

Instructor's Electronic Curriculum Resource-

For Techniques in Noninvasive Vascular Diagnosis-4th edition.

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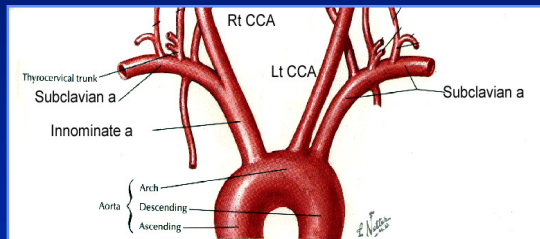
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Chapter 13. Arterial Evaluation-Upper

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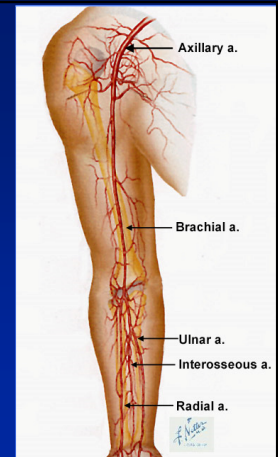
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Anatomy Review- Aortic Arch



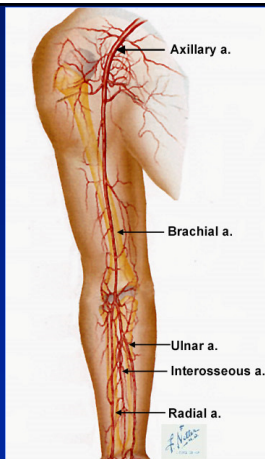
Anatomy

1. Axillary a.- from first rib to axilla.
2. Brachial a. - from axilla to antecubital fossa.
3. Radial a. - from distal brachial a. to wrist.

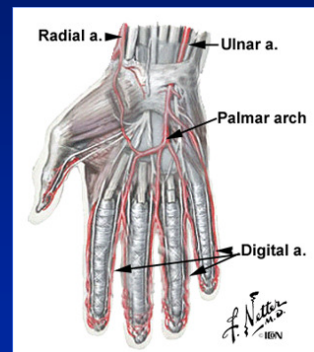
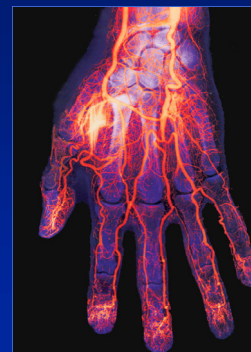


Anatomy

4. Ulnar a. - from distal brachial to wrist.
5. Interosseous a. - off the ulnar a. courses between radius and ulnar.



Hand Anatomy



Indications

- Arterial insufficiency
- Weakness in arm/hand
- Thoracic Outlet Syndrome (TOS)
- Vasospastic disorder- digit cold sensitivity
- Digital ischemia

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Indications

- Abnormal vertebral artery waveform
- Pre-operative assessment
 - Hemodialysis access
 - Radial artery harvest for CABG

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Contraindications

- No arm pressure measurement with hemodialysis access
 - PVRs with reduced inflation pressure, or Doppler waveforms are OK

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Upper Extremity Arterial Disease

- Atherosclerotic occlusive disease
 - Occurs predominately in the subclavian & innominate arteries
 - Axillary, brachial, radial, & ulnar arteries usually spared
- Takayasu's & Giant Cell Arteritis
 - An autoimmune disorder causing arterial stenosis

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Upper Extremity Arterial Disease

- Thromboemboli
 - Usually cardiac origin, or subclavian aneurysm
 - Large emboli may occlude brachial artery
 - Small emboli whacks digit perfusion

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Upper Extremity Arterial Disease

- Vascular thoracic outlet
 - Extrinsic compression of the SCA or axillary a.
- Subclavian artery aneurysm

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Thoracic Outlet Syndrome (TOS)

- Intermittent pain, numbness, weakness related to arm position
- 95% of cases are neurogenic cause
- 5% of cases are vascular etiology
- TOS (vascular) can cause thrombosis, or subclavian aneurysm

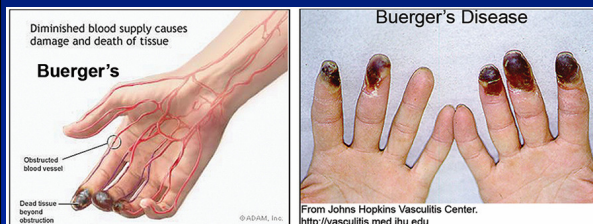
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Small Vessel Occlusive Disease – "Fixed"

- **Thrombo-angiitis obliterans (aka Buerger's Disease)**
 - Inflammatory process that causes thrombosis of the digital arteries (fingers and toes)
 - A "fixed" occlusive disease process
 - A "male" disease related to smoking
- **Thromboemboli to the digits**



Buerger's Disease



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Small Vessel Occlusive Disease – Vasospastic Disorder

- **Normal response to cold exposure is vasoconstriction in arteries of fingers, toes, ear and nose.**
- **Our bodies attempt to preserve core temperature.**
- **When cold exposure ceases, vasodilation occurs, flow increases.**
- **In vasospastic disorders, vasoconstriction occurs, but vasodilation does not.**

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Raynaud's Phenomenon Episodic Digital Vasospasm

- **Primary Raynaud's (Disease)**
 - Pure vasospastic disorder
 - No underlying cause
 - Normal digit perfusion at 'rest'
 - Spasm brought about by cold exposure, chemicals (nicotine), emotion and vibration injury

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Raynaud's Phenomenon Episodic Digital Vasospasm

- **Secondary Raynaud's (Syndrome)**
 - Vasospasm with underlying disease:
 - scleroderma, lupus, rheumatoid arthritis, etc.
 - Digit/palmar arteries often have fixed disease as well.

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Raynaud's Phenomenon

episodic digital vasospasm

- Affects fingers, toes, and nose
- Typically the affected area turns white, then blue, then often to bright red, or cyanotic.
- Symptoms include numbness, pain, pallor



Raynaud's Phenomenon

- Spasm may take 10-30 minutes to "release"



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Raynaud's Phenomenon

- 70-90 % of cases occur in females
- 40 % related to connective tissue disorders
- 40% idiopathic
- 20% miscellaneous (frostbite, vibration trauma)
- 5-10 % of Americans have Raynaud's

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Treatment

- Cessation of smoking
- Cold avoidance
- Calcium channel blockers
- Treat associated disease
- Relocate to a warm climate

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Arterial Disease

upper extremities - symptoms

- Arm/hand weakness w/exercise
- Reduced absent pulses
- Hand numbness/weakness/pain, position related
- Ischemic fingers
- Cold sensitivity

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Indirect Test Methods for Upper Arterial Disease

- Baseline exam to rule-out atherosclerotic disease
- Then tailored exam for specific symptoms (TOS, Raynauds, Buerger's, etc.)

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Diagnostic Examination

Step #1

- Rule out arterial occlusive disease with a baseline physiologic exam
 - Segmental arm pressures
 - Pulse volume recording
 - Or Doppler waveform analysis
 - Digit pressure from index finger

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Baseline Exam

- Introduce yourself to the patient and explain the exam.
- Obtain pertinent general HX, (smoking, diabetes, MI, HT, vascular operations)
- Obtain HX specific to patient's condition

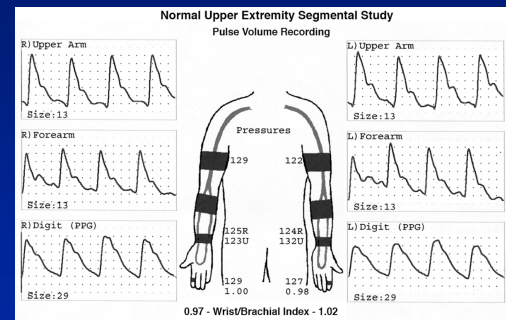
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Baseline Exam

1. Pt. in sitting position, obtain segmental systolic pressures at arm, forearm and index finger, bilaterally
2. Obtain PVRs from arm, forearm and index finger (or PPG at index finger)
3. Alternatively, obtain CW Doppler waveforms from axillary, brachial, radial, and ulnar arteries

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Baseline Upper Extremity Study



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Compare Brachial Pressures

- A gradient of 20 mmHg or greater suggests subclavian artery disease on the side with the lower pressure.



Brachial systolic pressures:
Abnormal on Left

- A pressure gradient of ≥ 30 mmHg between arm and forearm indicates brachial artery disease (it's rare).

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Diagnostic Examination

Step #2- Tailor subsequent testing for symptoms

- Position-related arm pain
 - Perform TOS test
- Ischemic, painful digits
 - Obtain digit pressures and waveforms
- SX of episodic vasospasm
 - Perform baseline digit exam then cold immersion test

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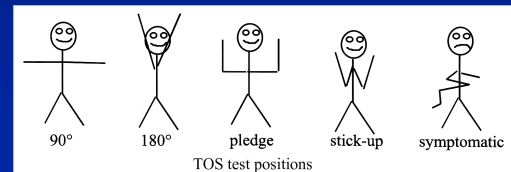
Thoracic Outlet Syndrome

- **Method:**
 - Rule out athero disease in arms (baseline exam)
 - Monitor limb with
 - CW-Doppler on radial artery
 - PVR of arms
 - PPG on index finger (beware of false positives)

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Evaluate in TOS Positions

1. Abducted 90 degree to torso.
2. Elevated 180 degrees above head.
3. Arm abducted 90 degrees, with elbow bend 90 degrees ("pledge" position). Evaluate with head turned toward, then away from hand.

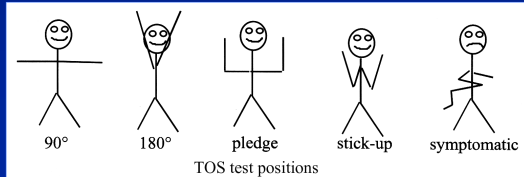


TOS test positions

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TOS Positions

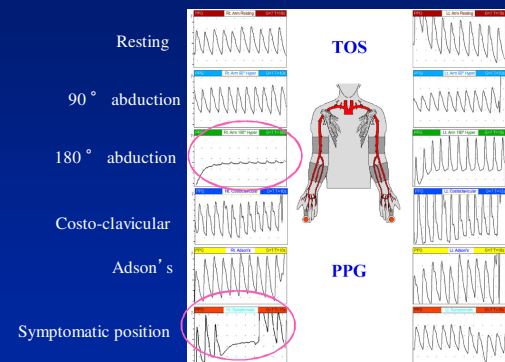
4. Elbows at side and to the back, hands up, shoulders pressed downward and back ("stick-up" position). Also called costo-clavicular position,
5. Most important position = the symptomatic position



TOS test positions

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TOS Study - Positive



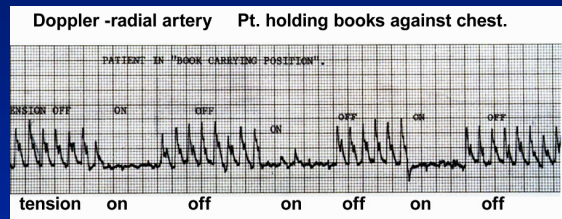
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TOS Case Study

- 16 year-old female student
- Rt. arm weakness when holding books against chest.
- TOS exam performed with CW Doppler on radial artery.
- Patient normal in all positions EXCEPT-symptomatic position

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Radial Artery Doppler TOS



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Digital Evaluation



Episodic Vasospasm

Normal Cold Immersion Study

Positive Cold Immersion Study

Raynaud's Cold Immersion Test

Digital Evaluation vasospasm vs. small vessel disease

Test "B"

- **Abnormal digit waveforms at rest could be due to vasoconstriction, spasm or fixed occlusive disease.**
- **Warm the hand with electric heat pad for 5 minutes, and retest.**
- **If no improvement, suspect fixed occlusive disease.**

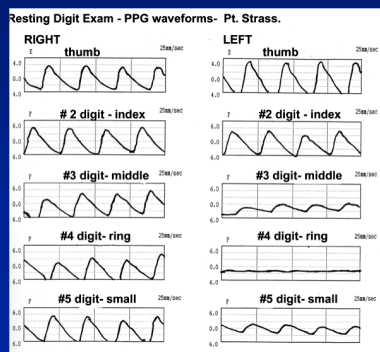
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Case Study

- A 62-year-old male presents with numbness and ischemic changed on his left 4th and 5th digits distally.
- No history of smoking or prior cold sensitivity.
- The arm physiologic study was normal. PPG waveforms were abnormal in the left 3rd, 4th, and 5th digits indicating reduced perfusion.
- Both hands were warmed in a heating blanket for 10 minutes and retested

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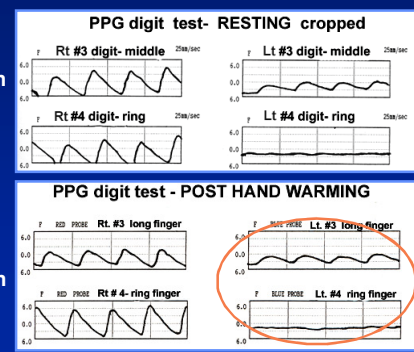
Patient had reduced perfusion to Left 3, 4 & 5 digits.



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Reduced perfusion Lt. digits 3,4,5 at rest and post warming

Reduced perfusion
Lt. fingers



No improvement
with 10 minutes of
hand warming with
heating pad

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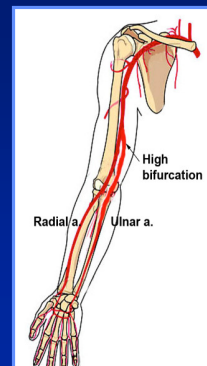
Results

- **Fixed occlusive disease was suspected.**
- **No history of smoking = probably no Buerger's disease**
- **Duplex imaging using high frequency, intraoperative "hockey stick" transducer.**
 - Digital arteries on 3 and 4th digit were thrombosed .
 - Thromboemboli was suspected to be the cause.
- **Pt. was scheduled for an echocardiogram**

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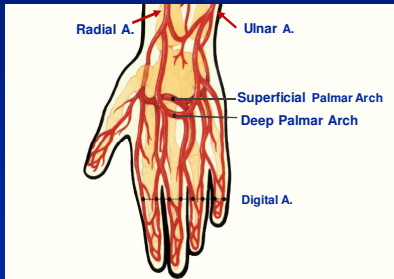
Pre-op Exam:

- Note any anatomy variations particularly the position of the radial and ulnar a. bifurcation.
- This sketch demonstrates an anomalous high bifurcation.

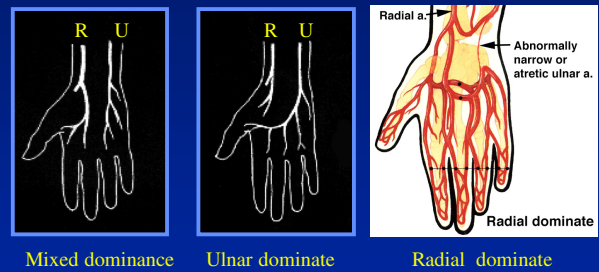


Radial Artery Harvest

- Palmar arch patency is essential



Incomplete Palmar Arch

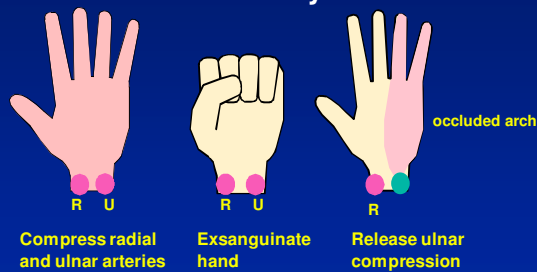


Mixed dominance

Ulnar dominate

Radial dominate

Allen Test: Palmar Arch Patency

Compress radial
and ulnar arteriesExsanguinate
handRelease ulnar
compression

Repeat with release of radial compression

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PPG Test Palmar Arch

- PPG sensors are placed on the thumb or index finger and the 5th digit (if a 2 channel system is available).
- PPG scale or gain is adjusted to establish similar amplitude
- Use a slow sweep-speed
- There should be no, or little, drop in the PPG amplitudes.

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PPG Test - Palmar Arch

- Compress and hold RA and UA simultaneously. Both waveforms should go "flatline".

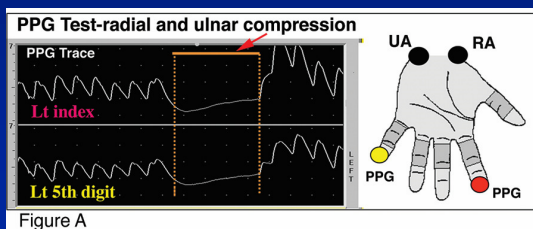


Figure A

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PPG Test - Palmar Arch

- Next, compress and hold RA. Both waveforms should NOT go "flatline".

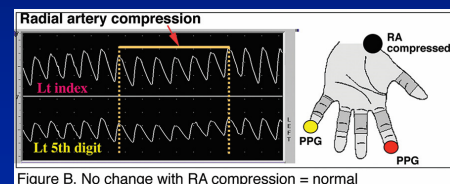


Figure B. No change with RA compression = normal

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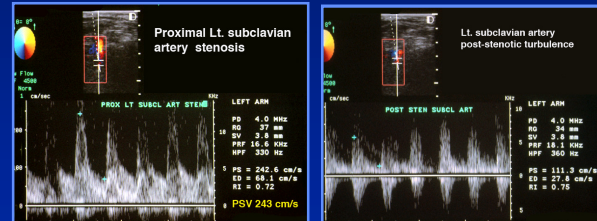
Abnormal Subclavian Artery Distal to Stenosis



Delayed Rise Time (from beginning to peak systole)

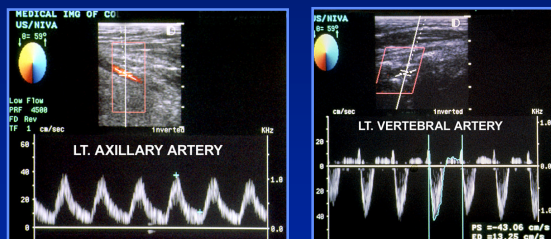
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Abnormal Lt. vertebral flow noted during carotid duplex exam; subclavian was evaluated.



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Case 1, continued: Subclavian artery stenosis, retrograde vertebral artery flow

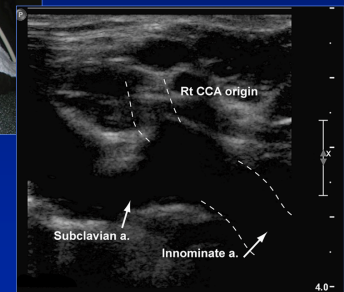


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Rt. Subclavian, Innominate Artery Scan

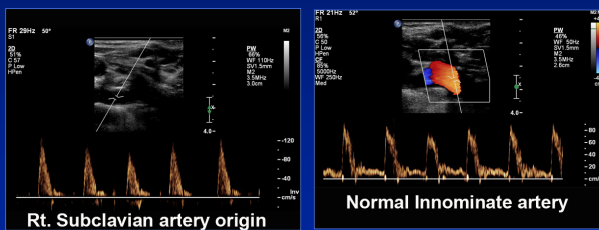


Identify CCA in transverse and follow it proximally to innominate artery



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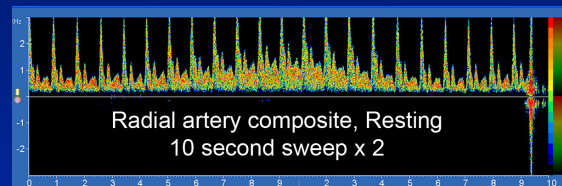
Rt. Subclavian, Innominate Arteries



It's not necessary to routinely scan the innominate artery; only when the CCA, subclavian, or vertebral waveforms are abnormal on the right side.

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Hand and digit perfusion is very vasoreactive; Doppler waveform morphology can change rapidly from a high resistance to low resistance



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Summary

- The upper extremity arterial exam has many facets
- Exam protocol should be tailored to answer the specific clinical question presented by the patients symptoms

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