You Want to Stick Me Where?  
Risks of Arterial Puncture Compared to Venipuncture

Brad S. Karon, MD PhD  
February 15, 2017

Disclosures

Relevant Financial Relationship(s):  
None

Off Label Usage:  
None
Learning Objectives

• List the primary risks of venipuncture and arterial puncture.
• Estimate the frequency of major medical complications related to arterial puncture and venipuncture.
• Describe the arguments for and against the routine performance of the modified Allen test before arterial puncture.

Complications of arterial puncture

• CLSI GP43-A4 (Procedures for collection arterial blood specimens)
• Vasovagal response
• Arteriospasm (unsuccessful collection)
• Hematoma
  • Hematomas likely to be larger than those associated with venipuncture, more common in elderly, anticoagulants, coagulopathy
• Thrombi/embolus/occlusion
  • Function of size of needle/cannula, time left in artery, size of artery
  • Why we do the Allen test
Complications of arterial puncture

- CLSI GP43-A4 (Procedures for collection arterial blood specimens)
- Order of preference of arteries
  - Radial artery: preferred unless Allen test negative (no collateral circulation to hand)
  - Brachial artery: 2nd choice, except generally avoided in infants (more complications, median nerve damage)
  - Femoral artery: 3rd choice, more complications (hematoma, infection), avoid in newborns (femoral artery thrombosis)

Risks of Arterial Puncture Compared to Venipuncture

- AARC Practice Guidelines Resp Care 1992;37:913-7
- Bleeding/hemorrhage
- Hematoma
- Pseudoaneurysm
  - Pulsatile hematoma, blood from artery continues to fill hematoma
  - Can lead to compartment syndrome, limb loss, often needs surgical treatment
- Thrombosis/arterial occlusion
- Arteriospasm
- Trauma to vessel
- Pain
- Vasovagal response, infection, air emboli, arteriovenous fistula
Complications of arterial puncture

- Studied complication rate in 4342 arterial punctures
  - Evacuation hospital in Vietnam
  - Mostly nurse collections (<20% physician collect)
  - Mostly femoral sticks (some brachial and radial)
  - 25/4342 (0.58%) resulted in hematomas
  - No hematomas prolonged hospitalization
  - No other complications noted
    - Fleming and Bowen, Military Medicine 1974;139:307-8

Complications of arterial puncture

- Studied complication rate in 6185 brachial artery punctures
  - Clinic and hospital patients (TX)
  - Certified pulmonary function technician
  - Manual compression 3 min (minimum), up to 10 min if anticoagulation
  - 127/6185 (2.0%) complications
    - 123 pain/paresthesia
      - 17 (0.3%) shock-like pain suggesting contact nerve
      - 1 pain lasting > 48 hours, but resolved by 2 mo
    - 4/6185 (0.06%) hematomas
    - Okeson and Wullbrecht, Chest 1998;114:748-51
Complications of arterial puncture

- Risk of thrombosis and vascular occlusion (hand ischemia)
- Modified Allen test
  - Patient makes tight fist
  - Occlude radial and ulnar arteries
  - Patient opens hand, palmar skin and fingers should be blanched
  - Release ulnar artery
  - Color should return to palmar skin and fingers in < 15 seconds
  - Positive test = color returns, normal ulnar circulation
  - Negative test = color does not return, avoid radial artery
  - Hyperextension of fingers can cause a false negative test

Case against Allen test

- Risk of thrombosis and vascular occlusion
- Data for arterial artery catheterization
  - Thrombosis risk increases with time in artery
- Partial vascular occlusion following radial artery decatheterization occurs up to 25% in multiple studies
  - No ischemia or disability of hand
  - Allen’s test not useful to predict thrombosis
  - Case reports of permanent vascular occlusion most often in patients with other risk factors
  - Profound hypotension, high-dose vasopressor therapy thought to be risk factors for hand ischemia
  - Controversial as risk factors are # attempts, hypercoag states (cancer, HIT, DIC), peripheral vascular dz, trauma to hand, others
Case against Allen test

- Risk of thrombosis and vascular occlusion
- Data for harvesting radial artery for coronary bypass graft
- Assessment of collateral circulation recommended before harvesting radial artery
- 10 studies have examined modified Allen test
  - Agreement with other methods to assess circulation
  - Ability to predict hand ischemia
- 4 studies found Allen test not predictive of results of ultrasound, digital plethysmography, or pulse oximetry
- 3 studies found Allen test good screening test
- To be predictive must use cut-off less than 15 seconds
- Up to 27% patients had negative Allen test
- Lack of evidence it can predict hand ischemia
- *Vascular medicine* 2012;17:352-61

Case for Allen test

- Hand ischemia thought to develop in ~ 1 in 500 cases thrombosis after radial artery catheterization
- Report described 8 patients with hand ischemia referred to vascular surgery after radial artery thrombosis
- 6 of 8 developed gangrene or required amputation of fingers despite surgical restoration of radial circulation
Complications of venipuncture

• Major complications
  • Vasovagal reaction
  • Hematoma
  • Nerve injury
  • Infection
  • Accidental arterial puncture

• Minor complications
  • Bruising
  • Pain
Incidence of complications

- 4050 people insurance exam
  - Minor complications (bruising, pain, hematoma)
  - Bruising within 48 h most common (10%)
  - Pain and minor hematoma 2% each
  - 14% total minor complication rate

- Major complications (syncope, seizure, cellulitis)
  - Near syncope most common (2.6%)
  - No infections (< 1 in 4000)
  - Total major complication rate 3.4%

*Galena HJ. J Fam Practice 1992;34(5):582-4*

---

Incidence of complications

- Risks of major complications of phlebotomy
  - NHANES II (large national study)
  - 15,858 people ages 6-74 yrs had venipuncture at 64 study sites (adverse reactions = syncope, near syncope and malaise)
  - 65/15,858 (0.4%) syncope/near-syncope
  - Age group 20-49 highest rate syncope
    - Corresponds to peak of needle phobia

Incidence of complications

- Study of ~100,000 blood donors in Italy (READ)
  - Trained phlebotomists
  - Mostly young, healthy adults
  - Larger volume blood removed
  - Major or moderate adverse events included hematoma, arterial puncture, phlebitis, nerve injury (alone or due to hematoma), vasovagal reaction (mod or severe, immediate or delayed)
  - Recorded events day of donation or if reported by donor

Garozzo et al., Blood Tranfus 2010;8:49-62
Incidence of complications

• Complications after blood donation
  • American Red Cross by donor report or interview
    • Contusion 22.7% (by interview)
    • Hematoma 0.32-1.7% (donor report and interview)
    • Arterial puncture 0.014% (donor report)
    • Nerve injury 0.016-0.032% (donor report)
    • 2 reports upper extremity thrombosis (extremely rare)

Nerve injury after phlebotomy
Nerve injury during phlebotomy

• Conventional wisdom
  Danger Points, How to prevent nerve injuries from venipuncture. Nursing 98;34-39.

• Avoid drawing within 2 inch of wrist as 3 major nerves run nearby (radial, ulnar and median nerve)

• Minimize number of attempts (2)

• Stop immediately if patient reports shooting pain, electric shock or pins and needles sensation

• Second type of nerve injury secondary to compression, develops 24-96 hr after phlebotomy

Nerve injury during phlebotomy

• Other tips to reduce nerve injury during phlebotomy

• Retract skin and stabilize vein

• Insert needle at 5-15 degree angle

• Avoid probing, reposition no more than 1 time

• Use shorter needles
Nerve injury during phlebotomy

- CLSI H3-A6: Procedures for the collection of diagnostic blood specimens by venipuncture

- Insert needle at angle of 30 deg or less
- If tingling, numbness, shooting or electric-like pain, terminate procedure and remove needle immediately. Repeat in another site if needed.
- Veins on the underside of the wrist must not be used (reason is nerve injury, though not stated in guideline)

Nerve injury during phlebotomy

- What is actually known about venipuncture and nerve injury?
- Reviewed 24 cases of severe nerve injury (causalgia) related to venipuncture
- Performed autopsies of 7 random cadavers (14 upper limbs) to document position of veins & nerves

Nerve injury during phlebotomy

- Horowitz 2000

- 17 venipunctures in antecubital fossa (70%)
- 3 wrist (radial nerve) procedures (13%)
- 4 back of hand (17%)
- Caveat: Among patients selected for having severe nerve injury after venipuncture, antecubital fossa draws presumably much more common
- Cannot assume antecubital fossa “safe” to avoid nerve injuries

Nerve injury during phlebotomy

- Horowitz 2000

- Symptoms of 24 patients with nerve injury
  - 22/24 (92%) immediate burning or shooting pain during draw
  - 2 experienced onset 12 and 18 hr later
- Other aspects of draws associated with nerve injury
  - 16 experienced hematoma and 1 abscess after
  - 9/24 had multiple sticks (5 with hematoma)
  - 3 described venipuncture as uneventful
Nerve injury during phlebotomy

- Horowitz 2000

- Outcomes of 24 patients with nerve injury (1.5-13 y)
  - 3 patients improved spontaneously (all reported uneventful procedures)
  - 6 patients no change (continued burning pain)
  - 15 got worse (increased and spread of pain)

Nerve injury during phlebotomy

- Horowitz 2000

- 7 random autopsies of upper limb ven. sites
  - Major branches of cutaneous nerves were superficial to and overlay veins in all areas
  - Nerves and veins were frequently found intertwined
  - Drawings in anatomy books are vastly oversimplified
  - Contact with nerves during phlebotomy is probably common
  - Supported by blood donor data (1% neurologic symptoms when asked)
Nerve injury during phlebotomy

- Treatment
  - Stop procedure
  - Almost always resolve spontaneously
  - Difficult to predict when will be severe/chronic
    - Immediate symptoms do not resolve within hours
    - Associated with hematoma
    - Patients with hematoma and continuing neurologic symptoms need to see physician
  - Rare instances severe: generally do not respond to treatment (nerve block and/or medication for chronic pain)

Accidental arterial puncture during phlebotomy
Accidental brachial artery puncture during venipuncture

- Newman Transfusion 2001;41:1390-2
  - Rate of accidental arterial puncture in 410,000 blood donation phlebotomies
  - Trained nurses
  - 12 accidental arterial punctures (0.0029%, 1/34,000)
    - 4 hematomas
    - 1 brachial artery pseudoaneurysm requiring surgical repair

Accidental brachial artery puncture during venipuncture

- Case reports of serious complications after accidental brachial artery puncture
  - 46 yo male undergoing home therapeutic phleb
    - Painful hematoma after 6th phleb at elbow
    - Pulsatile brachial artery pseudoaneurysm
    - Required surgical evacuation and artery repair
    - Transfusion 2013;53:1373-4
  - 3 previous case reports brachial pseudoaneurysm after blood donation
    - All required surgical intervention
    - All had immediate hematoma formation (2 pulsatile)
Brachial artery pseudoaneurysm during venipuncture

• Infants (preterm)
  • Rare complication of venipuncture
  • ~ 5 cases reported, all required surgical repair

• Children
  • 5 children ages 2 mo-2.5 years with accidental brachial artery pseudoaneurysms during venipuncture
  • 1 child with brachial artery embolus
  • 1 child with arteriovenous fistula
  • All required surgical correction
  • No long-term morbidity/problems

Incidence of venipuncture and arterial puncture complications

• Minor
  • Bruising
    • Common: ~ 10-30%?
    • Depends upon procedure
    • Definition overlaps with minor hematoma
  • Pain
    • Subjective
    • Common: ~ 2%?
Incidence of venipuncture and arterial puncture complications

• Major
  • Vasovagal (syncope/near syncope)
    • Most common major venipuncture complication: 0.4-0.6% most studies
    • Higher in blood donors, adolescents/young adults (2-3%)
    • Most getting arterial puncture lying down
  • Hematoma
    • Rate depends upon definition, procedure
    • 0.1-2% severe/require therapy
    • Increasing with prevalence of oral anticoagulation?
    • More serious consequences of hematoma after arterial puncture

Incidence of venipuncture and arterial puncture complications

• Major
  • Accidental arterial puncture during phlebotomy is rare (1/30,000-1/100,000), but more often results in serious complications (hematoma or pseudoaneurysm)
  • Contact with nerve (zingers) is common during both arterial and venipuncture, but serious nerve damage appears rare during both procedures
  • Infection, AV fistula, air emboli uncommon both arterial and venipuncture
Questions & Discussion