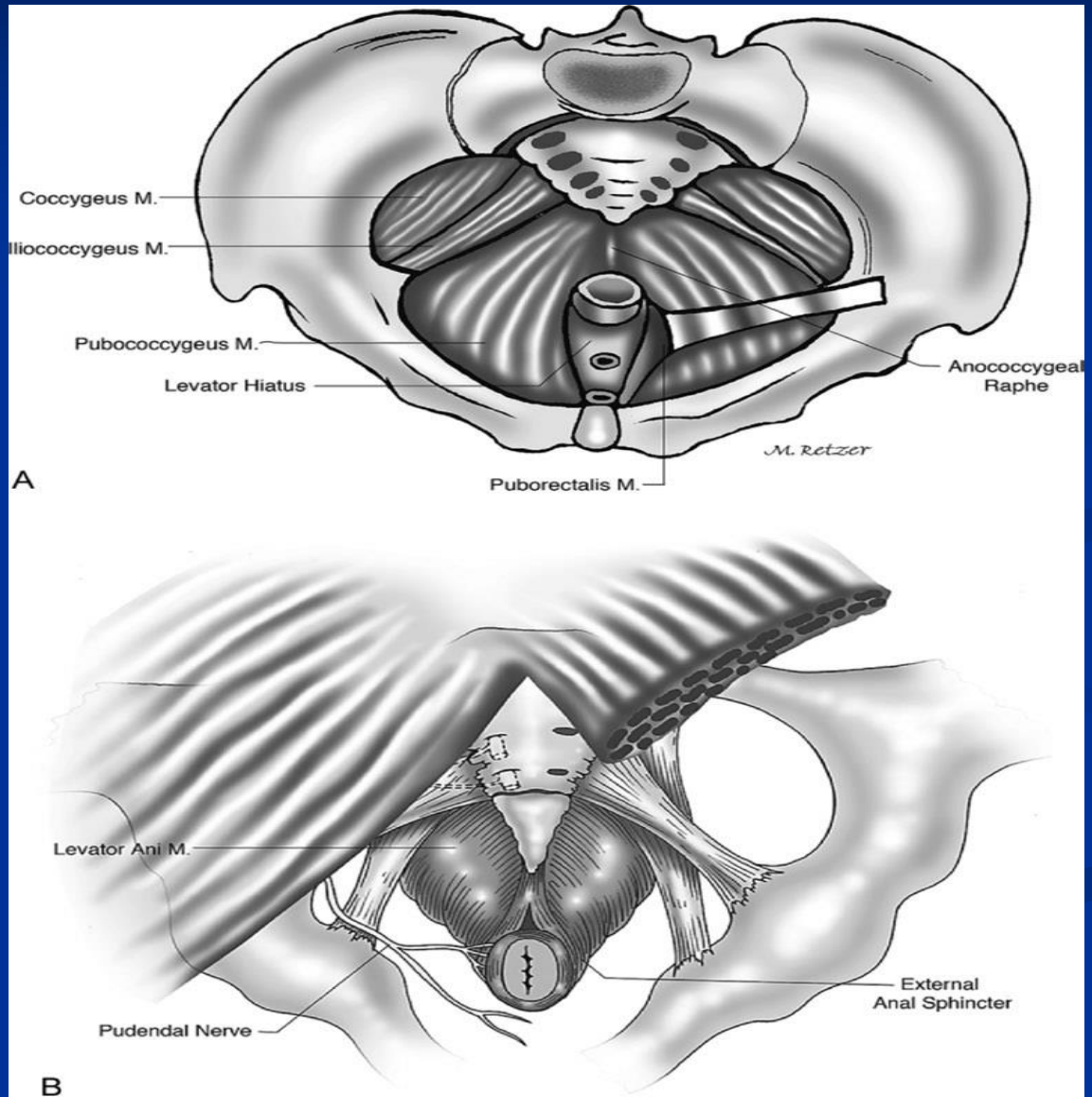
Clinical signifiance

- Injury to IAS-involuntary loss of stool & gases-passive incontinence.
- Injury to EAS- urge/active incontinence.
- Pseudoincontinence /diarrhoea/ overflow incontinence-due to faecal impaction.

Muscles of the anal canal.



Levator ani muscle. A Superior. B Inferior surface.



The ischiorectal fossa is subdivided by a thin horizontal fascia into : the perianal and ischiorectal space.

- Anal canal and the lower part of the rectum medially,
- pelvis laterally.
- Apex is at the origin of the levator ani muscle from the obturator fascia;
- Base- perianal space.
- Anteriorly, by the urogenital diaphragm and transversus perinei muscle. The ischiorectal fossa contains fat and the inferior rectal vessels and nerves.

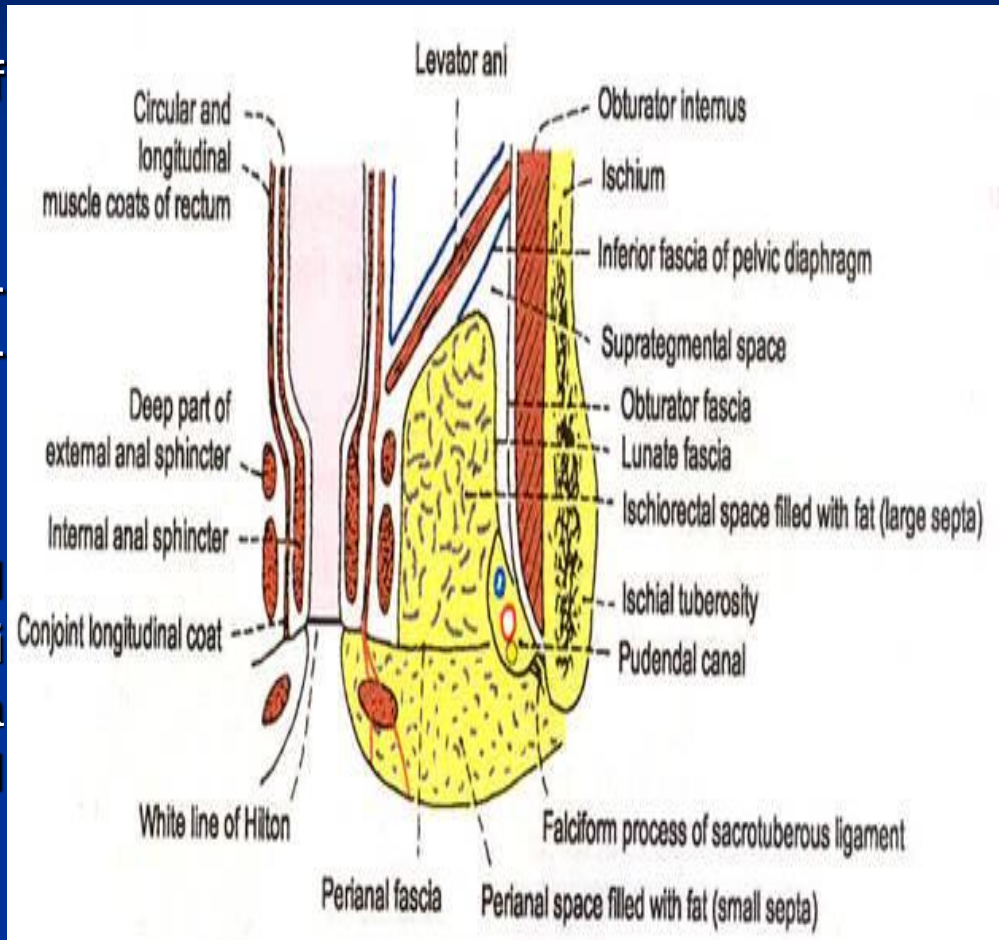


Fig. 28.7: Coronal section through the ischiorectal fossa.

Perianal space

- Surrounds the lower part of the anal canal and
- contains the external hemorrhoidal plexus, the subcutaneous part of the EAS, the lowest part of the IAS, and fibers of the longitudinal muscle.
- This space is the typical site of anal hematomas, perianal abscesses, and anal fistula tracts

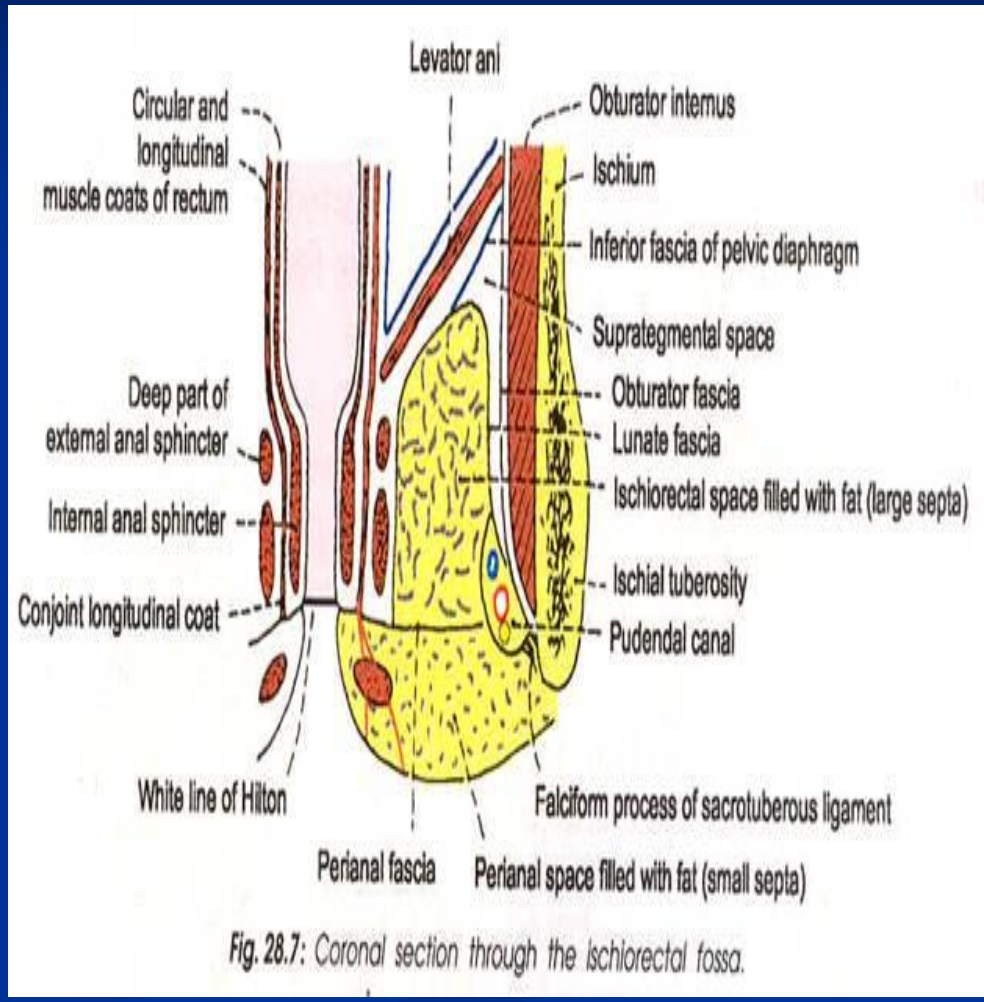


Fig. 28.7: Coronal section through the ischiorectal fossa.

- The intersphincteric space is important in the genesis of perianal abscess because most of the anal glands end in this space.

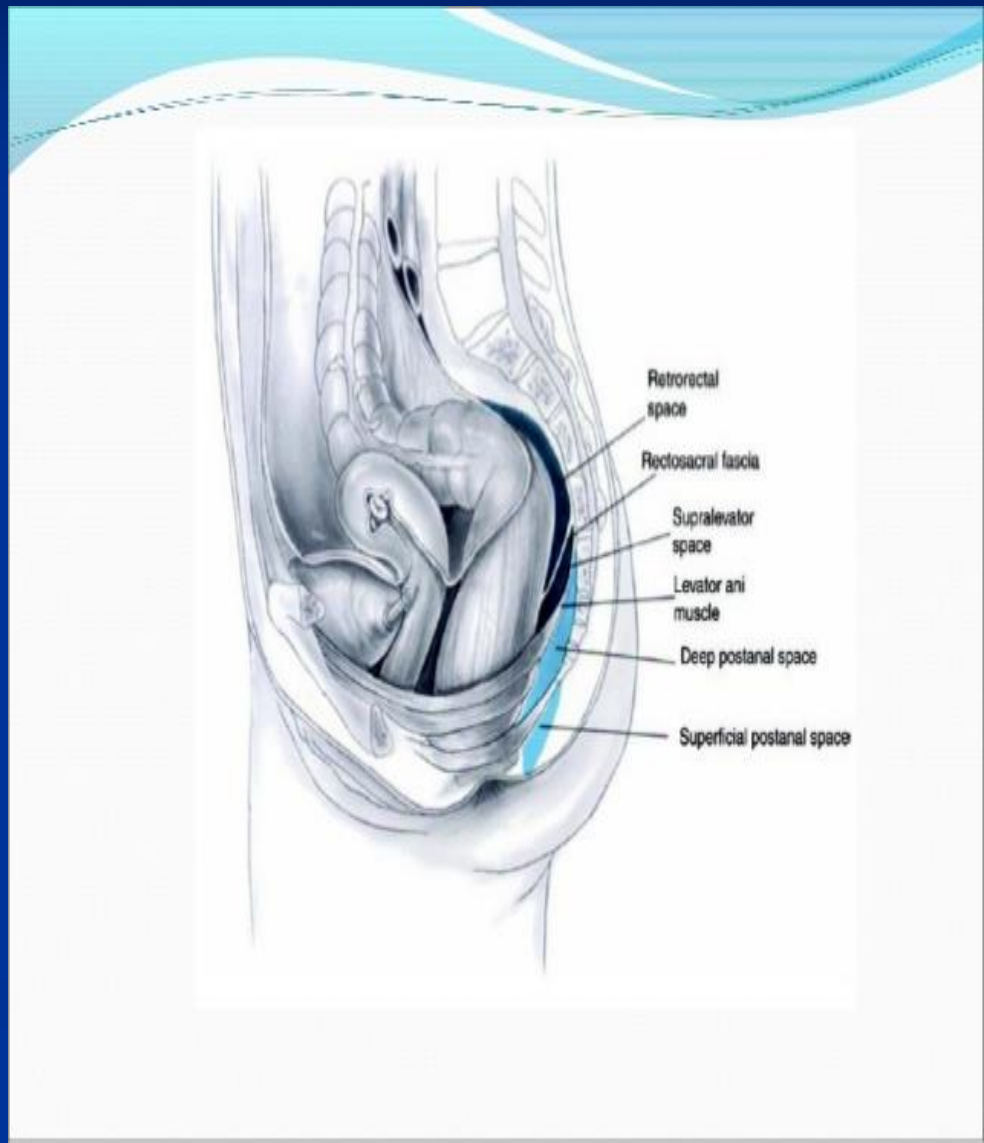
- Anal glands penetrate into the deeper tissues-
  - 80% submucosal
  - 8% internal sphincters
  - 8% conjoined longitudinal ligaments
  - 2% intersphincteric plane
  - 1% penetrate EAS.

The submucous space

- Situated between the internal anal sphincter and the mucocutaneous lining of the anal canal.
- This space contains the internal hemorrhoidal plexus .
- Above, it is continuous with the submucous layer of the rectum, and, inferiorly it ends at the level of the dentate line.

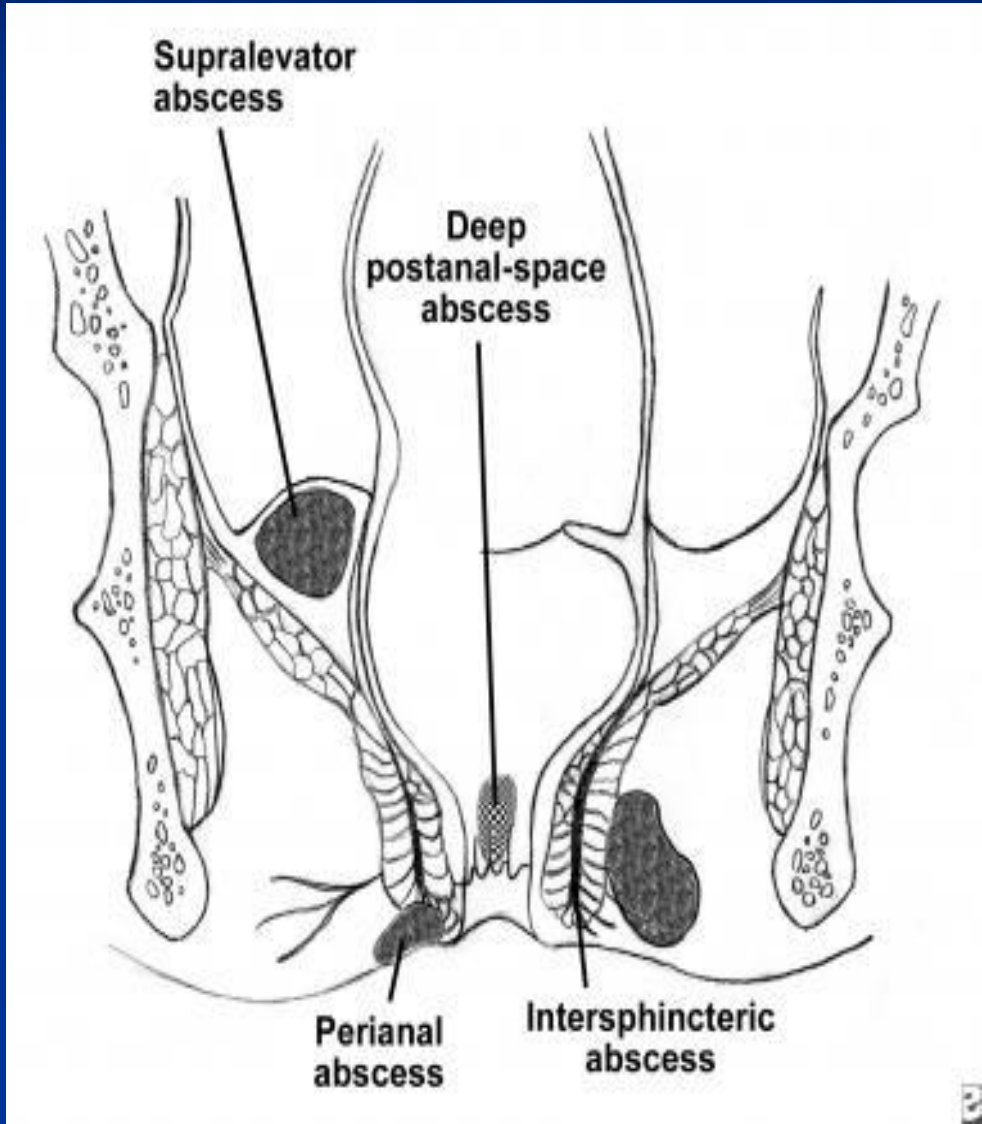
The superficial postanal space- between the anococcygeal ligament and the skin.

- The deep postanal space is situated between the anococcygeal ligament and the anococcygeal raphe.
- Both postanal spaces communicate posteriorly with the ischiorectal fossa and are the sites of horseshoe abscesses.



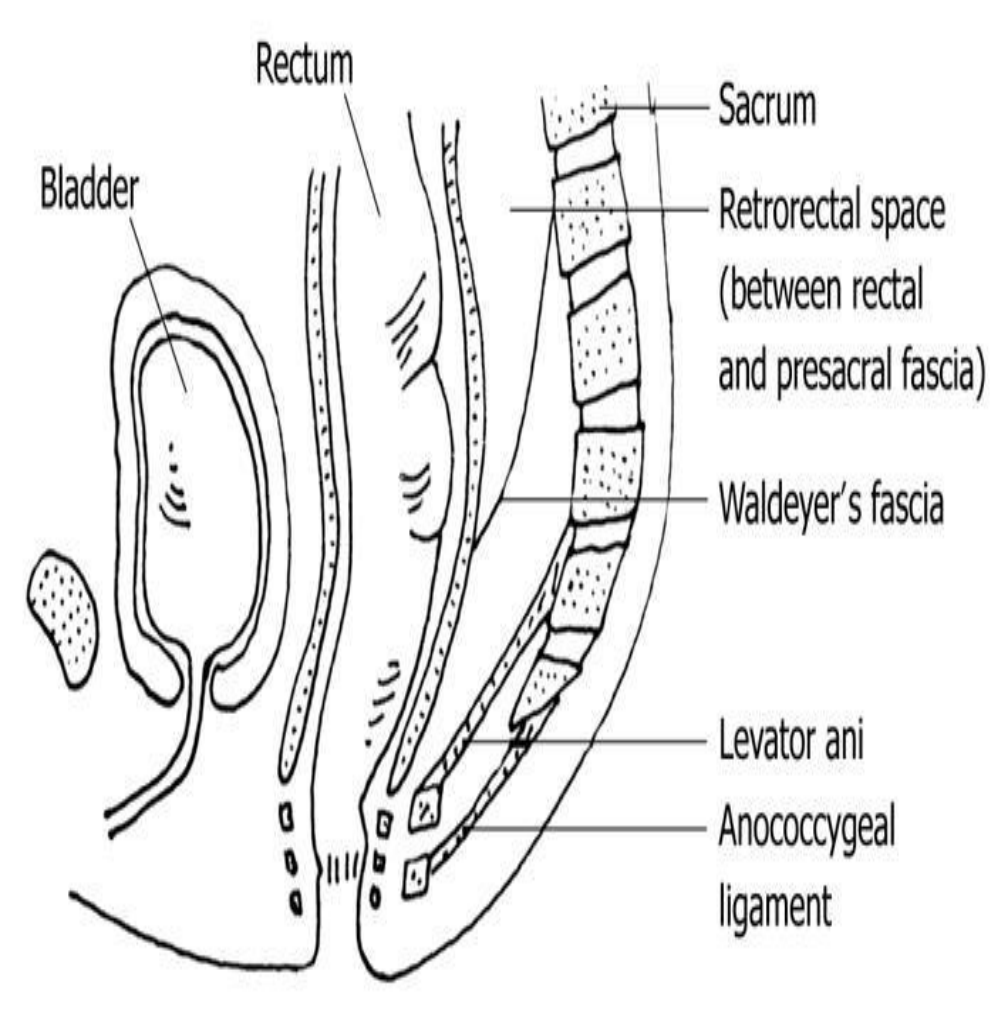
The supralevator spaces situated between the peritoneum superiorly and the levator ani inferiorly.

- Medially by the rectum, and
- laterally by the obturator fascia.
- Supralevator abscesses may occur as a result of upward extension of a cryptoglandular infection or develop from a pelvic origin.



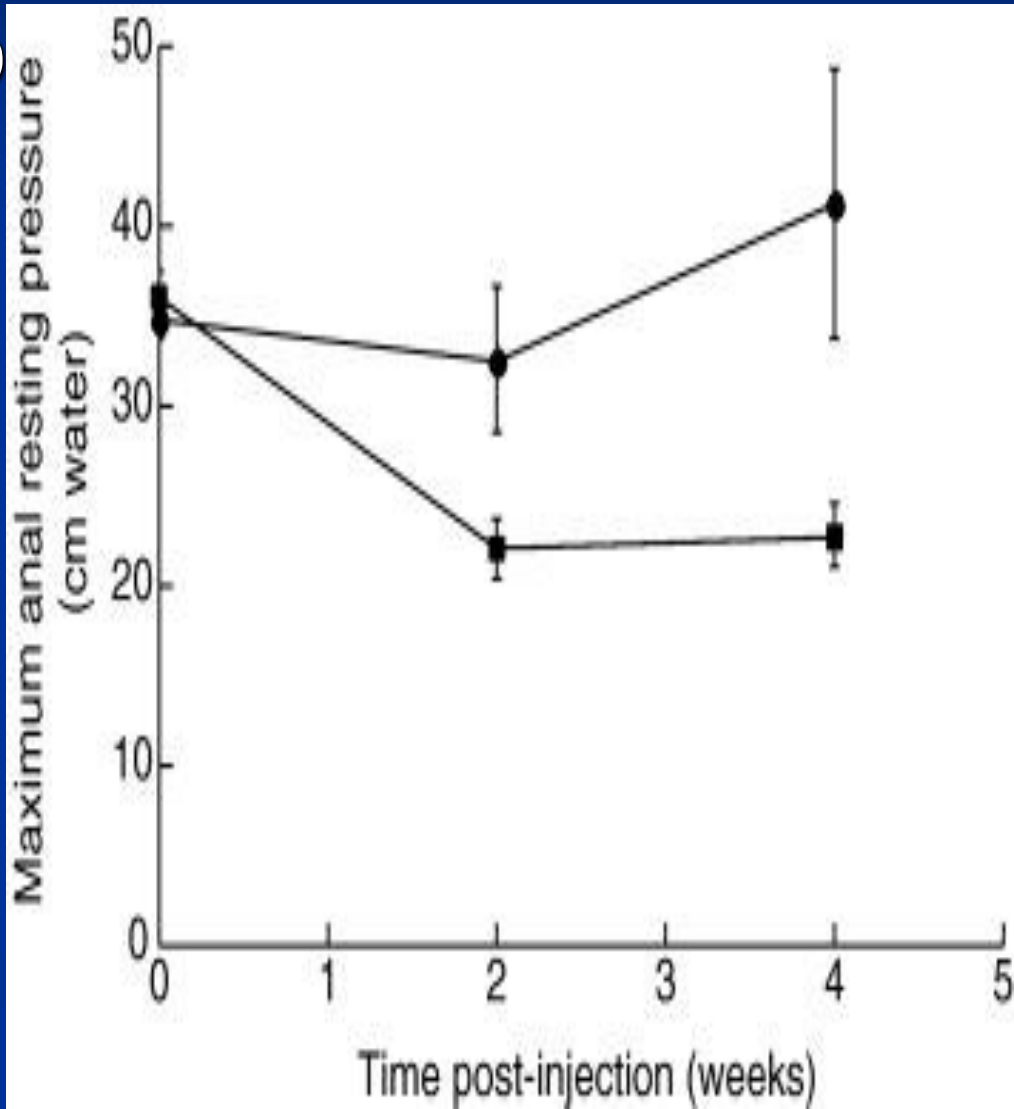
The retrorectal space between the fascia propria of the rectum anteriorly and the presacral fascia posteriorly.

- Laterally -lateral rectal ligaments and
- inferiorly the rectosacral ligament, and
- above the space is continuous with the retroperitoneum.
- The retrorectal space is a site for embryologic remnants and rare presacral tumors.



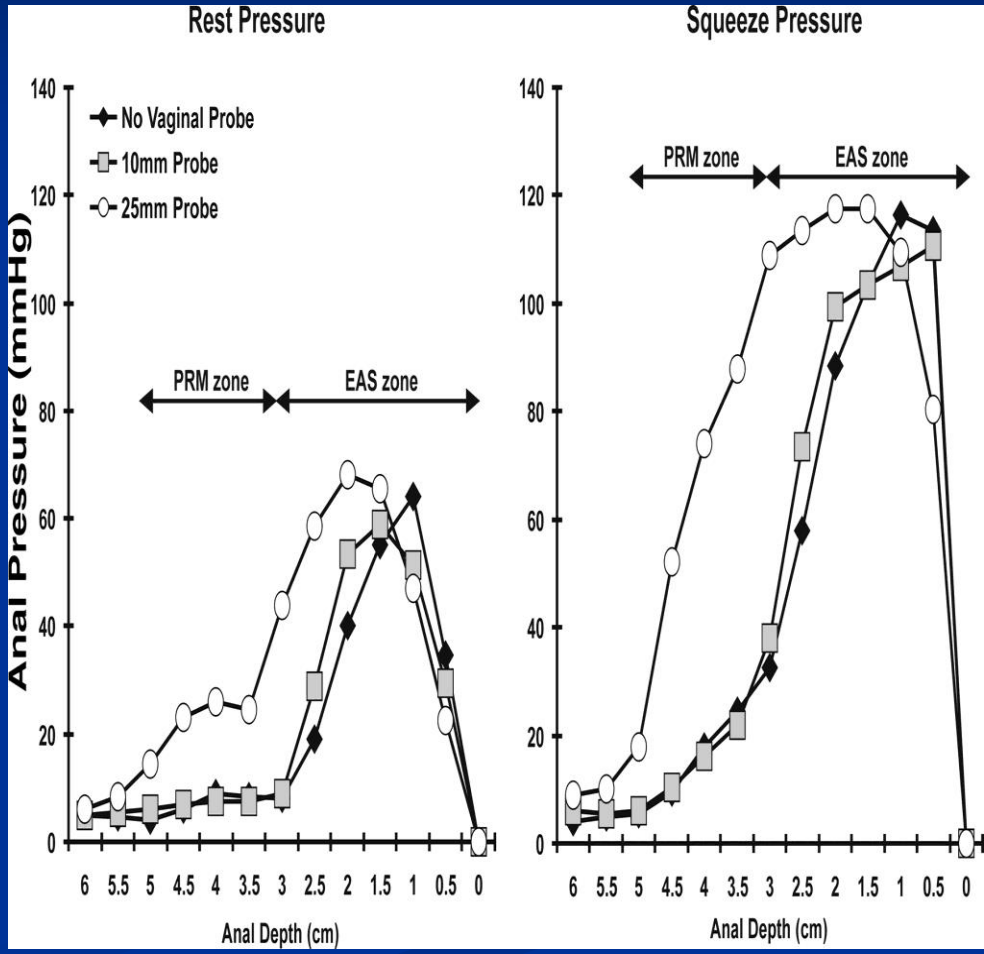
RAP

- Mean resting pressure-40-70 mm Hg.
- IAS- 55%, cushion-15%, EAS-30%.
- IAS injury- passive incontinence.



Squeeze pressure

- Max. squeeze pr.-2-3 times the baseline resting value.
- EAS main contributor.
- Becomes fatigue <1 min.
- EAS injury-active incontinence.



High pressure zone

- Zone along the IAS where pressure >1/2 of the maximum RAP.
- 2-3 cm in man.
- 2.5-3.5 cm in woman.

RAIR

- Rectal distension-transient reflex relaxation of IAS & contraction of EAS.
- Exact pathway unknown.
- Incontinent->rectal vol.->rectal relaxation.
- Constipation->resting anal pr. In prox. anal canal.

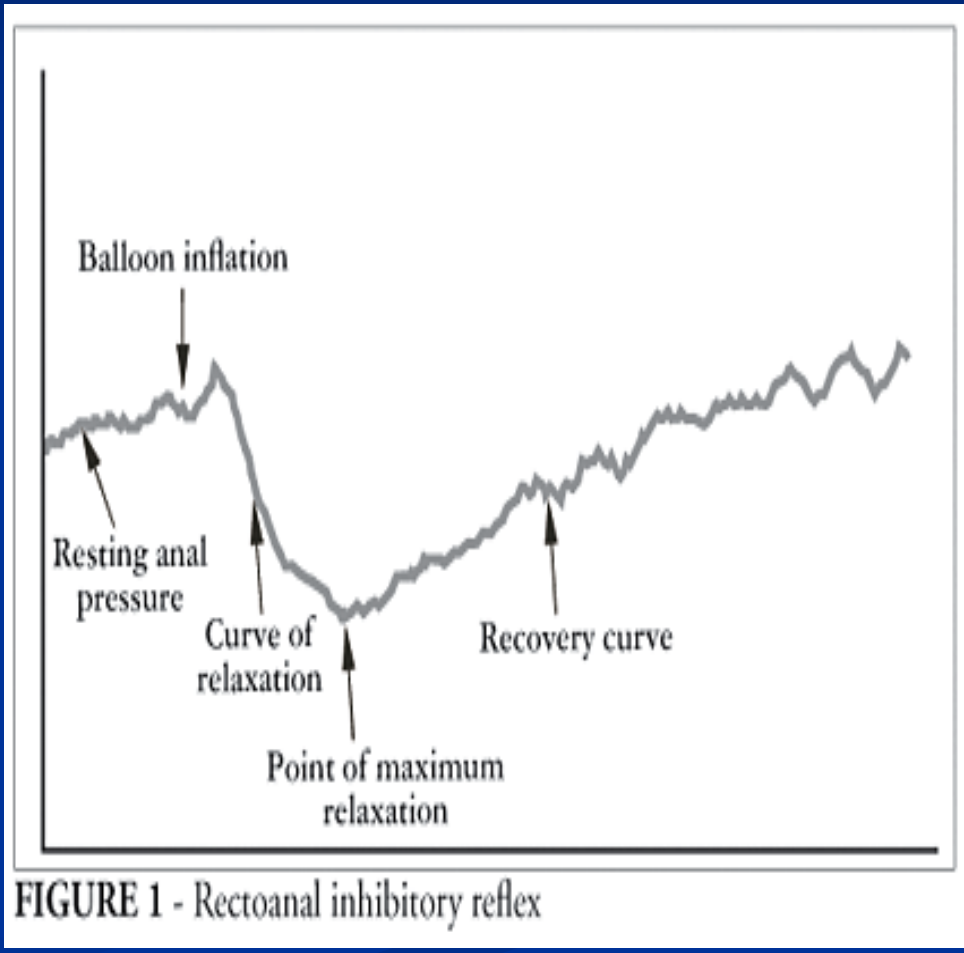


FIGURE 1 - Rectoanal inhibitory reflex

RAIR

- Fine adjustment of continence.
- Rectal distension(10-30)ml-contraction of EAS relaxation of IAS-sensory anal micosa distinguish solid liquid or gas.
- Absent in HPD,LAR chagas dis.sys. Sclerosis.

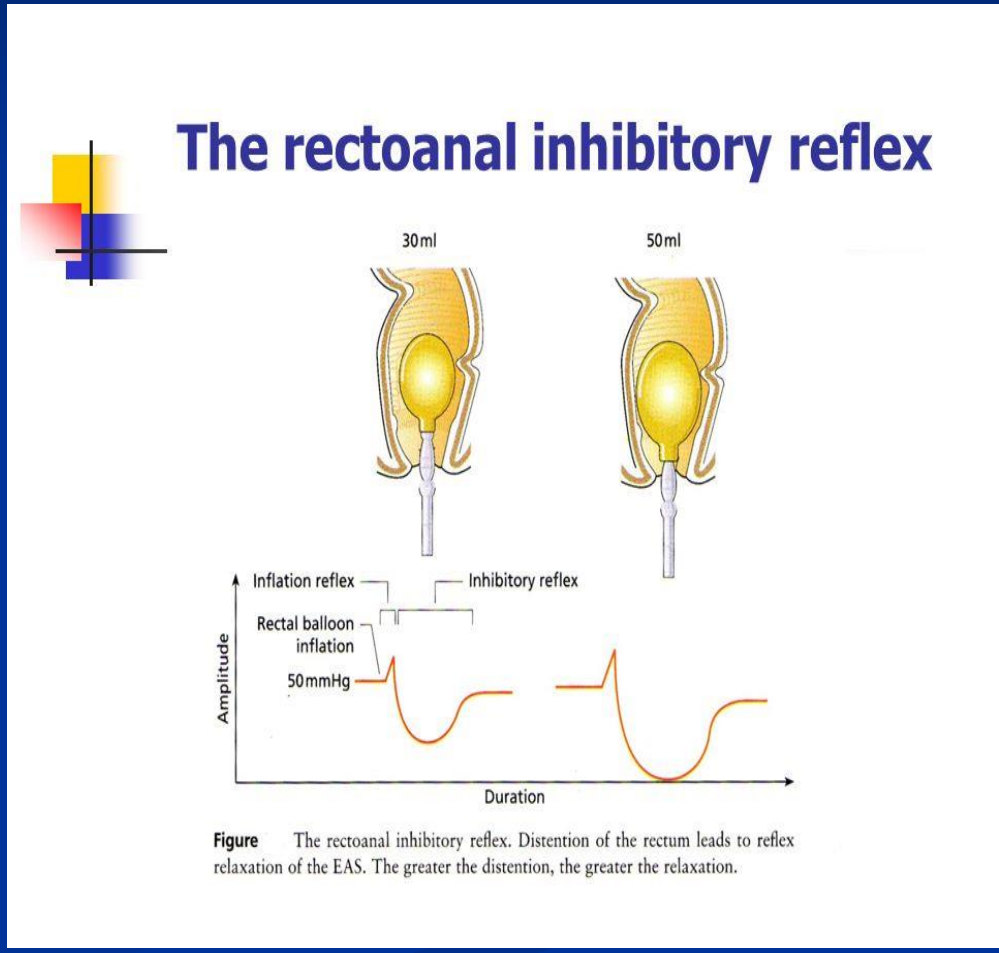
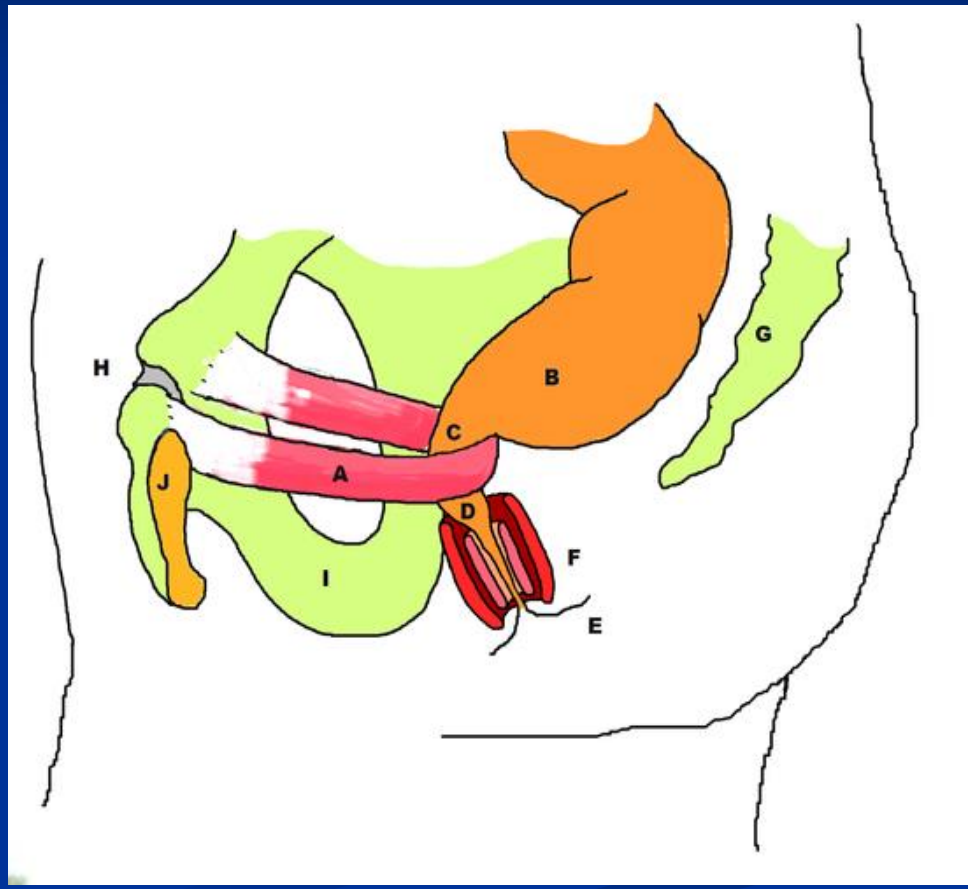


Figure The rectoanal inhibitory reflex. Distention of the rectum leads to reflex relaxation of the EAS. The greater the distention, the greater the relaxation.

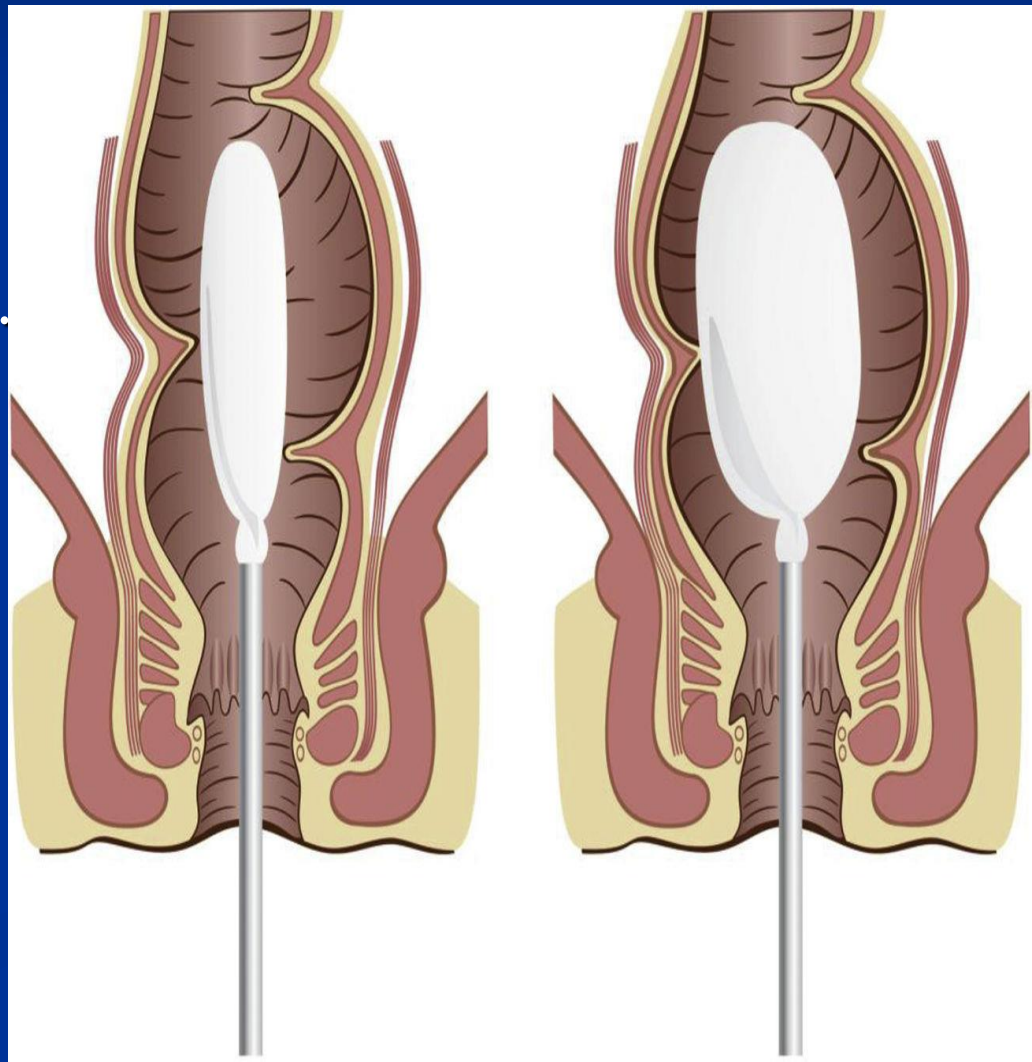
RAER or inflation reflex

- Contraction of EAS in response to rectal distension.
- Rectal distension sensation is most likely transmitted along the S2, S3, and S4 .
- Injury to the EAS. It would appear that patients that have both an abnormal PNTML and an abnormal distal RAER.
- RAER allow retrograde evacuation of the rectum and delayed defecation This is weak in incontinence group.



Rectal sensation

- By anal cushion, transitional zone.
- By progressive malloon inflation/ intrarectal NS.
- Normal perception of filling-10-20 ml
- Urge to defecate-60ml.
- Discomfort-230 ml.
- <rectal sensation-impaction-overflow incontinence.



Normal defecation

mass movement

↓

defecation reflex

stimulus:
- distension in rectum

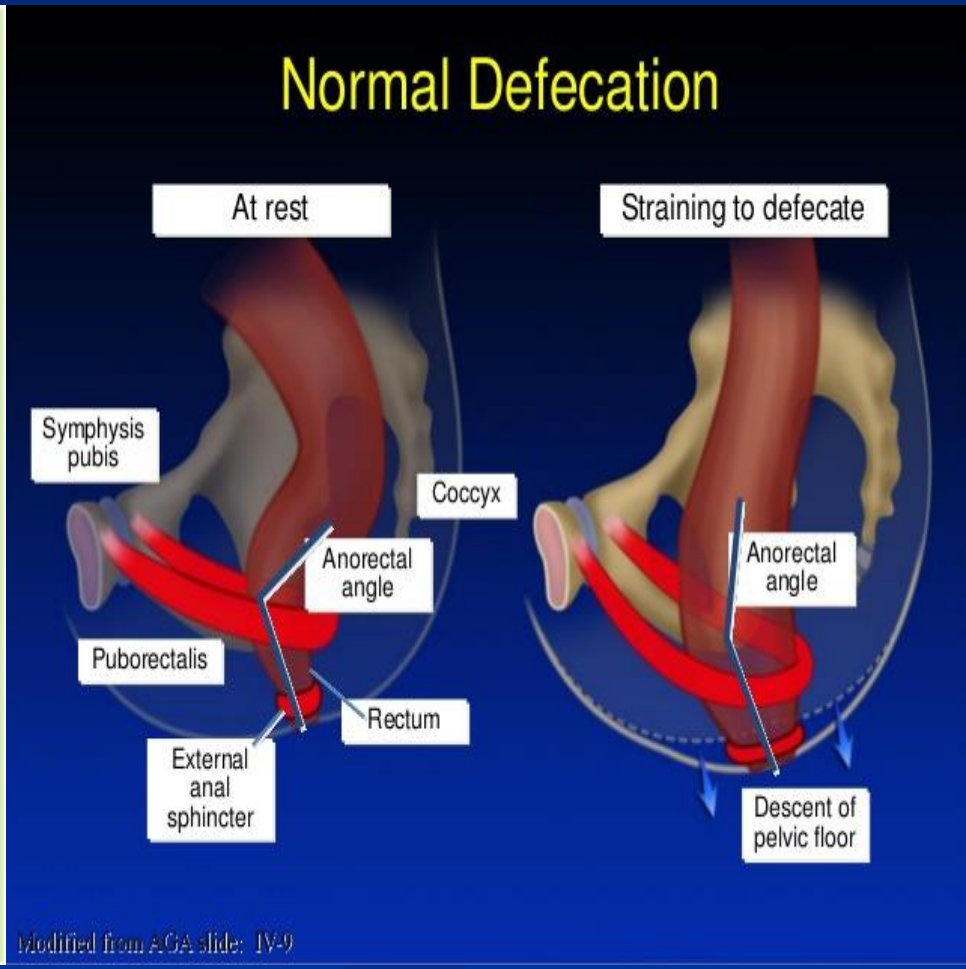
responses:
- contraction in rectum, sigmoid colon
- relaxation of internal anal sphincter
- contraction of external anal sphincter

↓

increased pressure in rectum

delay
- contraction of external anal sphincter
- contraction of puborectalis muscle
- reverse peristalsis in rectum

defecation
- relaxation of external anal sphincter
- relaxation of puborectalis muscle
- forward peristalsis in rectum, sigmoid colon
- Valsalva maneuver (increased abdominal pressure)

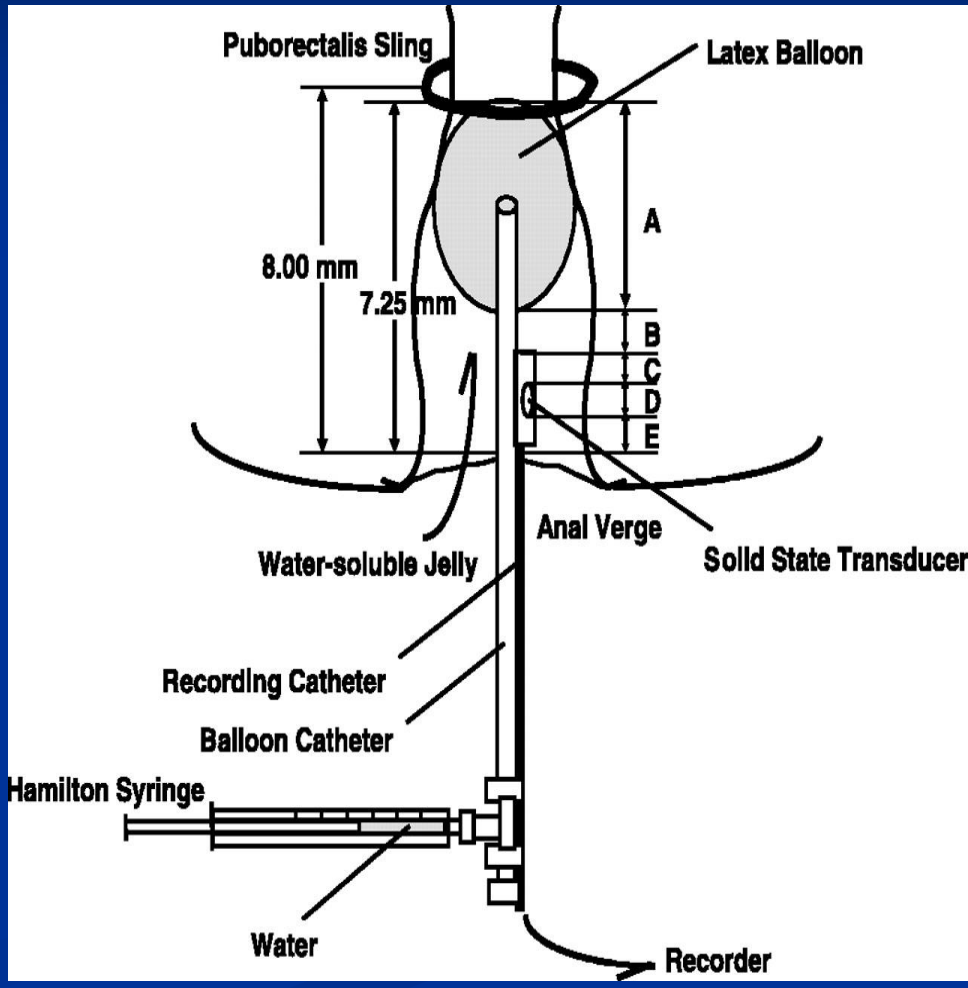


Defecation

- Segmental propagating colon contraction-solid/ liquid/ gas into rectum-rectal distension- +pr. Receptor on puborectalis,pelvic floor m.- +RAIR-sampling of contents-if solid contents ,& decision to defecate-sup. Frontal gyrus,ant. Cingulate gyrus-glottis closes, pelvic floor m. descent-diaphragm abd. Muscle contract- >IAP-puborectalis relax-straightening of anorectal angle-pelvic floor descends-EAS relaxes-defecation occurs.

Rectal compliance

- Changes in pr. Associated with changes in vol.
- Measured by inflating balloon with saline or air.
- Rate of infusion-70-240ml/min.
- Mean RC-4-14 ml/cm H2o with pr.18-90 cm H2o at max.tolerated vol.



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