Sep. 20 2017

Basic science seminar: Colorectal surgery

Anatomy of the anus, rectum and pelvic floor

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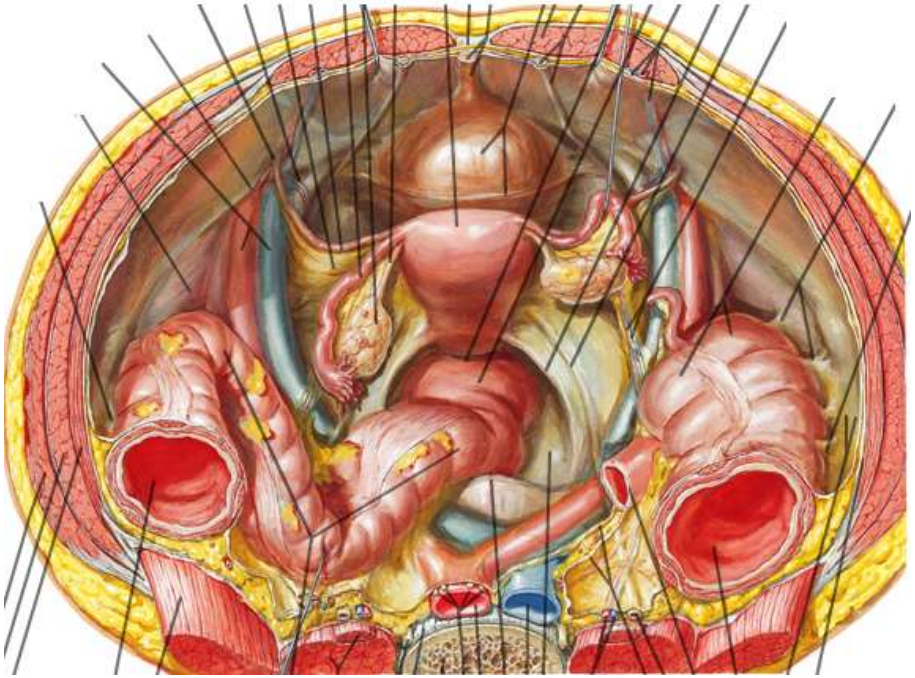
Introduction

- A region where anatomy is intrinsically related to physiology
- Several aspects remain controversial
- Focus on surgical relevance
  - Surgical conditions
  - Surgical procedures
  - Colonoscopy

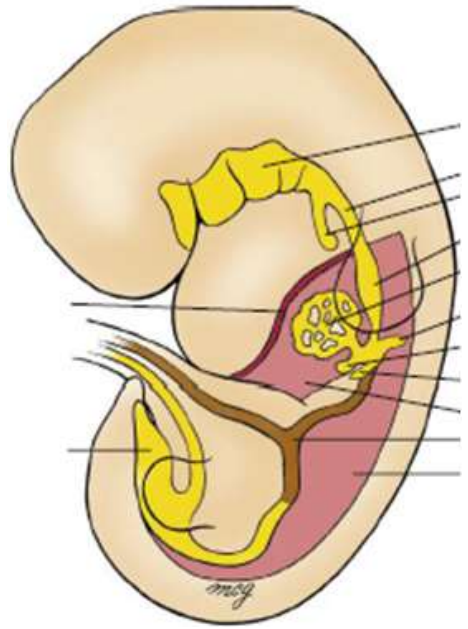
Outline

- **Rectum**
- **Anal Canal**
- **Muscles of anorectal region**
- **Anorectal spaces**
- Arterial supply
- Venous Drainage
- Lymphatic drainage
- Innervation



Embryology overview

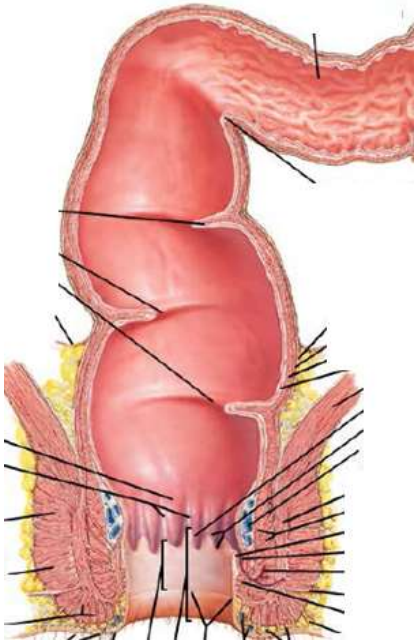
- **Cloaca** (terminal hindgut) = *rectum, anal canal above dentate line*
- **Proctodeum** (ingrowth from anal pit) = *anus below dentate line*
- **Anal tubercles** (swelling around anal pit) = *perineal body*
- **Cloaca lateral compressor** = *pelvic floor muscles*
- **Dorsal Cloacal sphincter** (post to perineal body) = *External anal sphincter*
- **Circular layer of rectum** = *internal anal sphincter*



Rectum: Rectosigmoid junction

- **Location** = Indistinct zone (last 5-8 cm sigmoid & upper 5 cm of rectum)
  - **Colonoscopy** => narrowest portion of colon & sharply angulated
  - **Gross** => point at which taenia coli fuse and haustra & mesocolon terminate
  - **Micro** => longitudinal muscle more prominent than sigmoid but less than rectum
- **postulate** => b/c rectum is usually emptied & contracted, sigmoid plays role in continence by acting as fecal reservoir
- **finding** => thickening of circular layer b/n rectum & sigmoid (functional sphincter)

  (Aka rectosigmoid sphincter, Spincter ani terius, pylorus sigmoidrectalis)



Rectum: General description

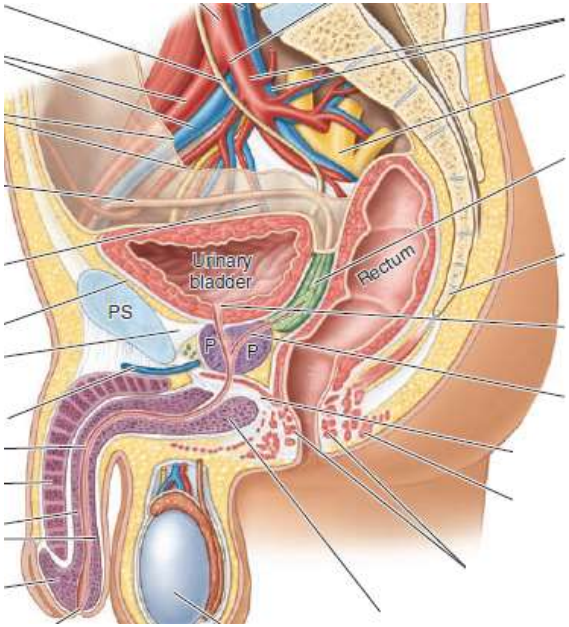
- **Location** = rectosigmoid junction – anorectal ring
- **Length** = 12-15 cm, ?10cm
- **Lumen** = smooth mucosa (no cresentric folds/haustra like sigmoid)

  = wide (*allow retroflexion of scope), easily distensible
- **Shape** = follows sacral concavity, ends 2-3cm below coccyx

  = lateral convexities corresponding to valves of huston
- **Relations**
  - Posterior = S3-5 vertebra & coccyx, anococcygeal ligament

    = median sacral vessel, sacral plexus
  - Anterior = cervix & vagina (female)

    = bladder, vas, seminal vesicle & prostate (male)

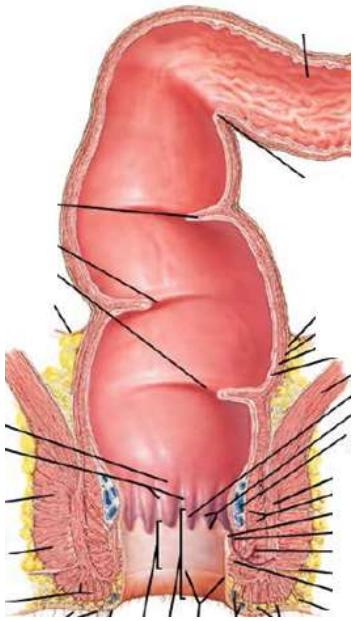


Rectum: Wall

- **Mucosa** = smooth & pink with visible submucosal vessels
  - Epithelium = glands
  - Lamina propria = connective tissue
  - Muscularis mucosa = * critical demarcation in diagnosis of carcinoma
- **Submucosa** = strongest layer
- **Muscularis propria**
  - Circular = auerbach's plexus
  - Longitudinal = the 3 tinea of colon are spread out and form a continuous layer
- **Serosa** = only at sites of peritoneal reflection (upper)

Rectum: Valves of huston

- **Superior & inferior valve** = on left, 7-8cm & 12-13cm
- **Middle valve** (kohlrausch's plica) = on right, 9-11cm (most consistent)
  - *level of anterior peritoneal reflection
- don't contain all layers, don't have specific function
  *excellent site for rectal biopsy
  * not present after mobilization (5cm length gained)



Rectum: Peritoneal relations

- **Upper 1/3** = anteriorly and laterally invested

  *laterally refection forms pararectal fossae (permit rectal distention)

- **Middle 1/3** = anteriorly only (reflection 9-7cm in male, 7.5-5cm in female)

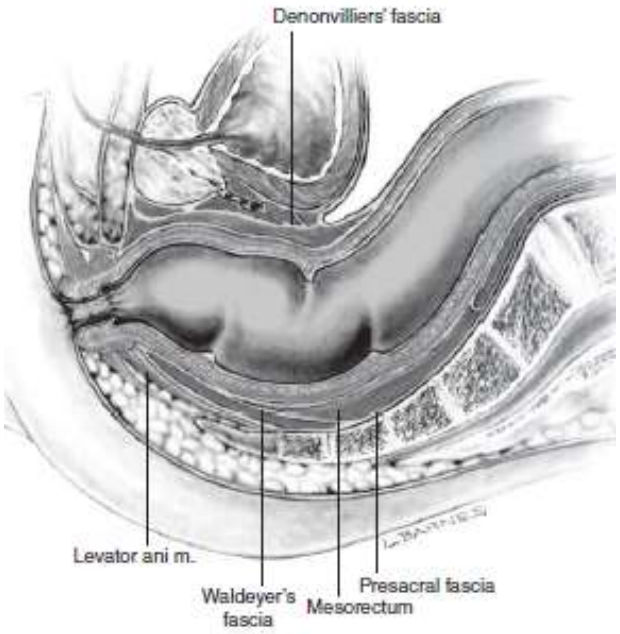
  *anteriorly refection forms rectovesical pouch or rectouterine pouch

- **Lower 1/3** = entirely extraperitoneal

  *diff. b/n high & low anterior resection (anastomosis above or below reflection)

  **ultralow anterior resection* = anastomosis at level of puborectalis (pelvic floor)

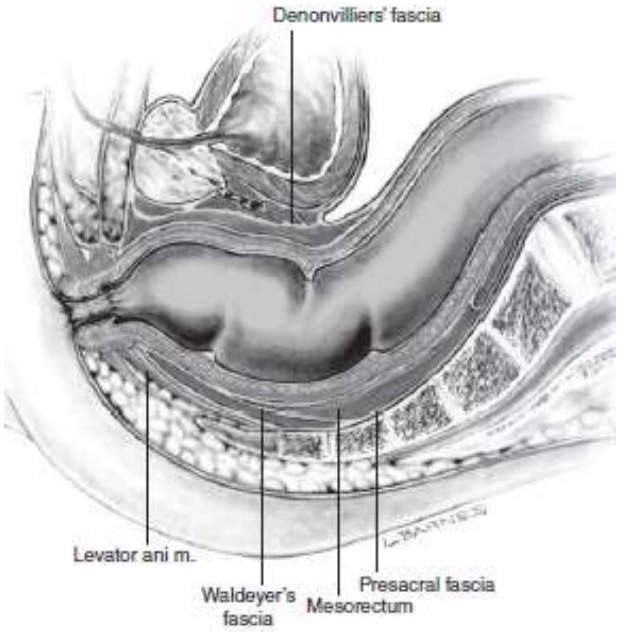
  *coloanal anastomosis = at level of dentate line



Rectum: Mesorectum

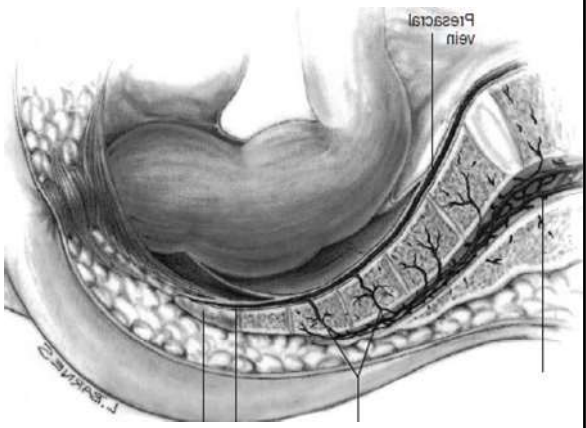
- *Perirectal adipose tissue (not proper "meso")*
  - **Location** = thicker posteriorly & extend laterally 3/4th (2-10 o'clock)
  - **Enclosed by** = fascia propria
  - **Contain** = IMA branches & LNs (but no functionally significant nerves)

*metastatic site for recta ca; removed during surgery without sequelae



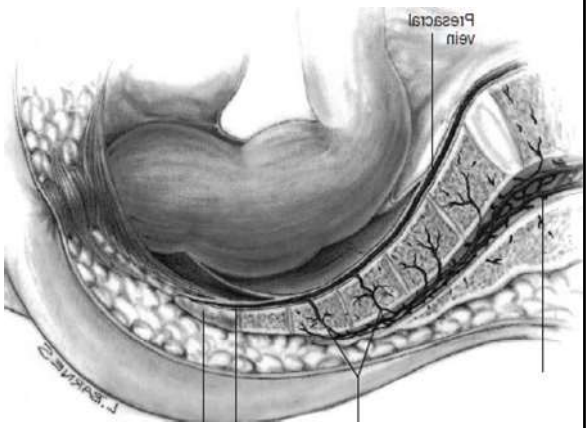
Rectum: Fascial attachments

- **Fascia propria** (visceral rectal fascia)
  - extension of endopelvic fascia (visceral) mainly in lateral and posterior rectum
  - Fuses with waldeyer fascia in lower rectum
  - **lateral ligaments** = distal condensation of fascia propria
    - *concerns during division of these ligaments during mobilization
      - don't contain important structures but closely related to MRA & pelvic plexus
      - contain branch of middle rectal artery in 25% (may bleed)
      - May be leaving behind lateral mesorectal margins



Rectum: Fascial attachments

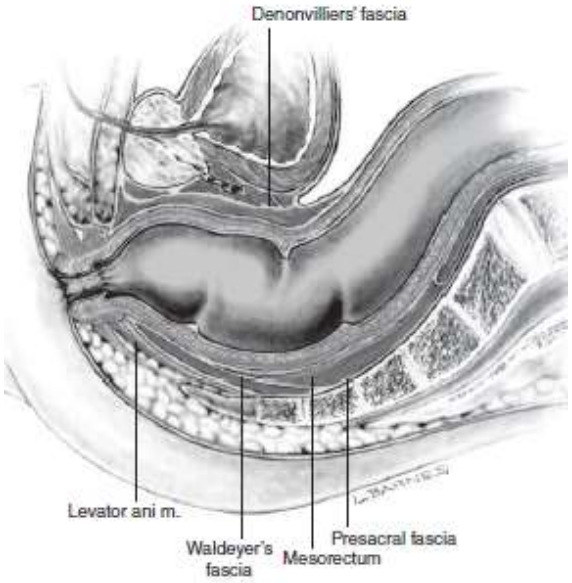
- **Presacral fascia**
  - Thick, parietal endopelvic fascia covering sacrum/coccyx
  - Also covers nerves, middle sacral artery, presacral veins
  - *Presacral veins are avalvular & communicate with internal vertebral veins
  - *concern during dissection of fascia
    - Life-threatening bleeding from presacral veins (inc pressure in lithotomy position 2-3x IVC)
    - Trouble controlling bleeding b/c of retraction into sacral foramen



Rectum: Fascial attachments

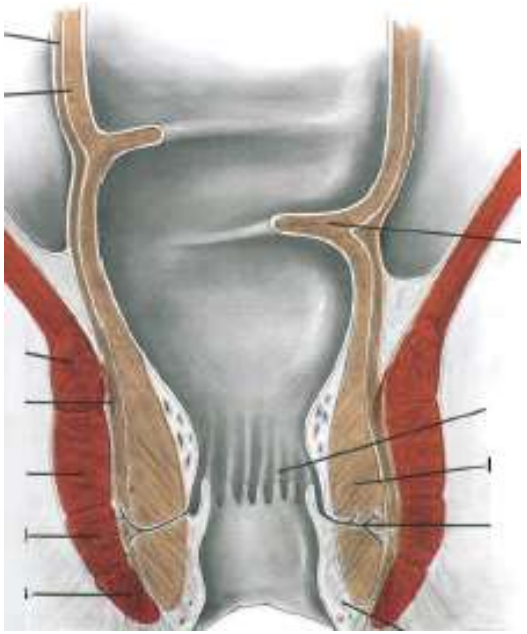
- **Rectosacral fascia** (waldeyer)
  - anterioinferiorly directed thick reflection from presacral fascia
  - * important landmark during posterior rectal mobilization

- **Denonvilliers fascia** (prostatoperitoneal fascia) / **Rectovaginal septum**
  - visceral pelvic fascia covering anterior extraperitoneal rectum
  - *controversy regarding anterior planes
    - Close rectal = perimuscular, not anatomic
    - mesorectal = continuation of posterior-lateral plane
    - extramesorectal = denovilliers
      = high risk of bleeding & injury to periprostatic plexus



Anal canal: general description

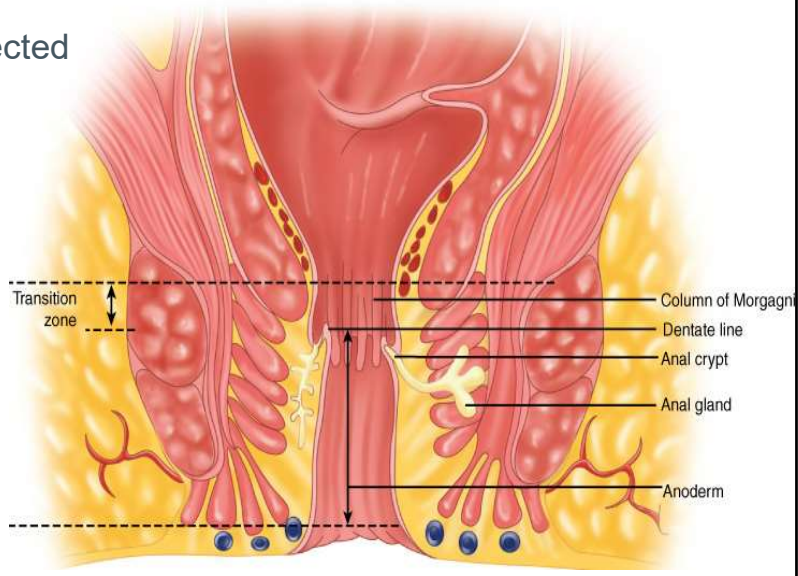
- **Location** = anal verge – anorectal ring
- **Length** = 3-5cm (shorter in women)
- **Relations**
  - Posterior = coccyx
  - Anterior = urethra (male)
    = lower vagina (female)
  - Lateral = ischeorectal fossa (fat, inf rectal vessel and nerves)
- **Anal orifice** = AP slit closed at rest (sphincter + cushion)



Anal canal: Epithelium

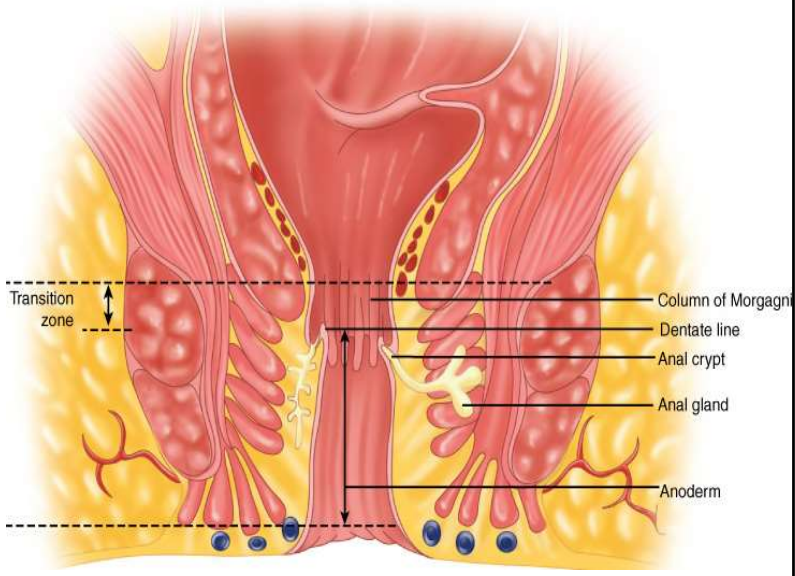
- **above dentate line** = columnar, pink (continuation of rectal mucosa)
  - **Rectal columns (morgagni)** – 8-14 longitudinal folds with base connected to valve at dentate line
  - **Anal papile** – lower end of columns, underlying internal hemorrhoidal plexus (deep purple)
  - **Crypts** - above each valve, total 3-12
  - **Glands** – 4-10, more on posterior, open into crypt,
  - **Ducts** – enter submucosa outward & inferior

    - 2/3 enter IAS, ½ terminate at intersphincteric plane
  - *obstruction of ducts (foreign material in crypt) lead to abscess & fistula



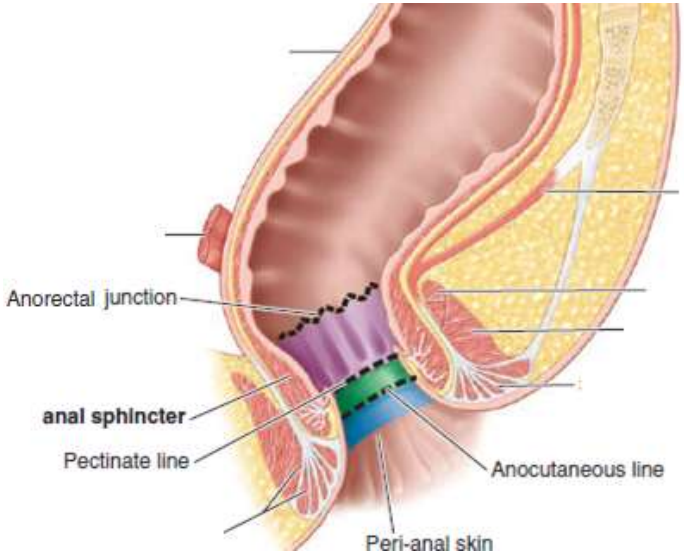
Anal canal: Epithelium

- **Transitional (cloacogenic) zone** – cuboidal, 0.5-1cm above dentate
  - *a site & source of anal tumors
- **Dentate (pectinate line)** – saw toothed junction 2cm form verge
  - *landmark for surgery/colonoscopy (more precise than anal verge)
  - *demarcate innervation (autonomic Vs somatic)
  - * demarcate vasculature (superior Vs inferior hemorrhoidal vessels)
  - *difference in classification & treatment of hemorrhoid



Anal canal: Epithelium

- **Below dentate line** = Cutaneous/squamous
  - **Pectin band** = modified squamous (devoid of hair/gland, smooth, thin, pale, stretched)
    - *round fibrous tissue divided in case of anal fissure probably represents spastic IAS
  - **Anal verge** (anocutaneos line of hilton)
    - *reference for colonscopy/surgery
  - **Perianal skin** (anal margin) = radius of 5cm
    - Overlying EAS – epithelium thicker, pigmented, radiating folds
    - Further distal – hair follicles & glands
    - *why hidradenitis suppurativa doesn't extend to anal canal & can be excised without anal stenosis

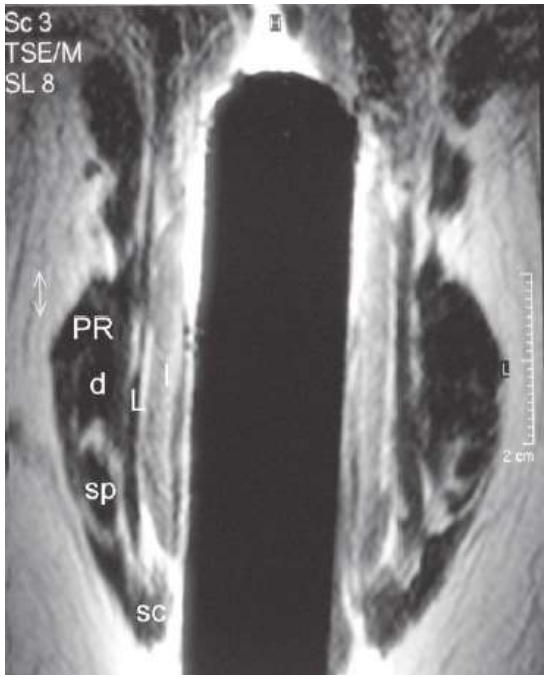


Muscles: Anal sphincter complex

- **Internal sphincter =** Smooth muscle
  - Location - distal condensation of circular muscle of rectum
  - Shape - circular band
  - Length - 2.5-4cm
    - Lower edge palbable 1.2cm distal to dentate
  - Thickeness – 2-3mm
  - *Endosongraphy - uniform hypoecogenicity
  - **Resting tone** - 50-80% (Continuous maximal contraction)
    - Natural barrier to involuntary loss of stool and gas

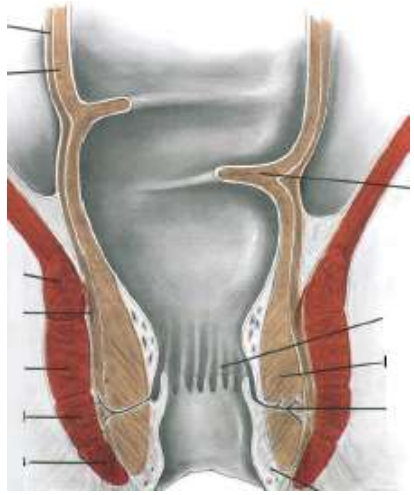
  *can be plapated slightly cranial to EAS

  * intersphincteric groove can be palpated over its distal edge (landmark for lateral sphincterotomy)



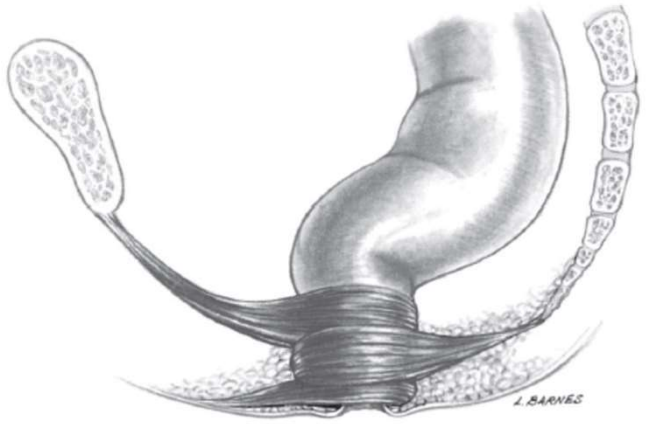
Muscles: Anal sphincter complex

- **Conjoined longitudinal muscle** = mixture of muscles in the intersphincteric plane
  - outer logitudnal layer of rectum at anorectal ring mixed with fibers of levator ani
  - Terminates as a fan of fibers transversing distal part of EAS around hemorrhoidal plexus
  - Some fibers insert to perianal skin (corrugator cutis ani)
  - * “evator ani” because during defecation cause shortening & widening of anal canal, eversion of orfice
  - * skeleton that supports IAS & EAS complex together, minimize deterioration of sphincter after surgery
  - *prevent hemorrhoidal and rectal prolapse
  - *divided adjacent tissues into subspaces (role in containment of sepsis)
  - * responsible for septation of thrombosed external hemorrhoid (cure requires excision of septated region)



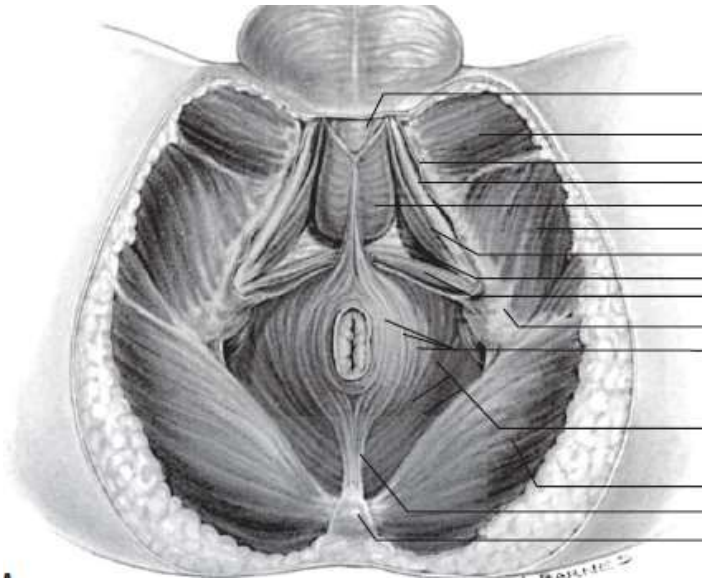
Muscles: Anal sphincter complex

- **External sphincter** – striated muscle
  - Location - envelops entire length of IAS and ends slightly more distal
  - Shape – cylinderic/funnel shaped,
  - Attachment = Anterior (perineal body)
    = Posterior (coccyx via anococcygeal ligament)
  - Parts
    - **deep component** (puborectalis & deep sphincter)
    - **superficial component** (subcutaneous tissue & superficial sphincter)
  - Thickness – 5-8 mm
    *endosonography - mixed ecogenecity (predominantly hyperecogenic)
    - similar to puborectalis (d/f by position, shape, location)
  - Resting tone (unlike other skeletal muscle) - 25-30%
    - Type I fibers (tonically contract)
    - Reflex arc at cauda equine (maintain resting tone, reflexively contract)
  - Difference b/n sexes
    - male = upper half enveloped by CLM, lower half crossed by CLM
    - female = entirely capsulated by CLM & IAS



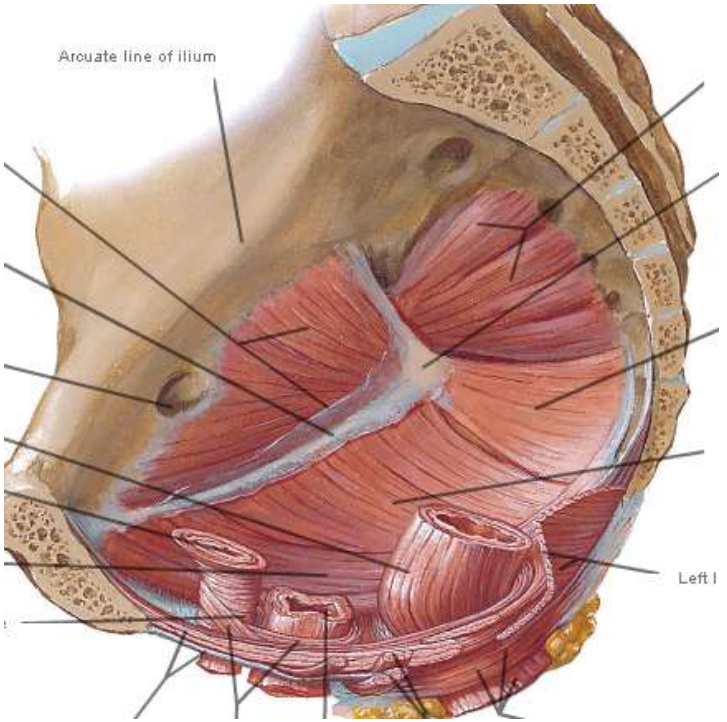
Muscles: Anal sphincter complex

- **Perineal body**
  - bulbous central portion of perineum where EAS, bulbospongiosus & transverse perineal muscles meet
  - *crucial support for perineum, sphincter repairs for incontinence involve reconstruction of this structure



Muscles: pelvic sidewalls

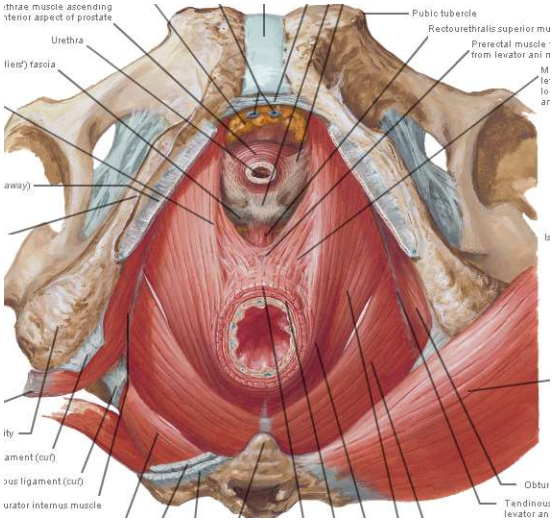
- **Obturator internus & Pririform**
  - *lack clinical relevance to anorectal disease
  -



Muscles: pelvic floor

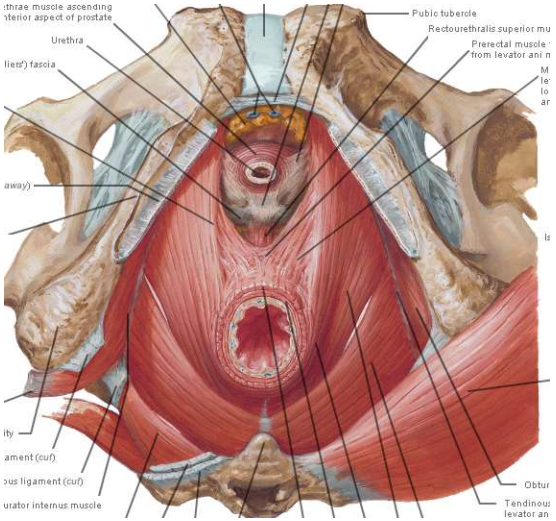
- **Pelvic diaphragm/ levator ani**
  - **Iliococcygeus**
    - Origin = distal ischial spine, post obturator fascia
    - Course = inferior and medial
    - Insertion = lateral aspect of S3, S4 and coccyx, anococcygeal raphe
  - **Pubococcygeus**
    - Origin = post pubis, ant obturator fascia
    - Course = dorsally along anorectal junction to decussate at anococcygeal raphe
    - Insertion = anterior surface of S4 Ischiococcygeus (variable component and Coccyx
  - **Puborectalis** – immediately cephalad to deep component EAS
    - Course = u shaped loop that slings anorectal junction to pubis (gives anorectal angle)
  - **Ischiococcygeus** = rudimentary (few fibers on sacrospinous ligament)

*weakness/dysfunction results in prolapse



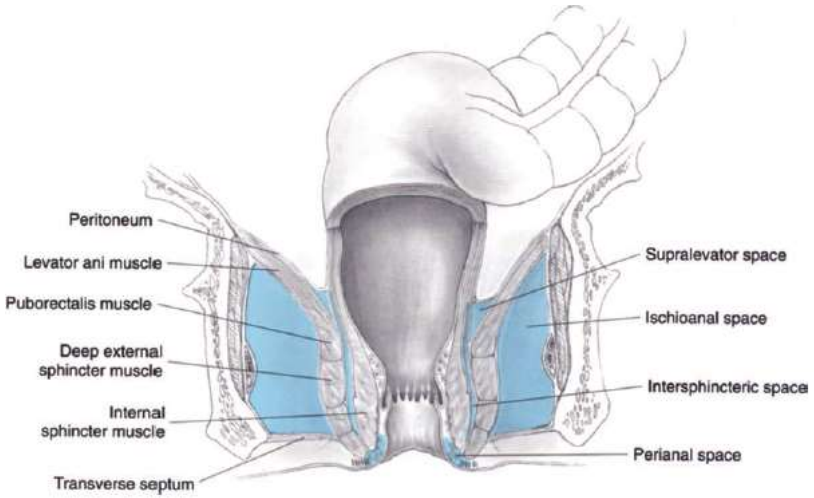
Muscles: pelvic floor

- ***anorectal ring** – muscular ring around anorectal junction
  (upper end of EAS/puborectalis/IAS)
  - *division during surgery for abscess/fistula inevitably results in fecal incontinence
- **levator hiatus** = elliptical midline defect between pubococcygeous
  - Male = rectum, urethra, dorsal vein of penis
  - Female = rectum, urethra, vagina
- **Hiatal ligament** = keeps hiatal viscera together
  - prevents their constriction during contraction of levator ani
- **Other muscles**
  - Rectococcygeus and coccygeous
  - Superficial and deep transverse perineal
  - (*identification guides anterior dissection to avoid urethral injury)



Anorectal spaces

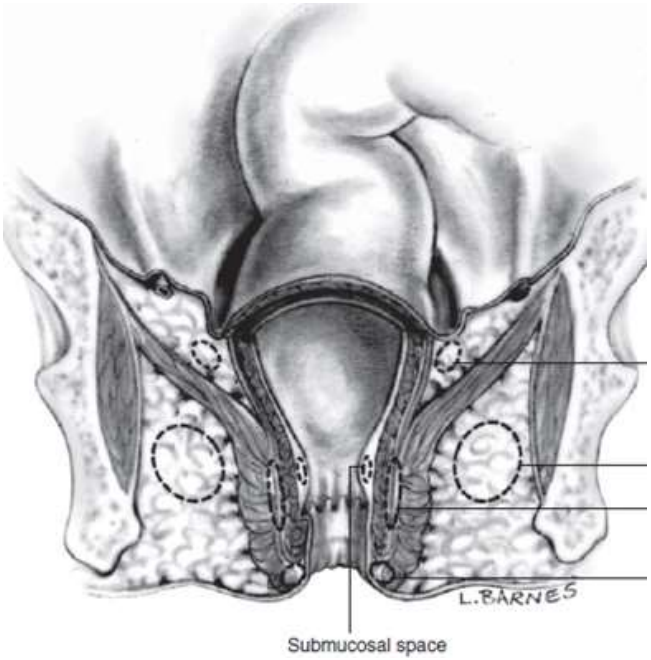
- **Ischiorectal** = upper 2/3 of ischorectal fossa
  - Medial - lateral = anorectum - pelvic sidewall (alcock canal)
  - Superior – inferior = origin of levator ani - perianal space
  - Anteirior – posterior = urogenital diaphragm/transverse perineal muscles – sacrotuberous ligament, gluteus maximus
  - Contents = fat, inferior rectal vessel & nerves



- **Perianal** = lower part of ischorectal fossa surrounding anal verge
  - Continous with = ischorectal space & subcutaneous fat of buttock laterally
    = intersphinctric space medially
  - Content = external hemorrhoid, lowest part of sphincter complex
  - *Tightly bound by corrugator cutis (hemorrhoidal thrombosis results in tender hematoma

Anorectal spaces

- **Intersphincteric** = potential space b/n EAS & IAS
  - Continuous with – perianal space inferiorly
  - *most of the anal glands end here (common site of abscess/fistula)
- **Submucous** – b/n IAS & mucocutaneous lining
  - Continous with submucus layer of rectum & ends at dentate line
  - Content = internal hemorrhoid, muscularis submucosa ani

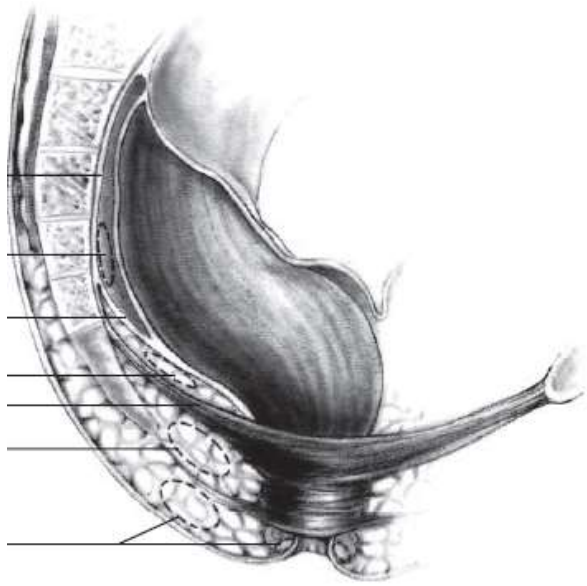


Anorectal spaces

- **Postanal space**
  - **Superficial** = b/n anococcygeal ligament and skin
  - **Deep** (retrosphincteric space of courtney) = b/n anococcygeal ligament & raphe
  - *communicate with isciorectal fossa anteriorly
  - *connection in horseshoe abscess

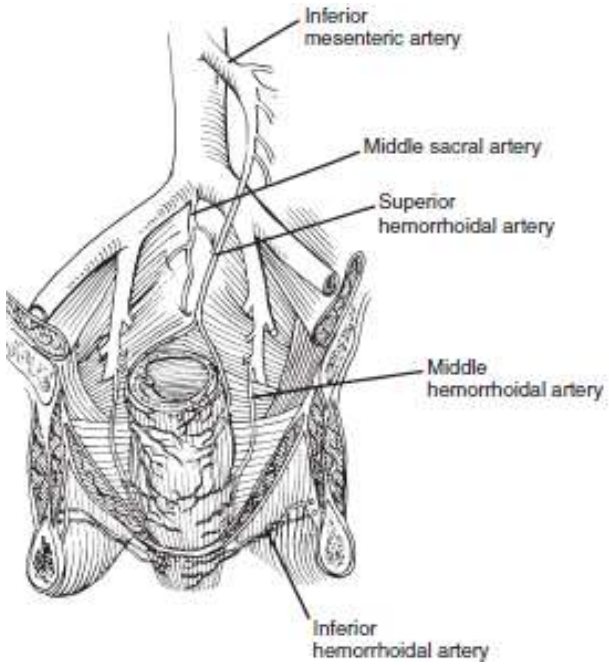
- **Supralevator** = b/n peritoneum superiorly – levator ani;
  = b/n rectum – obturator fascia
  - *abscess in this region could develop from a pelvic origin or can be an upward extension

- **Retrorectal** – fascia propria-presacral fascia; lateral ligaments; rectosacral ligament
  - Continous with retroperitoneum
  - *site for embryologic remnant and presacral tumors



Arterial Supply

- **Collateral circulation**
  - b/n sigmoid (marginal) and superior hemorrhoidal arteries
  - Profuse intramural anastomosis b/n the 3 hemorrhoidal arteres
  - b/n middle hemorrhoidal, internal iliac and external iliac
  - *may prevent gangrene of pelvis in lower extremity in distal aorta occlusion
  - *division of both superior & middle hemorrhoidal doesn't result in necrosis of rectum
  - *important in ileoanal reservoir & restorative proctocolectomy
- **Median sacral artery**
  - Origin – 1.5 cm above aortic bifurcation
  - Course – descend along L5 – coccyx and terminates supplying pararectal
  - *can be encountered during posterior mobilization

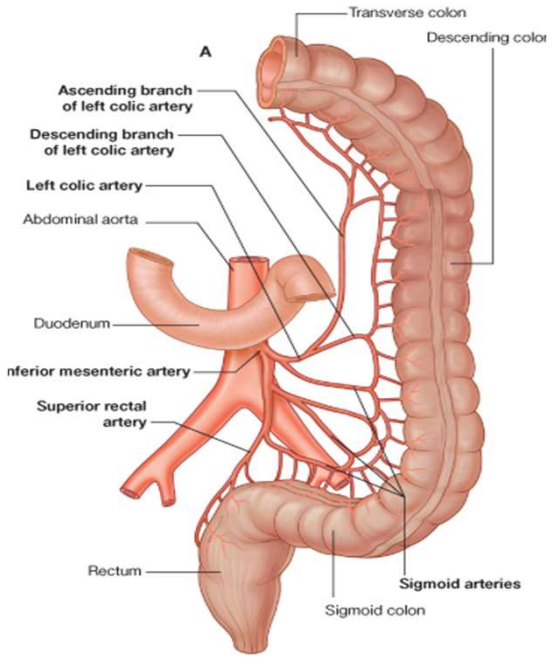


Arterial Supply

- **Inferior mesentric artery**
  - Origin – left anterior Aorta 3-4 cm above above bifurcation
  - Course – downward & left to enter pelvis
  - Branches – left colic artery & 2-6 sigmoidal arteries
  - Change name - to **superior hemorrhoidal/rectal artery** after cross left ilac
  - *care in dissecting around vessels during sigmoid mobilization b/c hypogastric plexus runs around it

- **Superior hemorrhoidal artery**
  - Course - Descendes in simgmoid mesocolon then to post rectum
  - Branches – 80% bifurcate into right & left; 17% multiple branches
  - Course - run within submucosa of rectum
    - condensate in capillary plexus at level of rectal column (5 branches) at 5,7,11 o'clock (internal hemorrhoid groups)

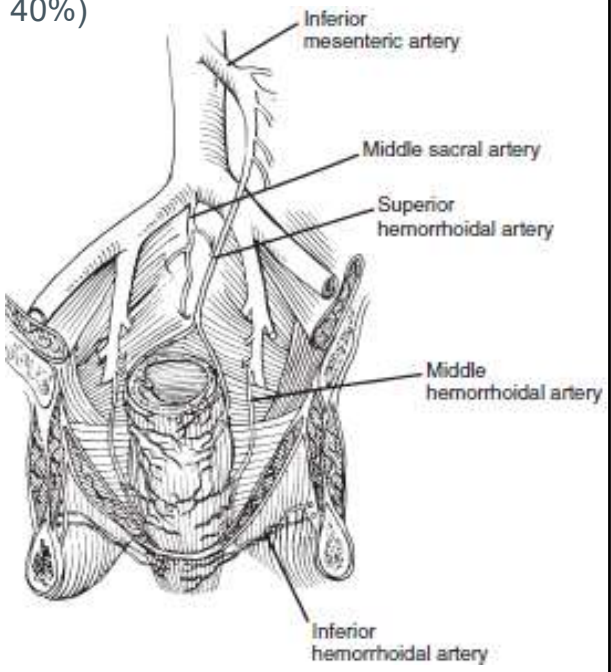
  *why hemorrhoidal bleeding may be bright red



Arterial Supply

- **Middle hemorrhoidal artery**
  - Contribution varies with size of superior hemorrhoidal (may even be absent, unilateral in 40%)
  - Origin – anterior division of internal iliac or pudendal
  - Course – anterolateral close to level of pelvic floor, deep to levator fascia
    - mostly caudal and anterior to lateral ligaments
  - *prone to be injured in low anterior resection on anterolateral dissection

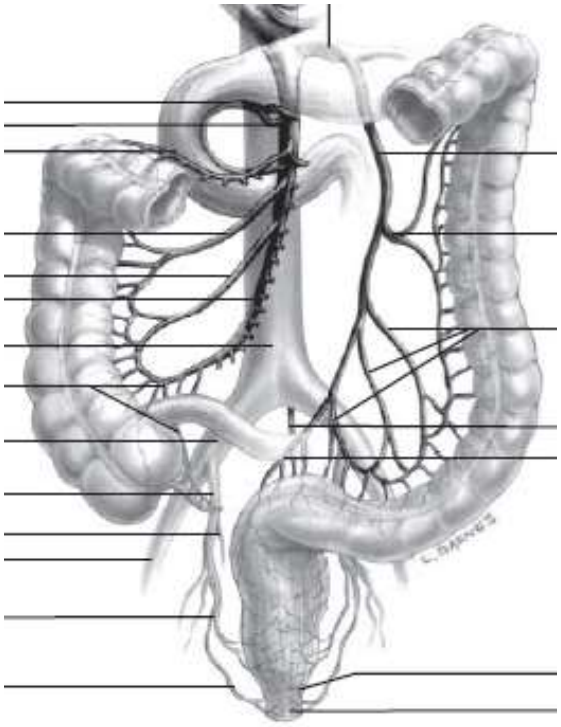
- **Inferior hemorrhoidal artery**
  - Origin - Paired Branch of pudednal artery (branch of internal illiac)
  - Course – pudendal canal>>ischorectal fossa>>EAS>>submucosa>>ascend
  - Variants – type I (85%) – posterior commissure less perfused
  - *when sphincter tone inc vessels could get contused
  - *genesis of anal fissure leading to ischemia of post commisurre
  - *needs to be ligated during perineal stage of APR



Venous drainage

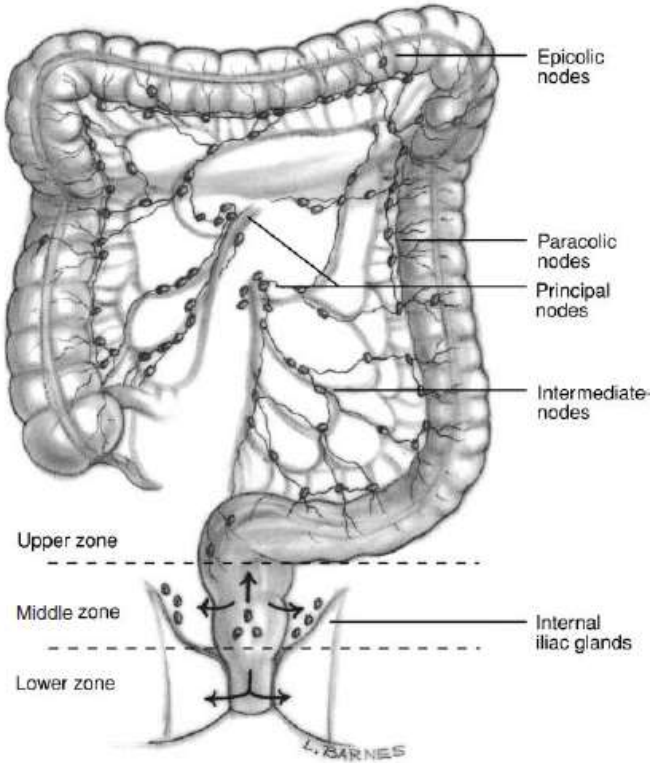
- Follow arterial supply
- Free anastomosis b/n all venous channels
  - **Superior hemorrhoidal vein**>> IMV >>portal vein
  - **Middle & inferior hemorrhoidal vein** >> pudendal>> internal iliac >> IVC
    - *communication among the venous systems may explain lack of correlation b/n portal hypertension & hemorrhoid

- **Anorectal arteriovenous plexus**
  - perirectal (perimuscular) rectal plexus
  - Internal hemorrhoid plexus – submucosal above dentate line
  - External hemorrhoidal plexus – subcutaneous below dentate line
  - * give hemorrhoids when dilated



Lymphatic drainage

- Rich network of lymphatic plexus in submucus & subserous
- Drain upward to perirectal node (mesorectum)
- Lymphatic channels follow vessels
  - **Upper 2/3 rectum** >> cephalad (along SHV) >> **inferior mesentric nodes**
  - **Lower – dentate line** >> cephalad (along SHV) >> **inf mesentric nodes**
    >> laterally (along MHV)>> **internal iliac nodes**
  - **Anus below dentate** >> lateral (along IHV)>> **superficial inguinal nodes**
  - *spread below level of rectal ca occurs only if extensive involvement of proximal LN
- **4 groups of colorectal LN**
  - Epiploic (nodules of gerota) = on bowel wall under peritoneum
  - Paracolic - on marginal artery & arcades
  - Intermidiate - on primary colic vessels
  - Principal – on superior & inverior mesentric vessel

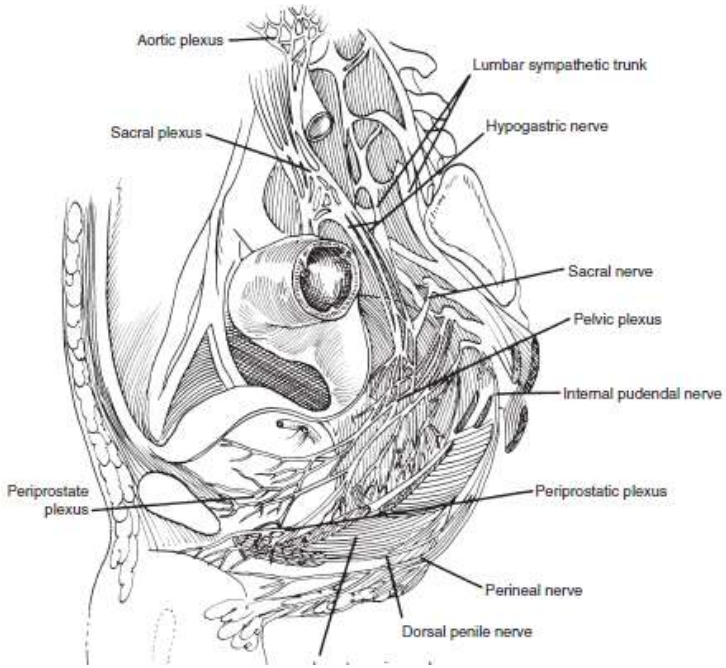


Innervation

- **Autonomic plexuses**
  - Aortic plexus
  - Inferior mesentric plexus (lumbar)
  - Sacral plexus
  - hypogastric plexus (sacral proumontory)
  - **pelvic plexus** (lat pelvis, close to superior surface of levator ani)
    - **Periprostatic plexus** (on denonvilliers' fascia)

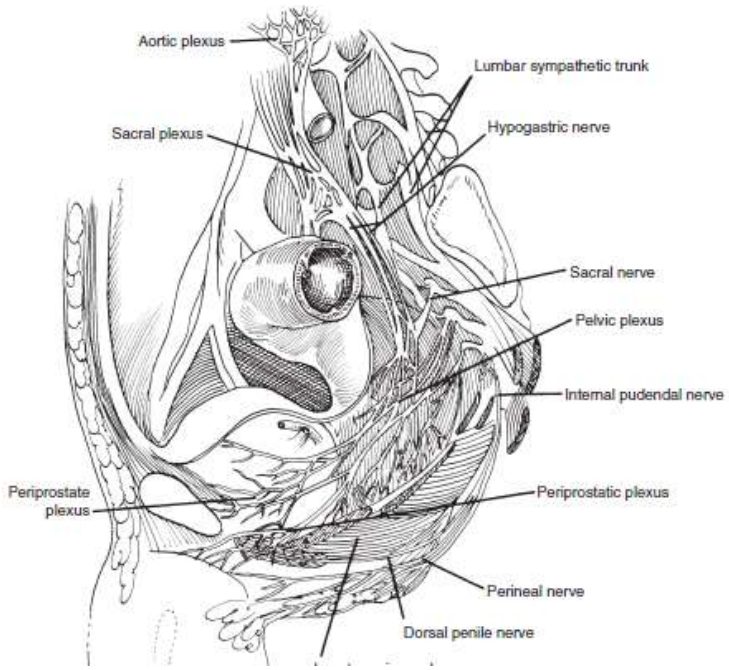
      *damage by excessive traction on rectum laterally or division of lateral stalk

      *urinary & sexual dysfunction after pelvic surgery (low anterior resection, APR)



Innervation

- **Sympathetic** (Lumbar trunk)
  - Upper rectum = L1-3
  - Lower rectum = presacral (aortic plexus & lumbar splanchnic)
  - IAS = L5 (motor)
- **Parasympathetic** (S2-4/ nervi erigentes)
  - emerge through sacral foramen & pass laterally, forward & upward)
  - *easily damaged (no protection like pudendal nerve)
  - isolated injury abolishes erectile dysfunction
  - IAS = (inhibitory)

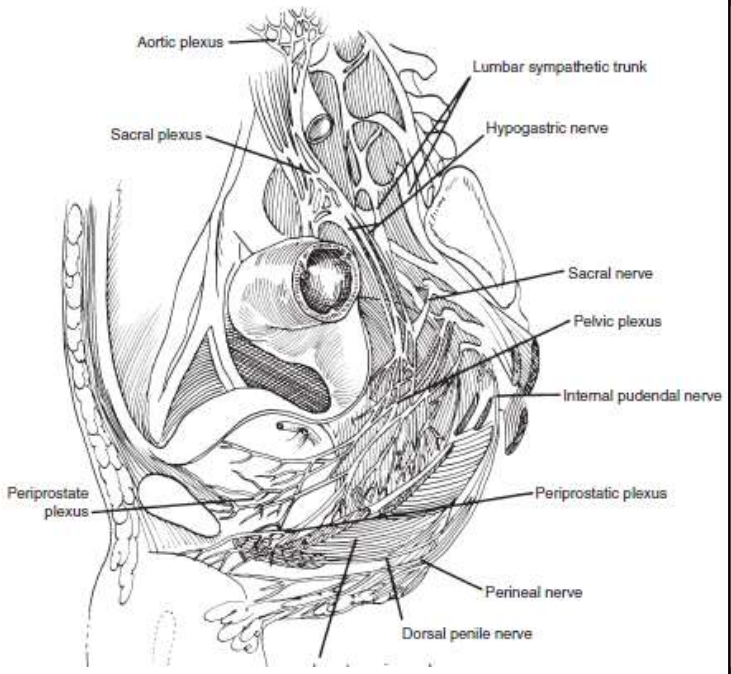


Innervation

- **Somatic** (S2-4/ pudendal)
  - *Travel through Alcock's/pudendal canal (obturator fascia)*
  - Levator ani – S2-4, perineal branch of pudendal
  - Puborectalis – inferior rectal
  - EAS - inferior rectal branch of pudendal (S2-S3) & perineal branch of S4

    *after unilateral transection, function is still preserved
  - Sensation = anal epithelium below dentate (pain in external hemorrhoid)

    *neorectal-anal reflex after proctectomy (? Sensation in pelvic floor)



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Thank You!