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AXILLARY ARTERY AND VEIN CATHETERIZATION

Evidence Based Medicine Guideline

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SUMMARY
The axillary artery and vein represent safe and feasible alternatives to subclavian, internal jugular and femoral artery or vein insertion sites. Ultrasound-guided axillary artery and venous catheter insertion is associated with higher success rates and lower complication rates than similar insertion based upon anatomical landmarks. Ultrasound-guided axillary artery and venous catheterization are techniques that every intensivist should become familiar with.

RECOMMENDATIONS

- **Level 1**
  - **None**
- **Level 2**
  - **Use of ultrasound increases successful catheter insertion and decreases central venous catheterization complication rates.**
  - **Central venous catheter placement in the chest is associated with a combined reduced risk of central line associated blood stream infections (CLABSI) and symptomatic deep venous thrombus formation.**
- **Level 3**
  - **Real-time ultrasound-guided axillary vein catheterization is a safe and reliable alternative to subclavian, internal jugular and femoral venous access.**
  - **Catheter-related infection rates are similar between axillary and internal jugular central venous catheters.**
  - **Axillary arterial lines are a safe and practical alternative to femoral access when radial sites are unavailable or inaccessible.**

INTRODUCTION

With the advent of advanced ultrasound technology, new techniques for arterial and venous access have emerged. Although catheterization of the axillary vessels has its own specific complications, it is a safe and reliable procedure for achieving vascular access to the arterial and venous system. Given the proximity to the aortic root, axillary arterial access may provide a more reliable arterial pressure measurement and waveform by which to guide resuscitative efforts. The robust collateral circulation of the arm and larger intraluminal diameter of the vessel results in infrequent thrombosis compared to other sites. These advantages must be tempered by the possibility of neuralgia or brachial plexus injury due to direct damage or hematoma formation. The extra-thoracic location and the ability to cannulate the axillary vessels under direct ultrasound guidance makes iatrogenic pneumothorax less likely (1-2).

LEVEL OF RECOMMENDATION DEFINITIONS

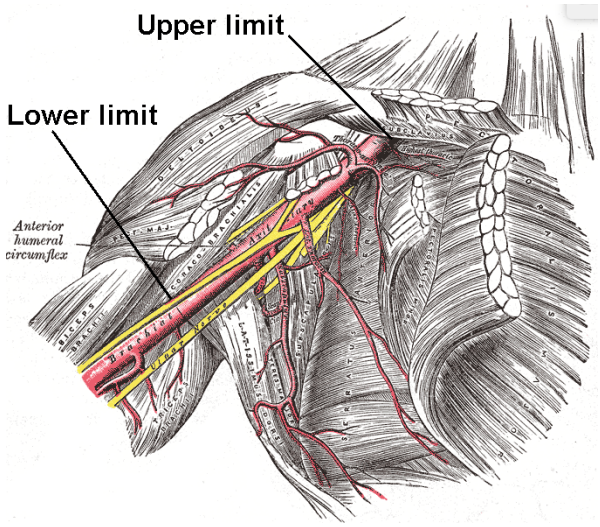
- **Level 1:** Convincingly justifiable based on available scientific information alone. Usually based on Class I data or strong Class II evidence if randomized testing is inappropriate. Conversely, low quality or contradictory Class I data may be insufficient to support a Level I recommendation.
- **Level 2:** Reasonably justifiable based on available scientific evidence and strongly supported by expert opinion. Usually supported by Class II data or a preponderance of Class III evidence.
- **Level 3:** Supported by available data, but scientific evidence is lacking. Generally supported by Class III data. Useful for educational purposes and in guiding future clinical research.

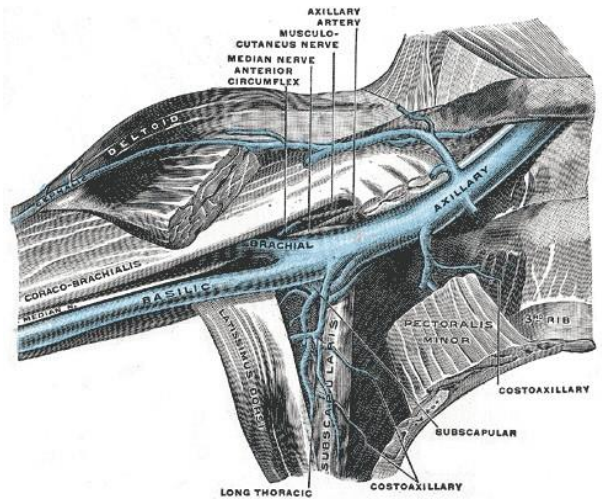
Recent studies have shown that there is a combined reduced risk of CLABSI and symptomatic deep venous thrombus formation with subclavian central venous access when compared to internal jugular and femoral access sites. There are multiple theories as to why this is seen including the fact that the chest has the lowest bacterial colonization as compared to the neck/groin; the catheter travels through more subcutaneous tissue prior to entering the blood vessel; dressing integrity and maintenance is much easier on a flat surface like the chest as opposed to the neck or groin (3). However, there are inherent risks associated with landmark-guided central venous access with arterial puncture and iatrogenic pneumothorax being some of the most feared complications. Cannulation of the axillary vein under ultrasound guidance offers a safe alternative to the landmark-guided subclavian site while maintaining the location of the catheter on the chest.

PROCEDURE

Educational videos detailing both arterial and venous catheterization techniques using ultrasound guidance are available on YouTube and the SonoSite website. Alternatively, videos are available on your smartphone using the SonoAccess® 2.0 Mobile App.

Anatomy



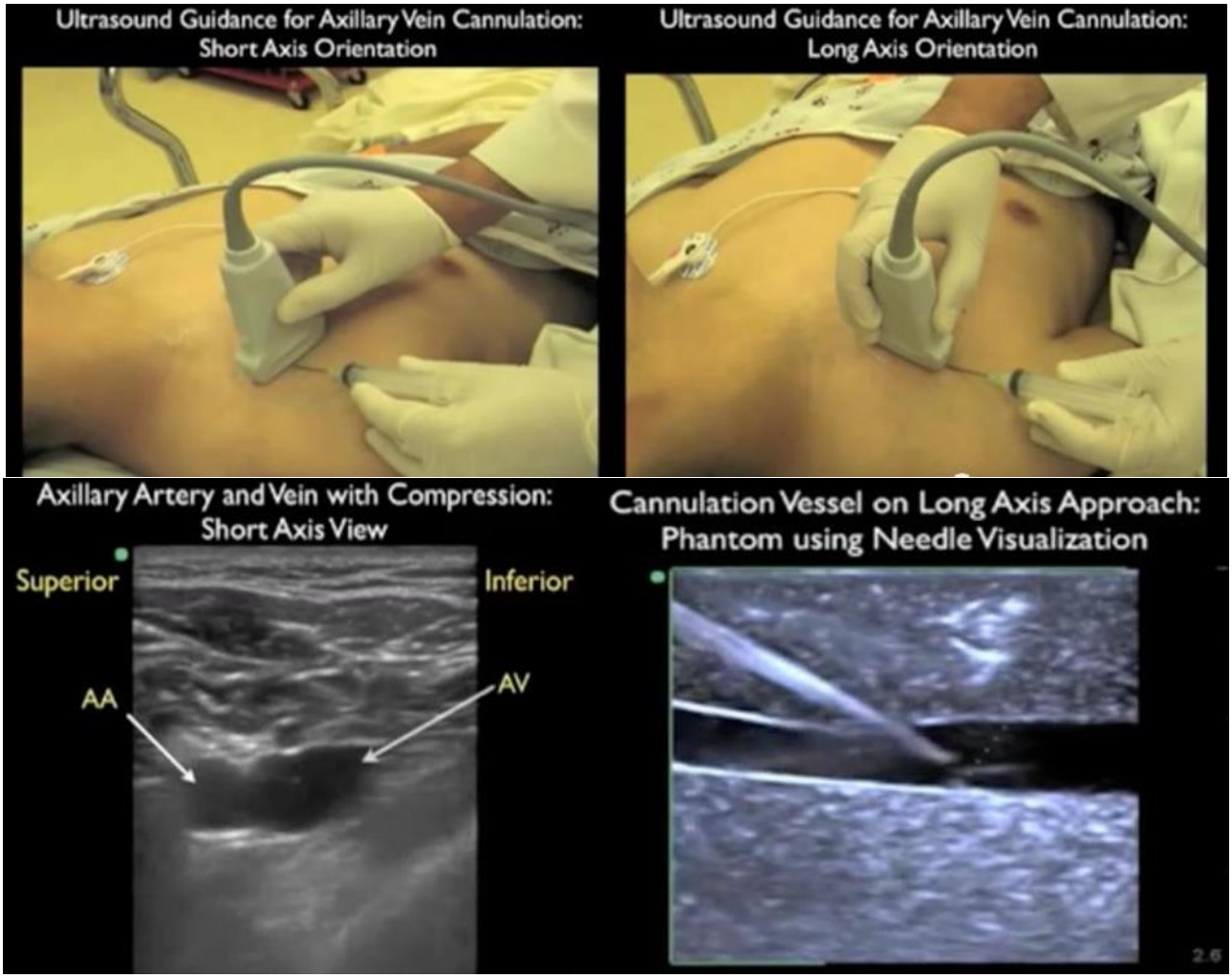


Patient Position

The patient is positioned supine in the Trendelenberg position with arms at their side much like a traditional subclavian approach. The vessels can be located between the crease of the arm and the clavicle in the deltopectoral groove. An axillary approach may also be utilized. If approaching from the axilla, care must be taken to puncture medially enough to not be in the brachial artery or vein. Alternatively, care must also be taken to avoid insertion of a catheter into the subclavian artery where compression upon catheter discontinuation may be difficult.

Ultrasound Guidance

Locate the vessels using either the long or short access view just inferior to the clavicle. The long access view allows better visualization of needle depth during the procedure. Consider using a 20 cm catheter as the distance is greater than with a traditional subclavian or jugular catheter. Short axis orientation has been shown to reduce the time to cannulation, but long axis orientation is associated with higher rates of single attempt successful cannulation. There was no significant difference in complication rates between the two (3).



LITERATURE REVIEW

Czarnik et al. prospectively examined the effectiveness of real-time ultrasound-guided axillary vein catheterization for inserting dialysis catheters in 29 ICU patients (2). They found the overall successful cannulation rate to be 93% with a 6.8% potentially serious complication rate, 10.3% minor complication rate, and a 0% life-threatening complication rate. They concluded that this was a reliable method of dual lumen hemodialysis catheter insertion and can be considered a reasonable alternative to jugular and femoral routes in special clinical circumstances.

Parienti et al. performed a multicenter randomized control trial which included 4 university and 5 community hospitals in France (3). The study consisted of 3027 patients (3471 catheters) to comparing CLABSI and symptomatic deep venous thrombosis (DVT) in different central venous access sites. They randomly assigned internal jugular, subclavian and femoral sites in a 1:1:1 ratio. They found that catheterization of the subclavian vein was associated with reduced risk of CLABSI and symptomatic DVT.

He et al. performed a retrospective study to compare longitudinal versus transverse approach to ultrasound-guided axillary vein cannulation (4). They looked at one-attempt success rate, operation time, iatrogenic arterial puncture, and pneumothorax. 236 patients were identified with an overall success rate of 100%. The transverse approach had shorter operation time, but the transverse approach group had greater first attempt success. Arterial puncture did occur twice in the transverse group (n=116) and only once in the longitudinal group (n=120), but there was no statistical difference. No pneumothorax occurred in the study.

Karimi-Sari et al. performed a randomized controlled trial comparing anatomical landmark and ultrasound guided methods for insertion of central venous catheters (5). They found a 100% success rate in the ultrasound-guided group and 88% in the landmark group. Also, the rate of complications was significantly lower in the ultrasound-guided group (4% vs. 24%).

Martin and Bruder prospectively compared catheter related infections after axillary and internal jugular catheter placement (6). A total of 141 catheters were examined by culturing the catheter tips. The incidence of catheter-related infection (including catheter-related sepsis, and bacteremia) was not different between the two groups (axillary vein: 8.1%; internal jugular vein: 7.6%).

Scheer et al. found the following complications related to axillary artery catheterization after reviewing 1989 reports of access: permanent ischemic damage, 0.2%; temporary occlusion, 1.2%; sepsis, 0.5%; local infection, 2.2%; pseudoaneurysm, 0.1%; hematoma, 2.3%; bleeding, 1.4% (7).

Timsit et al. performed a multicenter randomized trial to look at the effect of dressing disruption on catheter-related infections and applied to multiple access sites (8). The study included 1419 patients (3275 catheters). They found that dressing disruption (dressings required replacement prior to scheduled change due to soiling or inability for adequate dressing adherence) significantly increased skin flora colonization at catheter removal and a more than three-fold increase in risk for major catheter related infections. The subclavian site (on the chest) was associated with fewer dressing disruptions as compared to the internal jugular or femoral sites.

Table. Comparative analysis of arterial cannulation sites

	Brachial	Radial	Axillary	Femoral
Ease of cannulation	No data obtained	Less difficult in normotension, although hypotension and vasoconstriction may render cannulation difficult	Technically difficult, although pulsation and pressure are maintained even with peripheral vascular collapse	Less difficult, can be cannulated, even during profound hypotension
Collateral circulation	Lacks the anatomic benefit of collateral circulation	Dual circulation in most of the population	Extensive collateral circulation	Collateral circulation exists via a number of anastomoses
Inadvertent neural or adjacent structure injury	Damage to the median nerve may result in appreciable long-term disability	Carpal tunnel or sympathetic-mediated pain syndrome from median or radial nerve pressure or from blood extravasation into palmar sheath	Axillary sheath rapidly fills with blood; nerve damage and neuropathy secondary to brachial plexus compression	Potential for extraperitoneal hemorrhage from too high an entry site; vascular injury from femoral common branch entry; hematoma formation
Thrombogenicity	High risk; thrombotic sequelae may be profound	High risk, smaller arterial lumen associated with increased risk of thrombosis	Less risk; catheter at this site poses little risk if thrombosis occurs	Less risk; large intraluminal diameter and high rate of flow discourage thrombus formation
Accuracy of waveform	Substantial difference in contour and amplitude of ascending aortic and brachial waveform	Substantial difference in contour and amplitude of ascending aortic and radial waveforms	Proximity to aortic arch allows a reliable waveform, even during profound vasoconstriction	Morphologically reliable waveform
Accuracy of physiological data	Subject to inaccuracy inherent in distal location; overestimates systolic blood pressure; may be more accurate than radial approach	Subject to inaccuracy inherent in distal location; overestimates systolic blood pressure; underestimates central aortic pressure	More accurately reflects systolic blood pressure	More accurately reflects systolic blood pressure

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