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Editorial

The never-ending confusion between subclavian vein and axillary vein

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Maria Giuseppina Annetta[1], Timothy R. Spencer[2] and Mauro Pittiruti[3]

Abstract

The use of precise and unequivocal terminology is crucial in clinical and scientific communication. A frequent source of error involves the anatomical confusion between the axillary vein and the subclavian vein. Anatomically, the transition from the axillary vein to the subclavian vein occurs at the lateral border of the first rib, beneath the clavicle. Consequently, the vessel typically visualized by ultrasound in the infraclavicular region is the axillary vein, not the subclavian vein. Nevertheless, numerous international guidelines and clinical studies continue to misidentify the thoracic segment of the axillary vein as the "subclavian vein." This persistent mislabeling hinders the international standardization of ultrasound-guided procedures, complicates the comparison of various techniques, and—most importantly—risks misinterpretation of evidence-based recommendations for clinical practice.

Keywords

Central venous catheterization, ultrasonography, axillary vein, subclavian vein, nomenclature, anatomy

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Introduction

International guidelines recommend the infraclavicular area as the ideal exit site for central venous catheters—particularly in critically ill patients—to decrease the risk of catheter-related infections.[1–4] Such recommendation is often expressed as a suggestion to prefer "subclavian access" or "the subclavian site": this is an ongoing source of confusion, since it identifies (erroneously) the infraclavicular venipuncture site with the insertion via the subclavian vein.[5] Since the introduction of ultrasound-guided venipuncture into clinical practice, the axillary vein has become the most obvious venous access route associated with an infraclavicular exit site, as ultrasound most commonly identifies the axillary rather than the subclavian vein in this region.

This is pertinent from the point of view of complication and adverse event prevention, since the recommendation of preferring "subclavian access" or "a subclavian site" may be misinterpreted as an invitation to adopt the now obsolete and dangerous technique of performing a "blind" infraclavicular approach to the subclavian vein.

The underlying vascular anatomy indicates quite clearly that ultrasound guided venipuncture in the infraclavicular region with a linear probe is most inevitably ultrasound-guided puncture of the axillary vein.

Ultrasound visualization of the axillary vein and the subclavian vein

First, the anatomic features and trajectory of the axillary vein should be considered. The axillary vein is formed by the union of the brachial and basilic veins at the lower border of the teres major muscle, and then ascends - medially to the axillary artery—towards the lateral border of the first rib, where it continues as the subclavian vein. The subclavian vein runs from the lateral border of the first rib to the medial border of the anterior scalene muscle where

[1]Department of Anesthesia and Intensive Care, Fondazione Policlinico Universitario "A. Gemelli"- IRCCS, Rome, Italy
[2]Global Vascular Access, LLC, Scottsdale, AZ, USA
[3]Department of Surgery, Fondazione Policlinico Universitario "A. Gemelli"- IRCCS, Rome, Italy

Corresponding author:
Mauro Pittiruti, Department of Surgery, Catholic University Hospital 'A.Gemelli', Largo F. Vito 1, Roma, Lazio 00168, Italy.
Email: mauropittiruti@me.com

it joins with the internal jugular vein and with the external jugular vein to form the brachio-cephalic vein (also called innominate vein).[6,7]

Ultrasound-guided venipuncture is currently endorsed by all major international guidelines.[2, 8–10] In this context, the axillary vein is, in many cases, the only vein in the infraclavicular area that can be consistently visualized and accessed using ultrasound.

The two standard ultrasound views of the axillary vein are the short axis (transverse) view (Figure 1(a)) and the long axis (longitudinal) view (Figure 1(b)). Visualization of the axillary vein in oblique axis has been recently proposed, utilized for axillary cannulation if in-plane puncture is adopted, but it is not shown in these figures. When the patient is in normal supine position, the first rib cannot be visualized, since it is hidden by the clavicle (Figure 1(b)); therefore, the vein visualized in the infraclavicular area is the axillary vein. Since the subclavian vein starts at the outer border of the first rib, its visualization with a linear probe in the infraclavicular area in adult patients is possible only in few patients, and only when the shoulder is in a forced elevated position (Figure 1(c)): in this case, the first rib might be visualized and the transition between axillary and subclavian vein can be identified.

On the other hand, the old-fashioned 'blind' puncture of the subclavian vein in the infraclavicular region—which is currently discouraged because of the risk of severe complications (pneumothorax, hemothorax, lesion of the lymphatic duct, pinch-off syndrome, etc.)—was actually a direct puncture of the subclavian vein, as the needle was directed below and behind the clavicle, so to puncture the vein in an area that cannot be visualized. As all guidelines currently recommend ultrasound-guided venipuncture, the ultrasound approach to the subclavian vein can be performed today only by a supraclavicular approach, visualizing the vein in its long axis, as it runs behind the clavicle, using a linear probe appropriately tilted[11] (Figure 2(a)); moving the probe more medially, the confluence of the subclavian vein into the brachiocephalic vein can also be visualized (Figure 2(b)). An ultrasound-guided infraclavicular approach to the subclavian vein is rarely feasible; an analysis of CT scan of ultrasound infraclavicular venipuncture revealed that even the most proximal venipuncture (i.e. very close to the clavicle) does not guarantee a 'real' subclavian access.[12]

A correct identification of the trajectory of the axillary vein and of the subclavian vein, as well as a proper terminology in defining such vein, is a matter of relevance and has already been addressed by previous authors.[13–15] The inappropriate definition of the vein situated in the infraclavicular area is an obstacle to an international standardization of the ultrasound guided procedures and to a proper comparison between different techniques.

Inappropriate terminology in international recommendations

In a review of the optimal strategies to prevent catheter-related complications in critically ill patients,[16] the "subclavian site" is recognized as superior with regard to infectious and thrombotic complications but associated with greater mechanical complications.

In a position statement of the Society of Hospital Medicine on the use of ultrasound guidance for vascular access,[8] the use of real-time ultrasound guidance puncture of the 'subclavian vein' is recommended.

The French Society of Intensive Care Medicine[17] also recommends the use of 'subclavian vein' to decrease the risk of central venous catheter-related infection rather the jugular or femoral vein (strong consensus and grade 1 recommendation).

In the SHEA/IDSA/APIC practice recommendation on prevention of catheter-related infection,[1] the "subclavian vein" is considered the preferable site for central venous catheter insertion.

Another editorial on prevention of catheter-related infection in the critically ill[18] recommends to prefer the 'subclavian vein' for central venous catheter with the exception of short-term dialysis catheters.

According to the Standards of the Infusion Nurses Society,[2] the "axillo-subclavian approach" is associated with lower risks of infection and of thrombosis but may be associated with increased risk of mechanical complications on insertion.

In another recent review,[19] the "subclavian site" is regarded as the preferred insertion site for reducing the risk of catheter related blood stream infection, because of its low bacterial colonization of the skin.

All of these recommendations have some inconsistencies, due to inappropriate use of terminology and ongoing confusion between the subclavian vein and the axillary vein, so that is unclear if they actually recommend subclavian venipuncture in the infraclavicular area by the obsolete and dangerous "blind" landmark technique, or if they simply ignore the anatomic difference between axillary vein and subclavian vein.

Inappropriate terminology in clinical studies

Although the texts of anatomy offer a clear anatomical distinction between axillary and subclavian vein, in many clinical studies the nomenclature appears to be used interchangeably.

In 1995, in one of the first studies about ultrasound-guided cannulation in the infraclavicular area,[20] the misunderstanding is already present: the authors discuss

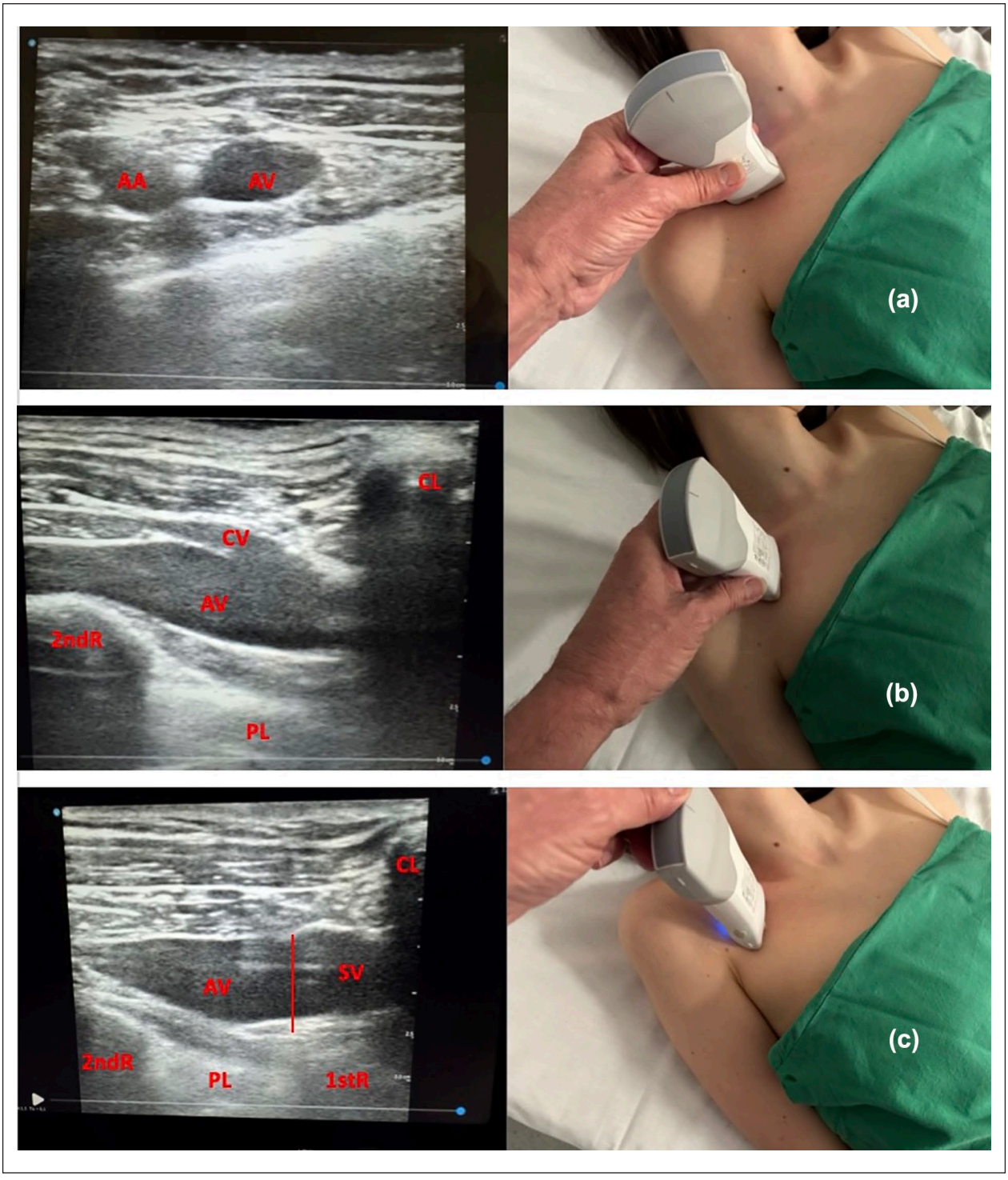

Figure 1. Ultrasound visualization of the axillary vein in the infraclavicular area, in short axis (a) and in long axis (b); the transition between axillary vein and subclavian vein can be visualized only in long axis, when the shoulder is in a forced elevated position (c).
1stR = first rib, 2ndR = second rib, AA = axillary artery, AV = axillary vein, CL = clavicle, CV = cephalic vein, PL = pleura, SV = subclavian vein.

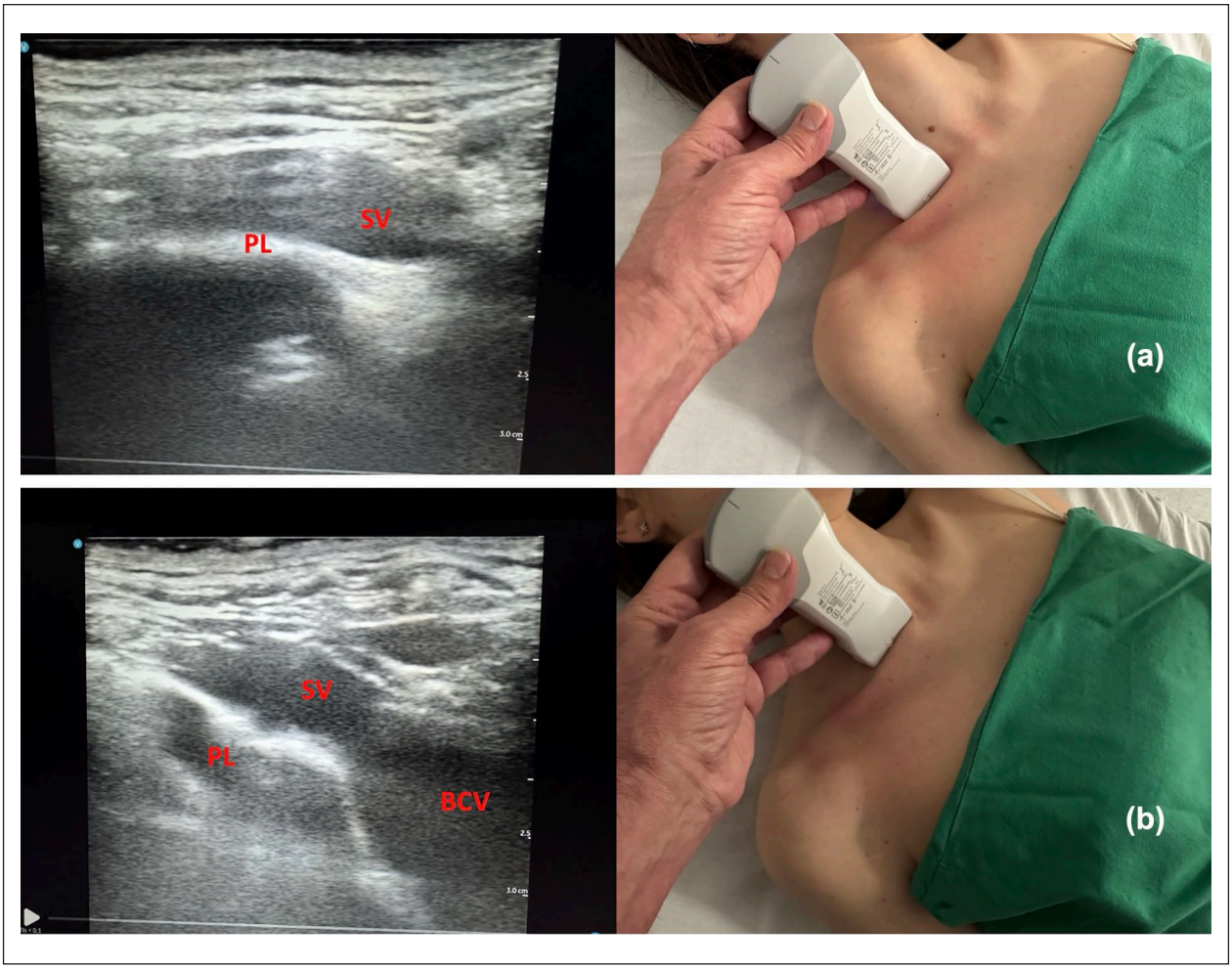

Figure 2. Ultrasound visualization of the subclavian vein in the supraclavicular area, in long axis, behind the middle third of the clavicle (a) and behind the medial third of the clavicle (b).
BCV = brachiocephalic vein, PL = pleura, SV = subclavian vein.

"subclavian vein catheterization" but the images show clearly an ultrasound guided cannulation of the thoracic tract of the axillary vein in the deltopectoral groove.

Twenty years later, a vast multicenter trial comparing three different venipuncture sites (jugular, subclavian and femoral)[21] reported that "subclavian vein catheterization" was associated with a lower risk of bloodstream infection (0.5%) and symptomatic thrombosis (0.5%) and a higher risk of pneumothorax (2%) if compared to jugular venipuncture. Though, the results of this study are unclear, considering that 85% of subclavian punctures were performed by the landmark-based technique (which explains the high rate of mechanical complications), while the remaining 15% were performed by ultrasound guidance (and most likely they were ultrasound guided punctures of the axillary vein, not of the subclavian vein). The forementioned study is also biased by the confusion between "puncture site" and "exit site": for example, the low rate of infection is related to the infraclavicular location of the exit site rather than to the venipuncture per se.[5]

Ultrasound-guided 'subclavian/axillary vein' cannulation is discussed by Senussi et al.,[22] but the described technique and the figures clearly refer to cannulation of the axillary vein: the venipuncture is performed in-plane directing the needle toward the periosteum of the second rib (i.e. where the vein is the axillary, not the subclavian).

In a randomized clinical trial in cardiac surgical patients,[23] the authors compared the short axis versus long axis ultrasound-guided infraclavicular cannulation of the "subclavian vein": the venipuncture – as performed with a linear probe in the infraclavicular area in both short and long axis view – is obviously an ultrasound guided access to the axillary vein.

Cannulation of the subclavian vein using real-time ultrasound guidance, was also discussed by Davies and coworkers[24]: the authors describe the correct anatomic course of the axillary and subclavian vein and the correct nomenclature, nevertheless they chose to call "subclavian vein" what is in fact the axillary vein, both in the text and figures.

In a study comparing ultrasound-guided supraclavicular vs. infraclavicular cannulation of the "subclavian vein"[25] Saini and coworkers described the infraclavicular approach in oblique axis below the clavicle, which is actually an oblique approach to the axillary vein.

A similar, randomized controlled trial compared the ultrasound supraclavicular vs. infraclavicular approach to the "subclavian vein"[26]: in fact, the supraclavicular approach (long axis, in-plane) to the subclavian vein was compared with the infraclavicular approach (short axis, out-of-plane) to the axillary vein.

In a very large Swedish multicenter study (>12,000 cases) focused on mechanical complications during central venous catheterization,[27] the authors discussed the cannulation of internal jugular vein, external jugular vein, femoral vein and "subclavian vein" (with no mention of the axillary vein): as they claim that ultrasound guidance was adopted in 93% of cases, it is not clear if the complications related to the "subclavian vein" are to be ascribed to (a) ultrasound guided cannulation of the axillary vein by the infraclavicular route, or (b) ultrasound guided cannulation of the subclavian vein by the supraclavicular area, or (c) landmark-based "blind" cannulation of the subclavian vein. Considering such ambiguity, the conclusions of the authors regarding the risk of complications related to "subclavian vein" cannulation are questionable and irrelevant for clinical practice.

In a recent meta-analysis[28] comparing ultrasound guided cannulation vs. landmark-based cannulation of the subclavian vein, the authors included studies addressing both axillary and subclavian venipuncture; thus, their conclusions ("real-time ultrasound-guided subclavian vein cannulation is safer and more efficient than a landmark approach") were quite inappropriate, since 'ultrasound-guided subclavian vein cannulation' is feasible in most cases only by supraclavicular approach. The proper message of their meta-analysis should be that "real-time ultrasound-guided axillary vein cannulation is safer and more efficient than a landmark approach to the subclavian vein."

In a recent systematic review and meta-analysis comparing the ultrasound-guided supraclavicular approach versus the infraclavicular approach,[29] the latter was ambiguously reported as 'axillo-subclavian' venipuncture.

All these studies above, perpetuating the confusion between the axillary and subclavian veins, contain misrepresentative statements which may be inappropriate and/or confusing when translated into clinical practice.

Clinical studies adopting the appropriate terminology

The ultrasound technique was described in the begin of the 2000's,[7,30,31] mostly describing supraclavicular approaches to the internal jugular vein. After the implementation of ultrasound-guided venipuncture and its widespread use in clinical practice, the infraclavicular approach has also become popular.

The "real" infraclavicular ultrasound approach to the subclavian vein has been described in 2014[32]: the authors described the infraclavicular cannulation of the subclavian vein using an 8-MHz micro-convex array pediatric probe, with vein visualization in long axis and in-plane puncture after the lateral margin of the first rib (which is the anatomical boundary between axillary and subclavian vein).

The supraclavicular ultrasound approach to the subclavian vein was described in the same year.[33]

Real time ultrasound-guided cannulation of the axillary vein was first described by Gawda et al.,[34] demonstrating that it was feasible both in short axis/out-of-plane and in long axis/in-plane.

Ultrasound approaches to the axillary vein in the infraclavicular area has been described by many other papers, showing the feasibility of different techniques (out of plane-short axis, in plane-long axis, in plane-oblique axis).[35–37] The oblique axis/in-plane puncture of the axillary vein has been described as particularly safe, providing the simultaneous visualization of vein, artery, and pleura.[36,37] A few articles have also discussed the effects of the abduction/adduction of the arm on axillary venipuncture.[38,39]

A randomized controlled trial compared an ultrasound-guided approach of the axillary vein in the proximal zone (close to the clavicle) versus the distal zone (closer to the axilla) using the long axis, in-plane technique in a group of elderly patients.[40]

In cardiac surgery patients at high risk of bleeding, the proximal versus distal long axis in-plane approach of axillary vein cannulation was compared, demonstrating that both approaches are safe and feasible.[41]

The ultrasound cannulation of the axillary vein has also been described for implantation of ports.[42]

Two randomized controlled trials compared ultrasound-guided cannulation of the axillary vein vs. ultrasound guided cannulation of the internal jugular vein, in critically ill patients[43,44]: in both studies, the infraclavicular cannulation was correctly described as cannulation of the axillary vein.

A recent meta-analysis on ultrasound guidance vs. landmark technique for infraclavicular venipuncture[45] appropriately compared ultrasound-guided cannulation of the axillary vein vs. landmark-based cannulation of the subclavian vein.

Since 2020, ultrasound-guided axillary vein puncture has also been adopted for implantation of cardiac devices.[46–56]

All the studies quoted above have adopted the correct terminology, differentiating between the axillary vein and subclavian vein, thus providing unequivocal and precise description of technique and offering data repeatable in clinical practice.

Table 1. Complications associated with different approaches to the subclavian vein and to the axillary vein.

	Blind puncture of the subclavian vein*	Ultrasound guided puncture of the subclavian vein	Ultrasound guided puncture of the axillary vein
Approach	Infraclavicular approach, so-called 'landmark-based'.	Supraclavicular approach: long axis, in-plane	Infraclavicular approach: short axis, out-of-plane; long axis, in-plane; oblique axis, in-plane
Clinical outcome			
Success rate	77%–85%[21, 57,58]	95%–100%[25,26]	98%–100%[23,25,26,31,36,37,40,42,58]
Pneumothorax	1%–4.9%[21, 57,58]	0%[25,26]	0% (in-plane)[23,31,36,37,40,42,58] 0%–1% (out-of-plane)[25,26]
Arterial injury	3%–5.4%[21, 57,58]	0%–2%[25,26]	0%–1.5% (short/oblique axis)[25,26,31,37,40,42,58] 2%–7% (long axis)[23,36]
Nerve injury	Possible	Never reported	Never reported
Pinch-off syndrome	Relatively frequent for silicone catheters	Impossible	Impossible
Infection**	Low risk	Low risk	Low risk
Thrombosis**	Low risk	Low risk	Low risk

*Strongy discouraged by current recommendations of clinical practice.[2–4, 8–10]
**The risk of infection and thrombosis is more likely to be affected by the exit site rather than by the vein that has been cannulated.[5]

Conclusion

Using accurate and unambiguous terminology is crucial in scientific communication. In most cases, the vein seen on ultrasound in the infraclavicular region is the axillary vein, not the subclavian vein. Misidentifying this vein can hinder the international standardization of ultrasound-guided procedures, complicate the comparison of different techniques, and—most importantly—lead to misinterpretation of best practice guidelines. Table 1 exemplifies the clinical differences between blind subclavian vein cannulation, ultrasound guided cannulation of the subclavian vein and ultrasound guided cannulation of the axillary vein, showing the importance of correctly distinguishing these two anatomical structures, since they differ in terms of procedural outcomes and complication profiles.

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ORCID iDs

Maria Giuseppina Annetta https://orcid.org/0000-0001-7574-1311
Timothy R. Spencer https://orcid.org/0000-0002-3128-2034
Mauro Pittiruti https://orcid.org/0000-0002-2225-7654

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