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Learning Module: Autonomics of the Abdomen

Sympathetic supply (vasoconstriction and inhibition of peristalsis):
- greater thoracic splanchnic n. (T5-9) - synapses in celiac and superior mesenteric ganglia, some presynaptic fibers reach suprarenal medulla; postsynaptic fibers supply caudal foregut and midgut
- lesser thoracic splanchnic n. (T10-11) - synapses in aorticorenal ganglion; postsynaptic fibers pass primarily into renal plexus
- least thoracic splanchnic n. (T12) - passes into renal plexus
- lumbar splanchnic nn. - L1-2 pass into intermesenteric plexus primarily, synapsing in inferior mesenteric ganglion and supplying hindgut; L3-4 pass into superior hypogastric plexus and into pelvis
- gray rami communicantes - L1-5 pass into lumbar ventral primary rami to innervate vascular smooth muscle, arrector pili muscles, and sweat glands in portions of the body wall and lower limb supplied by L1-5

Parasympathetic supply (stimulates peristalsis and secretomotor to glands):
- anterior vagal trunk - gastric and hepatic branches; supplies stomach and liver/gall bladder
- posterior vagal trunk - gastric and celiac branches; supplies stomach and remainder of caudal foregut and midgut (distribution of superior mesenteric a.)
- pelvic splanchnic nn. - send branches through fusion fascia to reach hindgut (from distal one-third of transverse colon to anal canal)

Review Items
Kidney: (N 334,342)
Paravertebral gutters (N 263,342,329) - space between psoas major and quadratus lumborum where kidneys lie
Pararenal fat - fat outside renal fascia
Renal fascia - layer of membrane between two layers of fat, perirenal and pararenal
Perirenal fat (adipose capsule) - fat deep to the fascia covering the kidneys and suprarenal gland
Renal (fibrous) capsule: directly surrounding kidneis; no fat deep to it (visceral fascia)
Hilum: opening on medial margin of kidney where vessels and ureter leave/enter kidney
Sinus: hollowed out area in medial margin; contains renal vessels, calyces, pelvis and perirenal fat
Cortex: outer layer of kidney; contains majority of glomeruli
Renal columns: cortical tissue in medulla btwn pyramids
Medulla: inner layer of kidney; contains tubules
Renal pyramids: cone of tubules in medulla
Renal papillae: tip of pyramid projecting into minor calyx
Minor calyx: drains one renal papilla
Major calyx: unification of several minor calyces
Renal pelvis: major calyces come together and form large collecting duct; dilated origin of ureter
Ureter: muscular tube that carries urine to bladder; passes over pelvic brim medial to testicular/ovarian vessels; passes obliquely through posterior wall of bladder and drains into posterolateral angle of the vesical trigone
Suprarenal gland: (N 347): endocrine gland located superomedial to the kidney; right
suprarenal gland is somewhat triangular in shape, left suprarenal gland is semilunar in shape
Cortex: manufactures corticosteroids
Medulla: manufactures EPI/NE
Branch of greater thoracic splanchnic n. (N 318,346): sympathetic innervation of medulla

**Diaphragm**: (N 185,263)
Lateral arcuate lig: thickening of quadratus lumborum fascia; fibers originating here along w/ fibers from medial arcuate lig fill in the gap between the crura and costal part of the diaphragm
Medial arcuate lig: thickening of psoas major fascia
Median arcuate lig: formed by right and left crus of diaphragm anterior to aortic hiatus
Central tendon: where everything attaches and aorta passes through
Right and left crura: right originates at L1-L3; left at L1-L2; fibers from right and left crus intermingle to form aortic hiatus; right splits to enclose esophagus
Aortic hiatus: formed by intermingling of right and left crus fibers; T12; transmits descending aorta, thoracic duct and azygos vein (sometimes)
Esophageal hiatus: formed by splitting of right crus; T10; transmits esophagus, ant/post vagal trunks, branches of left gastric vessels, and small lymphatic vessels
Caval foramen (hiatus): T8; transmits IVC, right phrenic nerve branches, small lymphatics
Vertebrocostal trigone: area of diaphragm superior to lateral arcuate ligament; muscle is deficient and primarily enclosed by fascia; herniation

**Muscles**: (N 263)
Psoas major & minor: originates at bodies and transverse processes of lumbar vertebrae; inserts at lesser trochanter of femur w/ iliacus via iliopsoas tendon; flexes thigh, lateral bends of lumbar; VPR L2-4; subcostal and lumbar aa.; minor only in 60% of individuals
Quadratus lumborum: originates on posterior part of iliac crest and the iliolumbar ligament; inserts on transverse processes of lumbar vertebrae 1-4 and 12th rib; laterally bends the trunk, flexes 12th rib; subcostal n. and VPR L1-4; subcostal and lumbar aa.; lateral arcuate ligament crosses anterior surface
Iliacus m.: origin at iliac fossa and crest, ala of sacrum; inserts on lesser trochanter of femur; flexes thigh and pelvis on thigh; femoral n.; iliolumbar a; combines w/ psoas

**Abdominal aorta**: (N 264)
Inferior phrenic a.: supplies diaphragm and suprarenal gland (via superior suprarenal aa.); first abdominal branch of aorta, may come off celiac trunk
Celiac trunk (N 300,301,302): refer to Dudodenum lab, comes off at L1
Superior mesenteric a. (N 306): comes off at L2
Renal aa. (N 332,335): comes off at L2 caudal to SMA; supplies kidney, upper ureter, suprarenal gland; right longer than left, right passes posterior to IVC
Interlobar aa.: branches of renal aa. supplying lobes of kidney
Supernumerary renal aa. (N 333): often there are multiple renal arteries coming directly off the abdominal aorta
Gonadal aa. (N 332,400,401): come off abdominal aorta at L3
Suprarenal aa. (N 332): supply suprarenal gland
Superior: multiple branches of inferior phrenic
Middle: directly off ab aorta
Inferior: off renal artery
Inferior mesenteric a. (N 307): comes off at L3
Lumbar segmental aa.: comes off at bottom margin of its respective level; course posterior to psoas major m
Median sacral a.: continuation of abdominal aorta in median plane
Common iliac aa.: comes off at L4; supplies pelvis and lower limb; aorta bifurcates at L4
to form common iliac aa.; common iliac bifurcates anterior to sacroiliac articulation into external and internal branches

**Inferior vena cava:** (N 265)
Common iliac vv.: paired w/ artery; joins IVC at L5
Lumbar segmental vv. (N 332): paired w/ artery
Right gonadal v. (N 332, 400, 401): joins IVC at L2; paired w/ artery; left drains into left renal
Right renal v. (N 332, 341): paired w/ artery; shorter than left
Right suprarenal v. (N 332): drains into IVC at L1
Right inferior phrenic v.: paired w/ artery; drains directly into IVC
Left renal v. (N 332, 328): drains into IVC at L1
Left gonadal v. (N 332, 400, 401): drains in left renal
Left suprarenal v. (N 332): drains into left renal
Left inferior phrenic v. (N 332): drains into left renal

**Nerves:**
Celiac branches of posterior vagal trunk (N 318, 319): fibers from posterior vagal trunk that innervate the organs supplied by SMA and celiac trunk
Celiac ganglia and plexus (N 318, 319, 320): preganglionic sympathetics arrive via greater thoracic splanchnic; postganglionic fibers distribute via plexus around celiac trunk; supplies vascular smooth muscle of branches of celiac trunk, sensory from stomach, liver, biliary system, spleen, upper half of duodenum and pancreas; usually 2 ganglia, branches of vagus pass through w/o synapsing
Aorticorenal ganglion (N 318): preganglionic sympathetic via lesser thoracic splanchnic; branches to renal plexus; vascular smooth muscle of renal aa.; pain from kidney, suprarenal gland and upper ureter; ganglion is located above or near origin of renal a.
Superior mesenteric ganglion & plexus (N 318, 322): preganglionic from celiac plexus; VSM of branches of SMA; pain from lower half of pancreas and duodenum, jejunum, ileum, cecum, appendix, ascending colon and transverse colon; at origin of SMA
Greater thoracic splanchnic n.: T5-T9; senses pain from abdominal viscera, causes release of EPI/NE from adrenal gland; passes through crus of respiratory diaphragm
Lesser thoracic splanchnic n.: T10-11; goes to aorticorenal ganglion, senses pain from kidney and suprarenal gland; passes through crus of diaphragm
Least thoracic splanchnic n.: T12; renal plexus; pain from kidney/suprarenal gland; synapses in minute ganglia of renal plexus
Lumbar ganglia (N 318):
Lumbar splanchnic nn. (N 318): lumbar sympathetic ganglia L1-4; VSM of abdominal and pelvic viscera; pain; contribute to preaortic abdominal plexuses
Intermesenteric plexus (N 318): lumbar splanchnic 1-2; renal, testicular/ovarian, ureteric brs; sympathetic to smooth muscle of vessels distal to splenic flexure; pain from descending, sigmoid colon and rectum; continuous w/ superior mesenteric plexus and inferior mesenteric plexus; doesn't carry vagal fibers; anterior to aorta
Superior hypogastric plexus (N 318): fibers from intermesenteric and lumbar splanchnic nn.; gives off hypogastric nn.; VSM of pelvic viscera; pain; crosses pelvic brim
Lumbar segmental nn. (N 267, 496, 497): form lumbar plexus; same as spinal nerves?
Lumbar sympathetic trunk (N 267, 318):
Gray rami communicantes: carries postganglionic sympathetic axons to the spinal nerve; spinal nerve carries those peripherally to body; connect to spinal nerve at all levels
White rami communicantes: T1-L2; axons synapse on postganglionic cell bodies to innervate body; carries pain signals; connect w/ sympathetic chain on level T1-L2; preganglionic sympathetic axons
Subcostal n. (N 267, 496): VPR of T12; has lateral/anterior cutaneous brs; innervates muscles of ab wall; skin of anterolateral ab wall
Lumbar plexus (N 267,497,498): VPR L1-4; see below for branches
  Iliohypogastric n.: VPR L1; muscles of lower ab wall; skin of lower ab wall, upper hip and thigh; contribution from T12 in 50% of cases
  Ilioinguinal n.: VPR L1; gives off anterior scrotal br.; muscles of lower ab wall; skin of lower ab wall and scrotum/labia; courses through inguinal canal and superficial inguinal ring
  Genitofemoral n.: VPR L1-2; genital and femoral brs; cremaster m.; skin of anterior scrotum and labia major and upper medial thigh; lies on anterior surface of psoas major in abdomen
  Lateral femoral cutaneous n.: VPR L2-3; sympathetic motor innervation to skin of lateral thigh; carries postganglionic sympathetic fibers to skin
  Femoral n.: VPR L2-4; muscles of anterior thigh; skin of anterior thigh; passes under inguinal ligament lateral to femoral a.
  Obturator n.: VPR L2-4; muscles of medial thigh; skin of lower medial thigh; passes through obturator canal

**Lymphatics:** (N 266,546)
  Lumbar (lateral aortic) nodes: along IVC and aorta from aortic bifurcation to aortic hiatus; empty into lumbar trunk; drains lower limb, pelvic organs, perineum, anterior and posterior ab wall, kidney, adrenal gland, diaphragm
  Lumbar lymph trunks: btwn lumbar vertebral bodies and IVC/aorta at upper end of lumbar chain of nodes; empties into thoracic duct/cisterna chyli; drains body below diaphragm
  Intestinal trunk: located on left side of aorta or btwn aorta and IVC near SMA; union of vessels from celiac and SM nodes; empties into left lumbar trunk (70%) or directly into cisterna chyli/thoracic duct (25%) (5% into right lumbar trunk); drains intestines; rich in fat lymph
  Cisterna chyli: union of left and right lumbar trunks; enlargement of thoracic duct present in 25% of people; btwn aorta and IVC around L1 or L2
  Femoral ring & deep inguinal lymph nodes:

**Clinical Terms:**
  Femoral nerve iatrogenic injury: during open abdominal surgeries, retractor blades rest on femoral nerve crushing it as it is in groove btwn iliacus and psoas major
  Renal calculus (kidney stone)
  Cystic kidney: growth of fluid filled cysts in kidney replacing functional tissue; can cause complications elsewhere distinguishing it from harmless cysts that come w/ age
  Horseshoe/pelvic kidney: kidneys united at inferior poles and migrate until stopped by IMA
  Hiatal hernia: portion of stomach protrudes through diaphragm; obesity and smoking risk factors; associated w/ reflux esophagitis (heartburn, difficulty swallowing, chest pain and belching); tx w/ H2 antagonists, proton pump inhibitors and antacids
  Congenital diaphragmatic hernia: congenital abnormal protrusion of ab contents upward through defect in diaphragm; treated surgically b/c it can interfere w/ breathing; common occurs on left
  Abdominal aortic aneurysm (AAA): distended and weakened area of aortic wall; usually below renal arteries and above bifurcation; sudden, severe ab pain w/ radiation to back
  Intravenous pyelogram (IVP): diagnostic test that follows time course of excretion of radiopaque contrast due through kidneys, ureters and bladder after injection into a cutaneous vein

The obturator nerve lies along the medial border of the psoas major muscle. The femoral nerve lies along the lateral border of the psoas major muscle, between psoas major and iliacus. The genitofemoral nerve pierces psoas major then lies on top of that muscle. The ilioinguinal nerve emerges at the lateral border of psoas major, then travels laterally.