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The Peripheral Vascular Exam

--Manuscript Draft--

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Overview:

The prevalence of peripheral vascular disease (PVD) increases with age and is a significant cause of morbidity in older patients, and peripheral artery disease (PAD) is associated with cardiovascular and cerebrovascular complications. Diabetes, hyperlipidemia, hypertension, and tobacco use are important disease risk factors. When patients become symptomatic, they frequently complain of limb claudication, defined as a cramp-like muscle pain that worsens with activity and improves with rest. Patients with chronic venous insufficiency (CVI) often present with lower extremity swelling, pain, skin changes, and ulceration.

While the benefits of screening asymptomatic patients for PVD are unclear, physicians should know the proper exam technique when the diagnosis of PVD is being considered. This video reviews the vascular examination of the upper and lower extremities and abdomen. As always, the examiner should use a systematic method of examination, though in practice, the extent of the exam a physician performs depends on their suspicion of underlying PVD. In a patient who has or is suspected to have risk factors for vascular disease, the vascular exam should be thorough, beginning with inspection, followed by palpation, and then auscultation, and it should include special maneuvers, such as determining the ankle brachial index. Maneuvers that make use of a handheld Doppler are demonstrated in a companion video.

Comment [JR1]: Also not demonstrated in this video: The vascular exam of the head and neck, nor the maneuvers to diagnose cardiac conditions that involve examination of the extremities. If necessary, this note can be added to the Overview.

(And if necessary, the sentence, "Maneuvers that make use of a handheld Doppler are demonstrated in a companion video" can be removed.)

Procedure:

1. Preparation.

1.1. Wash your hands prior to examining the patient.

1.2. Have the patient put on a gown. This examination should never occur through clothing.

1.3. Check the blood pressure in both arms.

2. The Upper Extremities.

2.1. Have the patient lie supine on the exam table, with the head raised to a comfortable position.

2.2. Begin with inspection by exposing the entirety of both arms. Note symmetry, color, hair pattern, size, skin changes, nail changes, varicosities, muscle wasting, and trauma (**Table 1**).

2.3. Palpate by using the back of the fingers to assess skin temperature. Examine from distal to proximal, comparing one side to the other.

2.3.1. Assess capillary refill by applying firm pressure over the distal 1st or 2nd digit for 5 sec. Release pressure and count how many seconds it takes for the normal skin color to return. A normal capillary refill time (CRT) is less than 2 sec, and values greater than 5 sec increase the likelihood of vascular disease. Additionally, CRT may be prolonged in hypovolemia and cooler ambient temperatures.

2.3.2. Palpate for edema over the dorsum of the hands using firm pressure for at least 2 sec. If present, palpate proximally, noting the extent and distribution of the edema, and whether or not it is pitting. Grade the edema as trace, mild, moderate, or severe.

2.3.3. Palpate the major arteries and note the symmetry, the intensity, and the regularity of the pulse. Useful terminology to describe the pulse intensity includes absent, diminished, normal, or bounding. If unsure, compare the patient's pulse to your own pulse. Use anatomical landmarks to find the pulse. If no pulse is felt, vary the pressure, then adjust your position, as there is variability in the path of each artery.

Comment [j2]: Landmarks will be demonstrated on the patient

Comment [AS3]: These are described in 2.3.3.1, 2.3.3.2, and 2.3.3.3.

2.3.3.1. Palpate the radial arteries, which lie lateral to the flexor carpi radialis tendon.

2.3.3.2. Palpate the ulnar arteries, which are just lateral to the flexor carpi ulnaris tendon.

2.3.3.3. Palpate the brachial arteries in the antecubital fossa, medial to the biceps tendon. The artery can be followed proximally in the medial groove between the biceps and triceps muscles.

3. The Abdomen.

3.1. Lower the head of the table so the patient is lying flat.

3.2. Inspect the abdomen for dilated veins. Dilated veins around the umbilicus may be due to portal hypertension or obstruction of the inferior vena cava (IVC).

3.2.1. For dilated superficial veins, determine the direction of filling by using a finger to compress the vein proximally.

3.2.2. Use a second finger to strip the blood distally from the vein and then leave the finger in place, thus compressing two points along the flattened vein.

3.2.3. Remove the proximal finger and note the speed at which the vein refills.

3.2.4. Repeat the process; however, remove the distal finger and compare the filling speed. Note the direction of the fast filling, which is away from the source of venous hypertension.

3.3. Palpate for the abdominal aorta, just above the umbilicus and slightly left of the midline. Use 3 to 4 finger pads of both hands to apply slow and steady downward pressure. The hands should point cephalad and slightly toward each other.

3.3.1. Once the pulse is encountered, gradually bring the fingertips closer together until the lateral walls of the aorta are felt. Measure the distance between the fingers.

3.4. Next, auscultate for bruits using the diaphragm of the stethoscope, applying moderate pressure. A bruit with a systolic and diastolic component is more likely to be pathologic than a systolic bruit alone.

3.4.1. Auscultate the renal arteries above the umbilicus and 1" to 2" lateral to the midline.

3.4.2. Auscultate the abdominal aorta above the umbilicus and to the left of the midline.

3.4.3. Auscultate the iliac arteries below the umbilicus and 1" to 2" lateral to the midline.

4. The Lower Extremities.

4.1. Begin with inspection by exposing the entirety of both legs, but leave the genitalia covered. Look for changes as described in Step 2.2 and **Table 1**.

4.2. Palpate for temperature, CRT, edema, and arteries, as described in Step 2.3.

4.2.1. Palpate the dorsalis pedis (DP) arteries, just lateral to the extensor hallucis longus tendon. One or both DP arteries may be congenitally absent in a small percentage of patients.

4.2.2. Palpate the posterior tibialis (PT) arteries at the posterior-inferior aspect of the medial malleolus.

4.2.3. Palpate the popliteal arteries, beginning with the leg slightly flexed at the knee. Place both thumbs on the patellar ligament and wrap your fingers around the knee, such that the fingertips land in the middle of the popliteal fossa. If there is difficulty identifying the pulse, gradually flex the knee in 15° intervals while continuing to palpate. If unable to encounter the pulse in this position, have the patient turn to the prone position, flex the knee, and support the lower extremity. Place your hands on either side of the knee and use the thumbs to palpate the popliteal artery.

4.2.4. Palpate the femoral arteries, just inferior to the inguinal ligament, approximately midway between the anterior superior iliac spine and the symphysis pubis.

4.3. Auscultate the femoral arteries using the bell or diaphragm of the stethoscope, using light pressure, so as not to artificially induce a bruit.

5. Special Maneuvers.

5.1. Use the Allen test prior to cannulating the radial artery to ensure adequate collateral flow through the palmar arch from the ulnar artery.

5.1.1. Begin by palpating the ulnar and radial arteries on the side.

5.1.2. Ask the patient to make a tight fist.

5.1.3. Apply sufficient pressure over the ulnar and radial arteries to occlude them.

5.1.4. Ask the patient to open the fist, and note the pallor of the palm.

5.1.5. Release the ulnar artery. If sufficient collateral flow is present, the palm should become pink again within 3 to 5 sec.

5.2. Use Buerger's test to assess for PAD of the lower extremities, and it may also be useful for predicting the severity of the disease. With the patient supine, elevate the legs to 60° for 2 min or until the pallor of the distal extremity is noted.

5.2.1. Lower the legs and allow them to dangle below the table's edge. Observe for 2 min or until a hyperemia is observed over the dorsum of the foot, indicating arterial insufficiency.

5.3. Perform the following maneuvers in patients with varicose veins to localize the site of incompetent valves. **Figure 1** illustrates the superficial and deep venous system of the legs.

Comment [AS4]: These tests have unhelpful test parameters when performed without Doppler. They are described in the text for completeness but not demonstrated in the video. Each test is performed in patients with varicose veins.

5.3.1. Perform the Brodie-Trendelenburg test with the patient in the supine position.

5.3.1.1. Elevate the leg of interest and strip the blood proximally out of the great saphenous vein (GSV).

5.3.1.2. Compress the GSV just below the sapheno-femoral junction (SFJ), and ask the patient to stand.

5.3.1.3. Observe the filling of the GSV, which under normal circumstances, fills distal to proximal and takes 20 to 30 sec. Rapid filling with the GSV occluded suggests insufficiency of the perforating veins.

5.3.1.4. Release the pressure over the GSV. Accelerated filling suggests venous insufficiency at the level of the SFJ.

5.3.2. Perform the cough test to detect reflux at the SFJ. With the patient standing, palpate over the SFJ with light pressure.

5.3.2.1. Instruct the patient to cough. A palpable thrill suggests retrograde flow and venous insufficiency.

5.3.3. To perform the Perthes test, place a tourniquet around the leg, just below the knee.

5.3.3.1. Instruct the patient to perform 10 heel raises. Emptying of the varicose veins suggests incompetence above the level of the tourniquet (SFJ, sapheno-popliteal junction, or thigh perforating veins). If the veins remain distended, the site of insufficiency is the calf perforating veins.

Summary:

Peripheral vascular disease is an important cause of morbidity, particularly in older patients. The detection and subsequent treatment of PVD can improve quality of life and potentially mitigate cardiovascular and cerebrovascular complications. General screening for peripheral vascular disease of the extremities is not a current recommendation by the US Preventive Service Task Force (USPSTF). However, the USPSTF does recommend ultrasound screening for abdominal aortic aneurysms in males who have smoked and are aged 65 to 75. Additionally, the American Heart Association/American College of Cardiology recommends a comprehensive vascular exam in anyone at risk of PVD.

The most important findings that make PAD more likely in a patient include characteristic ulcers, asymmetric temperature difference in the foot, absent pulses, and limb bruits. The most important finding that argues against significant PAD is the presence of at least one pedal pulse on a given leg. A positive Buerger's test increases the likelihood of more extensive disease. Of the physical exam maneuvers to localize the site of reflux in patients with varicose veins, Perthes and Brodie-Trendelenburg tests are the most helpful for ruling out a particular location as the site of reflux. The overall accuracy of these venous reflux maneuvers is limited, however, and detection of the site of reflux is improved through use of a handheld Doppler.

This video reviewed a systematic method and proper technique of vascular examination of the extremities and abdomen, and included a review of special diagnostic maneuvers that should be performed if PVD is suspected. Like all aspects of the physical exam, practice is critical for improving accuracy, and an understanding of the relevant anatomy is important to a successful examination and interpretation of the exam findings.

Figures and Tables:

Figure 1: The major arteries and superficial and deep venous system of the legs.

Table 1: Skin changes associated with peripheral vascular disease.

Comment [JR5]: Office base Doppler procedures are reviewed in an accompanying video.

Comment [JR6]: We've found two separate images in a textbook (Page 20 and 23 of http://www.amazon.com/gp/product/0974769436/ref=oh_aui_detailpage_o00_s00?ie=UTF8&psc=1).

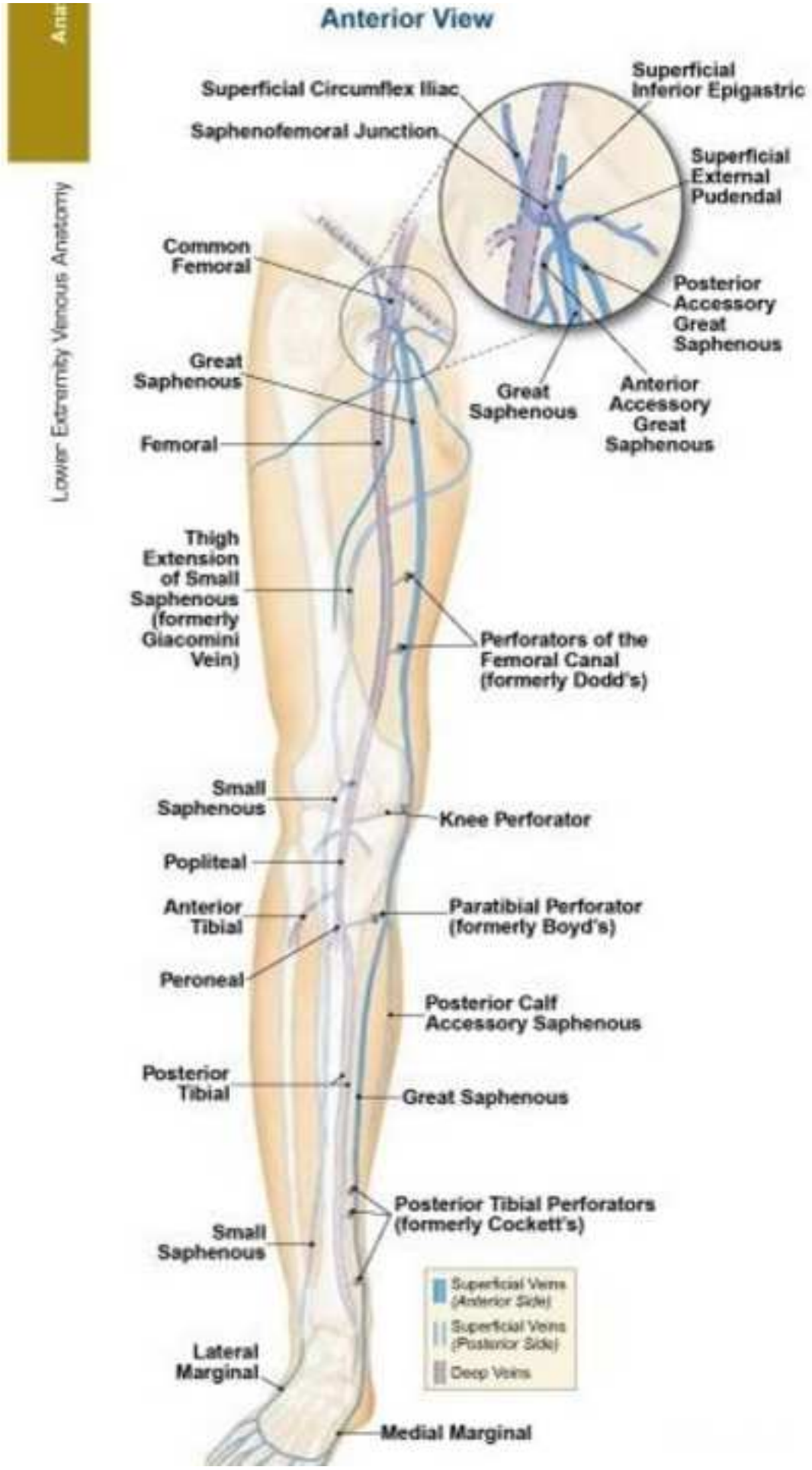
We don't have permission to use these images, so if possible, could these two images be re-created and combined into one image?

The anterior view of the venous system of the leg could be placed next to the anterior view of the major arteries of the leg. This Figure could then be used for both this manuscript and also the Doppler manuscript.

A potentially easier re-creation could be done based off of the image in this link, which the author confirmed would work: http://www.ucirvinehealth.org/layouts/modules/StayWell/Default/GetImage.aspx?imageId=125516

Finding	Peripheral Arterial Disease	Chronic Venous Insufficiency
Edema	Absent or mild	Present, unilateral, or bilateral
Ulcers	Well demarcated, often distal leg, dorsum of foot, toes (trauma sites)	Irregular margins, often over anterior shin and medial malleolus
Hair Distribution	Decreased	No change
Color	Pallor (acute), dependent hyperemia (chronic), distal gangrene (severe)	Brown-red hyperpigmentation
Nails	Decreased growth, thickened	Thickened, darkened, onychomycosis
Varicose Veins	Absent	Present
Muscle Atrophy	May be present	Difficult to detect due to significant edema
Skin Appearance	Thin, shiny, atrophic	Thickened, scaly
Temperature	Cool	No change

Click here to download Photo or Graphic File: Part 1 of Figure (A).jpg

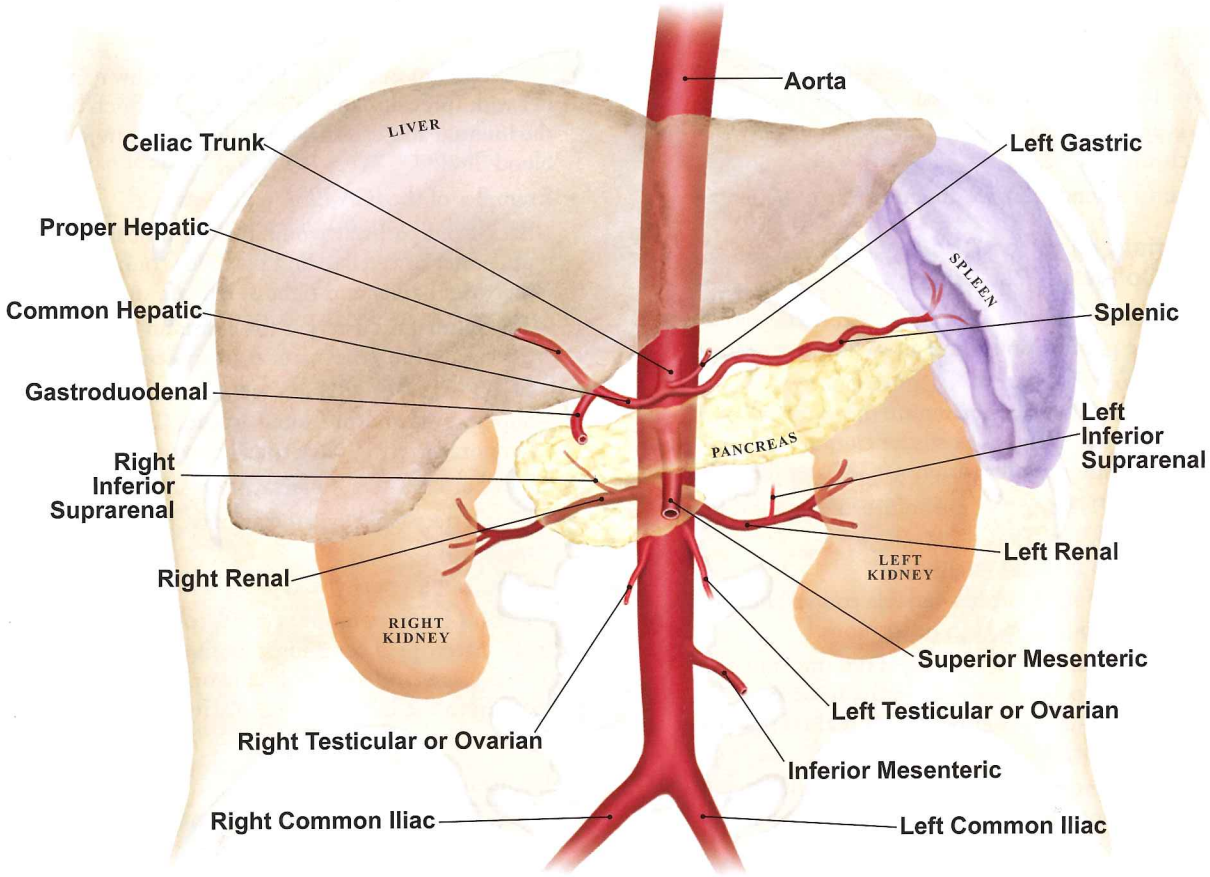


Click here to download Photo or Graphic File: Part 2 of Figure (B).jpg

Anatomy

Abdominal Vasculature

Abdominal Arterial System



Abdominal Arterial Anatomy

- The abdominal aorta begins as the descending aorta and crosses the diaphragm.
- The abdominal aorta bifurcates into the right and left common iliac arteries at the level of the umbilicus.
- The abdominal aorta has five main branches:
  - **Celiac artery**: (also known as the celiac trunk or celiac axis) supplies the liver, gallbladder, stomach, intestines and pancreas.
    - There are three branches of the celiac artery:
      - Splenic artery
      - Common hepatic artery
      - Left gastric artery

In some cases, the SMA and celiac trunk have a common origin off the abdominal aorta.

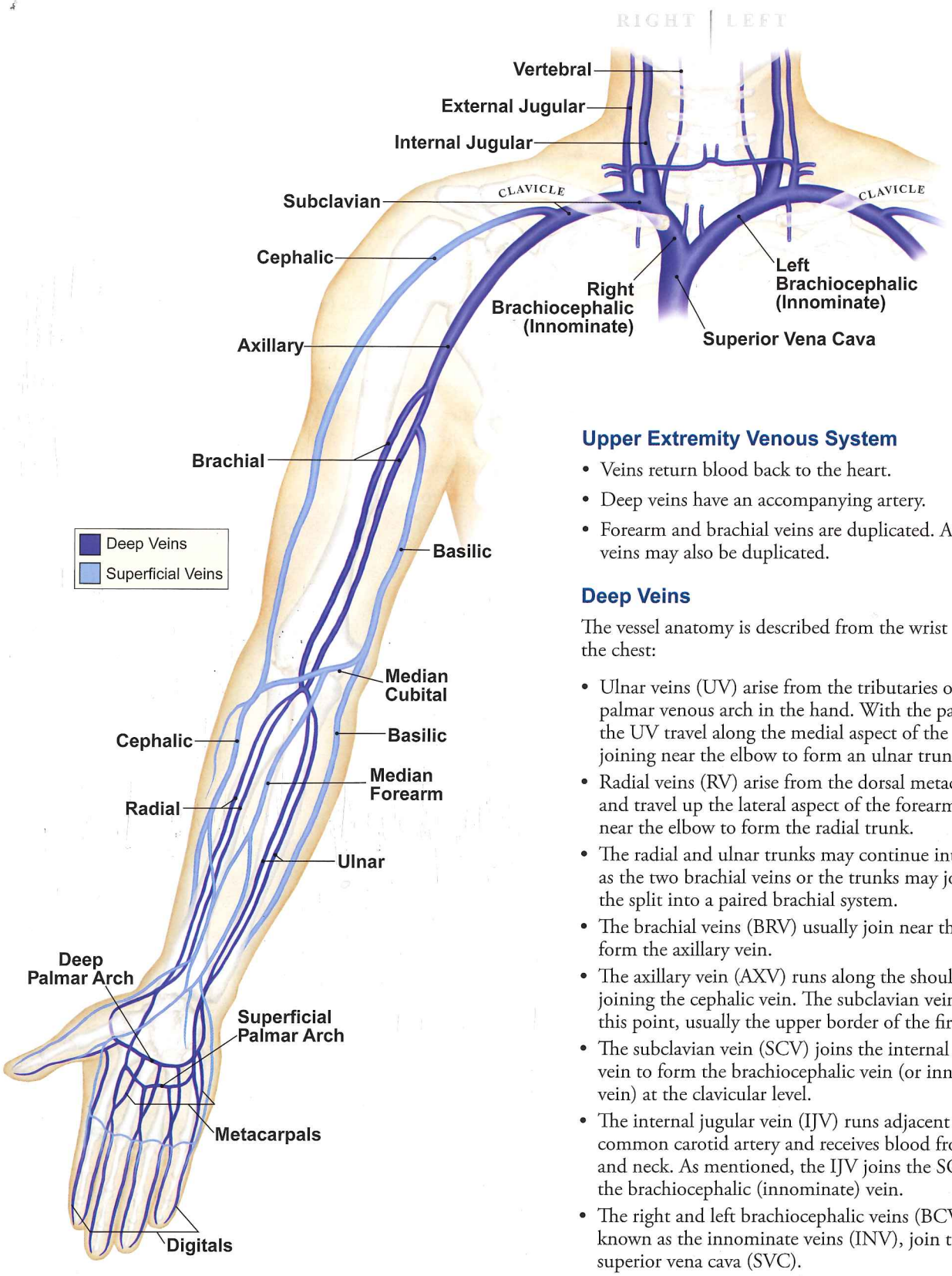
  - **Superior mesenteric artery** (SMA): originates approximately 1 cm inferior to the celiac trunk. The SMA supplies the intestines and pancreas.
  - **Renal arteries** (right and left): supplies the kidneys and adrenal glands.
  - **Inferior mesenteric artery** (IMA): supplies the colon and rectum.
- For the purposes of the ultrasound examination, the abdominal aorta is divided into three regions:
  - Proximal aorta: diaphragm to the origin of the superior mesenteric artery
  - Mid aorta: superior mesenteric artery to the renal arteries
  - Distal aorta: renal arteries to the aortic bifurcation

Some labs use alternative terms, dividing the aorta into the suprarenal, juxtarenal and infrarenal aorta.

- The average diameter of the abdominal aorta is 2.0 cm (range: 1.1-3.0 cm).
- The aorta normally decreases (tapers) in diameter from the diaphragm to the aortic bifurcation.

Anatomy

Upper Extremity Venous



Upper Extremity Venous System

- Veins return blood back to the heart.
- Deep veins have an accompanying artery.
- Forearm and brachial veins are duplicated. Axillary veins may also be duplicated.

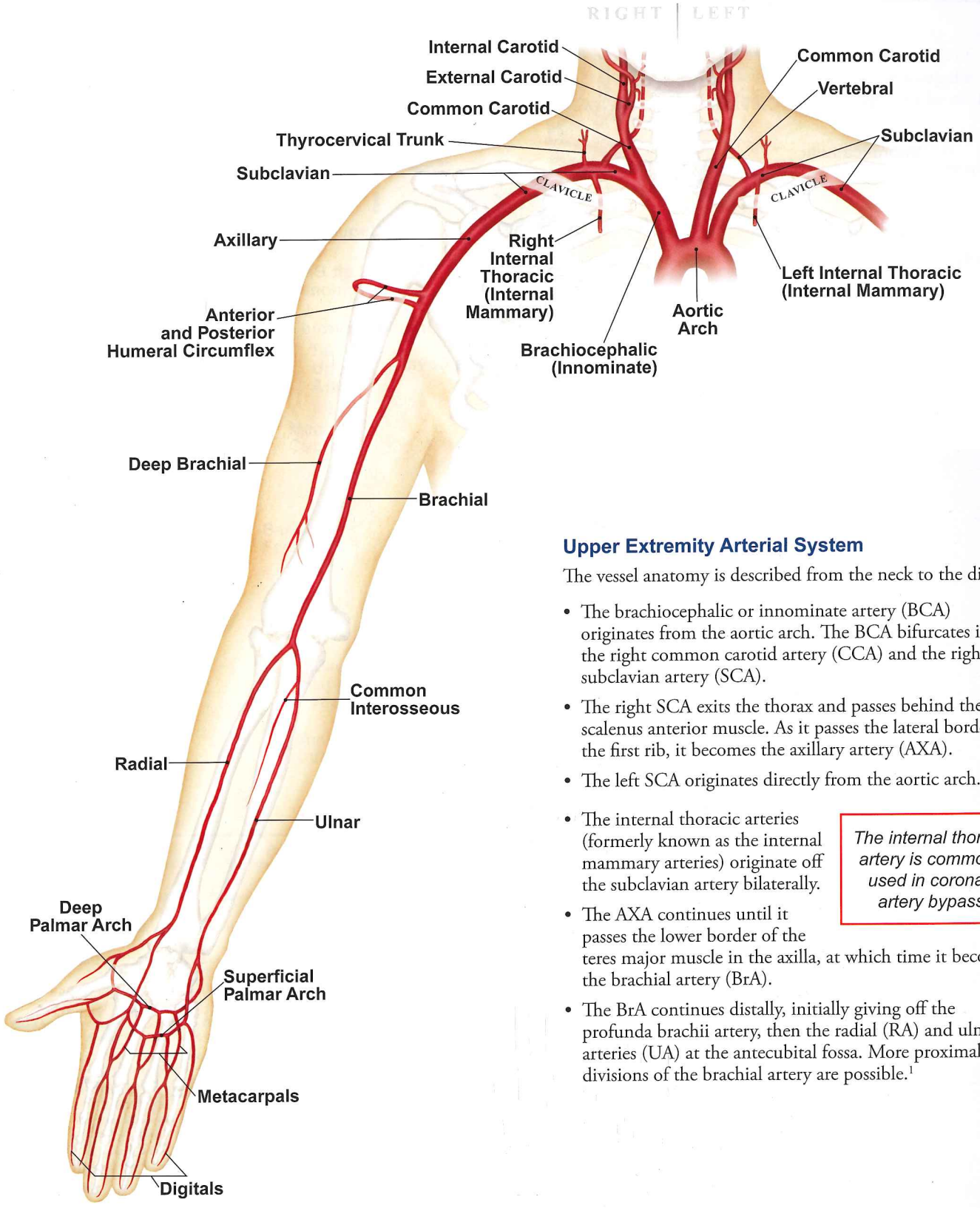
Deep Veins

The vessel anatomy is described from the wrist to the chest:

- Ulnar veins (UV) arise from the tributaries of the palmar venous arch in the hand. With the palm up, the UV travel along the medial aspect of the forearm, joining near the elbow to form an ulnar trunk.
- Radial veins (RV) arise from the dorsal metacarpal veins and travel up the lateral aspect of the forearm, joining near the elbow to form the radial trunk.
- The radial and ulnar trunks may continue into the arm as the two brachial veins or the trunks may join before the split into a paired brachial system.
- The brachial veins (BRV) usually join near the axilla to form the axillary vein.
- The axillary vein (AXV) runs along the shoulder until joining the cephalic vein. The subclavian vein begins at this point, usually the upper border of the first rib.
- The subclavian vein (SCV) joins the internal jugular vein to form the brachiocephalic vein (or innominate vein) at the clavicular level.
- The internal jugular vein (IJV) runs adjacent to the common carotid artery and receives blood from the face and neck. As mentioned, the IJV joins the SCV to form the brachiocephalic (innominate) vein.
- The right and left brachiocephalic veins (BCV), also known as the innominate veins (INV), join to form the superior vena cava (SVC).
- The SVC enters the heart at the right atrium.

Anatomy

Upper Extremity Arterial



Upper Extremity Arterial System

The vessel anatomy is described from the neck to the digits

- The brachiocephalic or innominate artery (BCA) originates from the aortic arch. The BCA bifurcates into the right common carotid artery (CCA) and the right subclavian artery (SCA).
- The right SCA exits the thorax and passes behind the scalenus anterior muscle. As it passes the lateral border of the first rib, it becomes the axillary artery (AXA).
- The left SCA originates directly from the aortic arch.
- The internal thoracic arteries (formerly known as the internal mammary arteries) originate off the subclavian artery bilaterally.
- The AXA continues until it passes the lower border of the teres major muscle in the axilla, at which time it becomes the brachial artery (BrA).
- The BrA continues distally, initially giving off the profunda brachii artery, then the radial (RA) and ulnar arteries (UA) at the antecubital fossa. More proximal divisions of the brachial artery are possible.[1]

The internal thoracic artery is commonly used in coronary artery bypass.