


Case Report

The Axillary Vein Revisited – An Unacknowledged Alternative to the Challenge of Vascular Access in Trauma

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Abstract

Establishing venous access in the Emergency Department (ED) or Intensive Care Unit (ICU) can be challenging. Trauma, burns, obesity, may dramatically decrease the peripheral or central veins available for cannulation. The axillary vein (AXV), a large vessel traditionally used for insertion of pacemaker leads, offers an additional, valuable, but widely unacknowledged, insertion site for central catheters. The AXV is renamed to subclavian vein after the outer border of the first rib, and its cannulation encompasses several advantages compared to the use of a subclavian catheter, the main one being that it is performed under real-time ultrasonographic guidance. We present a case of a multiple trauma patient who required external fixation of pelvis and insertion of chest drain due to a large pneumothorax in the ED; the initial CT scan also revealed an unstable fracture of the second cervical vertebra. The patient suddenly became hemodynamically unstable requiring vasopressor support. The presence of pelvic external fixation pins and hard cervical collar hindered access to the femoral and jugular veins respectively; due to the presence of pneumothorax and chest drain, inserting an ipsilateral subclavian catheter using the anatomical landmarks technique was attempted multiple times but failed. Finally, an ipsilateral to the pneumothorax and chest drain axillary venous catheter was safely inserted using ultrasound. Conclusively, the unique characteristics of each individual patient may substantially decrease the sites available for line insertion; the axillary vein is a valuable alternative, especially when cannulation of other central veins is prohibited or has failed.

Keywords: Axillary vein; Axillary artery; Vascular access; Ultrasound-guided central catheter cannulation; Emergency Ultrasound; Ultrasound in emergency central vein access; Multiple trauma patient; Central line catheter insertion; Pneumothorax

Introduction

Establishing venous access in the Emergency Department (ED) can be challenging. Circulatory insufficiency of various etiology, obesity, intravenous drug abuse and previous need for vascular access, comprise only a small part of situations where standard intravenous access procedures may fail or prove insufficient to meet the clinical needs of the patient [1]. The use of ultrasound guidance in establishing peripheral or central venous access is well supported by evidence, and many health associations strongly encourage point-of-care-ultrasound particularly in settings where reliable vascular access is urgently required [2,3]. Especially in the ED, where delays in achieving access can be life-

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Citation: Kyriazidou Anastasia, Baksiova Afroditi, Morfesis Petros, Soilemezi Eleni, Liatsi Domna. The Axillary Vein Revisited – An Unacknowledged Alternative to the Challenge of Vascular Access in Trauma. *Anesthesia and Critical care*. 8 (2026): 62-66.

Received: March 30, 2026

Accepted: April 07, 2026

Published: April 24, 2026

threatening, the use of ultrasound has been shown to decrease the number of attempts and length of time to cannulation [4-6].

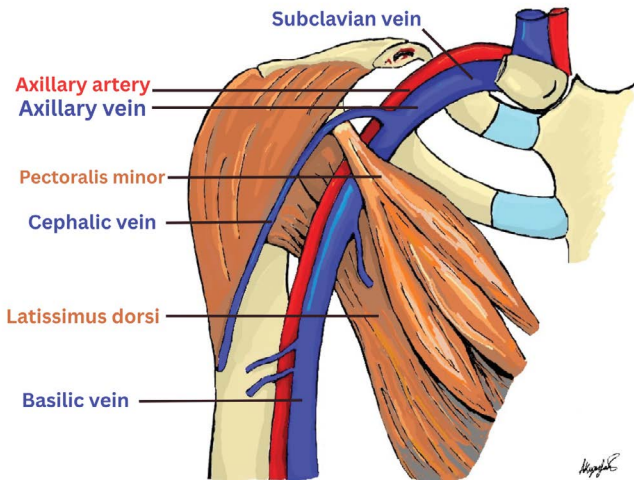


Figure 1: (Original artwork) Illustration of the origin, course and relationship of the axillary vein to neighboring structures.

The subclavian vein (SCV) is an important site for emergent vascular access. It offers a consistent landmark for insertion, and its patency is usually maintained even in hypovolemic states, as in trauma. However, cannulation of the SCV is associated with mechanical complications such as laceration of the subclavian artery or the visceral pleura, resulting in the development of a hemothorax or intrathoracic hematoma, or pneumothorax respectively [7,8]. Ideally, it would be preferable to insert a subclavian line under the direct guidance of ultrasound; however, the presence of the clavicle leaves little room for effective handling of the transducer during the procedure.

The SCV is the direct continuation of the axillary vein (AXV), the latter becoming the SCV at the lateral border of the first rib (Figure 1). It is a large vessel suitable for central venous catheters placement, traditionally used for insertion of pacemaker leads. The AXV encompasses all the advantages of SCV cannulation and has an additional benefit; placed outside the thoracic cage can be visualized all the way its anatomical route with ultrasound, being associated, therefore, with a lower risk of pleural puncture compared to the technique based on anatomical landmarks. The AXV has long been described as an additional anatomical site for placing central venous catheters in the Operating Theatres, the ICU and the ED [9-13], however, mainly as an effective alternative to other common insertion sites.

In this submission, we present a unique case where the AXV was the only vessel available for vascular access, with possible access to all other central veins either contraindicated, prohibited or failed when attempted.

Case Report

A multiple trauma patient required external fixation of pelvis and insertion of chest drain due to large pneumothorax in the Emergency Department. The initial CT scan also revealed an unstable fracture of the second cervical vertebra. Immediately after the completion of the stabilization of pelvis, the patient started to become hemodynamically unstable and required vasopressor support. The presence of pelvic external fixation prevented from access to both femoral veins, whereas an attempt to cannulize the internal jugular veins was considered as not without posing an additional risk to the patient, since it would require removal of the cervical collar and manual stabilization of the patient's head and neck during the procedure. Insertion of a contralateral to the pneumothorax subclavian line was not attempted due to the risk of causing bilateral pneumothoraces. Due to the presence of pneumothorax and chest drain, inserting an ipsilateral subclavian venous catheter was considered the safest option for the patient but multiple attempts by two different ED doctors failed. The patient was transferred to the ICU receiving all necessary fluids and vasopressors through the only peripheral vein found, until, finally, an axillary central venous catheter, ipsilateral to the side of pneumothorax and chest drain, was inserted on admission to ICU using ultrasound (Figure 2).

Sonoanatomy and Cannulation Technique

Without any change in the patient's position on the spine board, the ICU physician positioned himself on the patient's right side and the ultrasound machine was placed on the patient's left side, allowing for comfortable viewing of the ultrasound screen. The high-frequency linear transducer L12-4 (Philips Sparq, Philips) was placed in the right deltopectoral groove, where the axillary artery was initially identified due to its thick, echogenic walls and pulsating appearance. Slight caudal tilt of the transducer allowed for identification of the AXV, with fluctuation of the vessel's width with the respiratory movements and compression of the vessel with pressure. The distance from the skin surface to the vein was noted, along with the distance to the neighboring pleura (Figure 3). After sterile drapes and probe cover were applied appropriately, the transducer was placed parallel to the long axis of the axillary vein ("in-line" scanning). In this longitudinal orientation, the needle was inserted in the midpoint of the small footprint of the transducer (Figure 4), enabling an in-plane view. The inserting needle was visualized throughout the entire procedure while maintaining a view of the vessel and adjacent anatomical structures, mainly the pleura. Once the tip of the needle was identified within the lumen of the vein, the guidewire and subsequently the central venous catheter were threaded according to the Seldinger technique. The catheter was secured and infusion of vasopressors began (Figure 5). The patient's hemodynamics

improved and he was transferred to the Operating Theatre for surgical stabilization of his cervical fracture.



Figure 2: Multiple trauma patient with external fixation of the pelvis, unstable fracture of the second cervical vertebra necessitating the use of the hard collar and right-sided pneumothorax; an axillary venous catheter was inserted using ultrasonographic guidance.



Figure 4: High-frequency linear transducer placed along the deltopectoral groove, parallel to the long axis of the axillary vein.

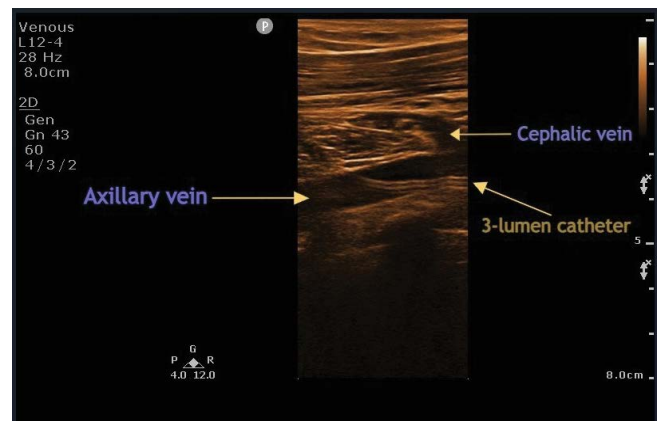


Figure 5: Ultrasonographic image of a 3-lumen catheter inserted in the axillary vein; the cephalic vein is also identified, draining in the former.

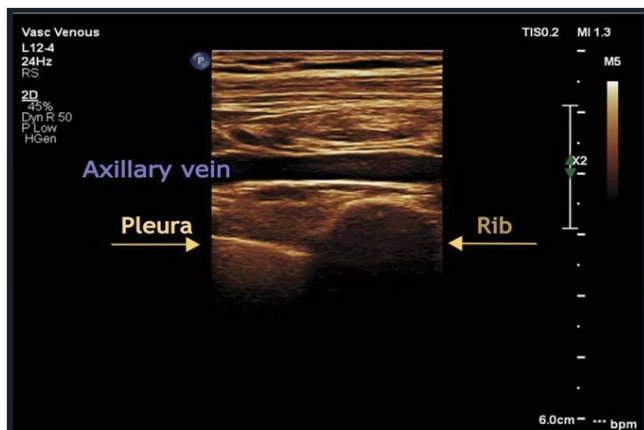


Figure 3: Tubular appearance of the vein, as it is visualized along its long axis. This “in-plane” scanning view allows for continuous visualization of the vein, the neighboring pleura and the advancing needle during the catheterization attempt, making the procedure more precise and safer.

Discussion

Our submission involves a case of a multiple trauma patient where central vascular access was especially challenging, since it was either prohibited due to the site of patient’s injuries, or failed when attempted. Consequently, the ED doctors found themselves in a clinical dead end, being unable to safely administer fluids and vasopressors in a patient becoming rapidly hemodynamically unstable. The problem was finally resolved when an axillary line was inserted under ultrasound guidance. Our presented case is unique, since

the axillary vein was not just a convenient alternative for achieving vascular access, but at the specific moment in time, was the only available insertion site associated with the least additional risk posed to the patient.

In our case, the option of access to the jugular veins would necessitate removal of the anterior part of the hard cervical collar to enable the procedure of line insertion. Even though manual spinal immobilization remains an accepted practice in acute trauma patients with suspected or confirmed cervical spine injury, there is data to suggest that it does not limit movement or may even increase subluxation at unstable segments, especially during procedures such as laryngoscopy and intubation [14,15]. Additional manipulations to remove the cast used to secure the patient’s head and neck neutral position to the spinal board would be required. Ultrasound visualization of the femoral veins was hindered by the presence of the pelvic external fixation pins. Apart from the relevant technical difficulty, femoral line insertion is also not advisable in such clinical cases due to consideration of complications

such as infections and possible further mechanical injury [16]. A rational approach to our patient would be to attempt to insert a SCV catheter in the ipsilateral to the pneumothorax and existing chest drain site. Indeed, both emergency physicians on duty attempted to cannulize the SCV using the anatomical landmarks technique but to no avail. Attempt to catheterize the contralateral SCV was not considered due to the risk of causing bilateral pneumothoraces, a devastating scenario with potential consequences in the patient's already compromised hemodynamic condition. Lastly, infusion of vasopressors via a peripheral venous catheter could also be considered, acknowledging, however, the difficulty in establishing an additional peripheral line in a vasoconstricted trauma patient; in the latter scenario, the risk of extravasation and potential tissue damage must also be considered.

Ultrasound-guided cannulation of the AXV, as finally achieved in our case, deserves a place in the ED, Operating Theatre and ICU setting, especially when options for intravascular access are limited. It can be performed by physicians with experience in either ultrasound-guided regional anesthesia or ultrasound-guided procedures that involve in-plane visualization of a needle; such procedures are not uncommon even in the ED [17,18]. It is worth mentioning that the technique is documented to have a steep learning curve, with medical trainees achieving AXV cannulation using ultrasound on simulation models more rapidly compared to cannulation of SCV using the anatomical landmarks technique [19]. With increasing experience in the technique, additional advantages such as higher success rates of cannulation and decreased incidence of mechanical complications are documented, compared to cannulation of the SCV using the anatomical landmarks technique [20]. Finally, a major advantage of the procedure is that it can be performed without any change in the patient's position, as documented in our case; this is extremely significant in the ED and ICU settings, where position changes can be potentially deleterious in high-risk populations, as in multiple trauma or brain injury patients.

The incidence of mechanical complications for the ultrasound-guided AXV access is low. Constant visualization of the needle tip is essential to avoid penetration of the posterior vessel wall and, subsequently, the pleura. A 3.3% incidence of pneumothorax, probably the highest recorded in large series of AXV cannulation, was recorded in ICU patients who had received cannulation in the proximal segment of the vessel, on the border with the subclavian vein, with most patients being ventilated with values of positive end-expiratory pressure up to 15 cm H₂O [21]. It is well described that previous unsuccessful insertion attempts, especially in an emergency setting, are the most common predictor of mechanical complications [22]; therefore, the ICU physicians in our case wisely did not retry using the landmarks technique, but decided to go for ultrasound-

assisted attempted insertion. The use of ultrasound to insert central catheters not only decreases the difference in insertion success rates between experienced and non-experienced operators but can also prove a valuable tool to an experienced operator who is otherwise unable to achieve access to the vessel [23]. The "in-plane" catheterization technique used in our case may, theoretically, increase the risk of puncturing the axillary artery, which lies in close proximity to the vein and is not visualized throughout the procedure. However, a meta-analysis by Wu et al. [24] reported a several-fold reduction of complications including arterial puncture, hematoma formation and hemothorax, when distal AXV was cannulized using ultrasound guidance, when the latter was compared to the ultrasound-guided proximal AXV or SCV cannulation. More recent literature further suggests that ultrasound-guided access to AXV can be considered as a feasible and safe method of central venous cannulation for cardiac surgery patients susceptible to bleeding [25]. Finally, even if inadvertent arterial puncture does occur during the procedure, application of pressure for a few minutes resolves the issue, due to the extra-thoracic, superficial position of the AXV.

In conclusion, our report adds to an extensive body of literature demonstrating that real-time, ultrasound-guided central venous catheter placement is associated with improved insertion success rate and fewer overall and specific complications. Especially in the ED and ICU environment, where each case presentation is totally unique, the axillary insertion site represents an extremely valuable option, sometimes the only available one, not to be overlooked by the physician.

Declaration of Interest: The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this article.

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