



Therapeutics

A novel technique for ultrasound-guided supraclavicular subclavian cannulation ☆, ☆ ☆

Michael Mallin MD^{a,*}, Hunter Louis MD^b, Troy Madsen MD^a

^aUniversity of Utah Emergency Medicine, Salt Lake City, UT 84132, USA

^bCarolina Healthcare Roper Hospital, Charleston, SC 29401, USA

Received 16 June 2009; accepted 19 July 2009

Abstract

Objective: Ultrasound-guided subclavian (SC) access is an inadequately described procedure in the current literature. We recommend using the endocavitary (EC) probe to perform supraclavicular (SUP) SC line placement and evaluate emergency medicine residents' skill and comfort in using this technique after an education session.

Methods: The EC probe placed in the SUP fossa was used for direct visualization of SUP SC cannulation. Fifteen residents at the University of Utah were educated on this technique. Residents were graded on their ability to visualize the SC vein and answered questions before and after the training. Residents reported their comfort with the technique using a 5-point Likert scale.

Results: All 15 residents correctly identified the SC vein and rated their understanding of the SUP anatomy before and after the training; average resident comfort rating was 2.9 before training and 4.4 after (95% confidence interval, 1.1–1.9; $P < .001$). Most residents reported significant ease of visualization and stated that they would likely attempt the procedure as their next method of central venous access.

Conclusion: Ultrasound-guided SUP SC central access using the EC probe may be technically advantageous because of the relatively small probe footprint and fit into the SUP fossa. All participants were able to identify the vein and reported subjective improvement in the understanding of anatomy and comfort with the procedure after a brief training session.

© 2010 Elsevier Inc. All rights reserved.

1. Introduction

Recent advances in ultrasound (US) technology have revolutionized the means in which central vascular access can be obtained. In comparison with the use of superficial

anatomical landmarks, advantages of US-guided venous access include direct visualization of anatomy and in vivo visualization of venous cannulation. Ultrasound-guided percutaneous venous catheter placement is well described in the literature as a safe method of obtaining vascular access [1]. One study comparing US-guided venous access to the traditional anatomical landmark-guided technique found that US-guided access required, on average, 1.9 fewer attempts and 369.4 fewer seconds to achieve cannulation in a “difficult sick” group [2]. In addition, the Agency for Health Care Research and Quality proclaimed US-guided central lines as an intervention that should be established immediately in patient care to boost patient safety. The American College of Emergency Physicians (ACEP) has also recog-

☆ Prior presentations: Society for Academic Emergency Medicine Western Regional Research Conference, Park City, UT, January 2009. American Institute of Ultrasound in Medicine annual conference, New York, NY, April 2009.

☆☆ Prior posters: Society for Academic Emergency Medicine, New Orleans, LA, May 2009.

* Corresponding author. University of Utah Emergency Medicine Division, Salt Lake City, UT 84132, USA. Tel.: +1 801 581 2730.

E-mail address: michael.mallin@hsc.utah.edu (M. Mallin).

nized this initiative by releasing a formal policy statement, the *Emergency Ultrasound Imaging Criteria and Compendum*. This statement established criteria for the use of, among other things, emergency US for guided central venous access. Purported advantages, according to the ACEP, include improved patient safety, decreased attempts, and decreased time of procedures [3].

Internal jugular (IJ) access, which has been well described in numerous sources as a safe means of US-guided access, can be achieved using a standard linear array or endocavitary probe [4]. Despite the recent paradigm shift to US-guided venous access, little has been described regarding US-guided subclavian (SC) lines. A recent review of the supraclavicular SC approach describes the procedure mostly as a landmark-guided technique owing to little room in the supraclavicular fossa to place a standard US probe [5]. Subclavian venipuncture is the most common means of central venous access and has been taught in residency training programs for more than 30 years. The infraclavicular approach was the first approach used and has remained the dominant method in training centers nationwide [6]. A multitude of research has surfaced, however, suggesting that the less common supraclavicular approach is safer and easier for the inexperienced operator. The supraclavicular approach has been found to be easier to perform during cardiopulmonary resuscitation or with the patient sitting. It has also been associated with fewer accidental pneumothoraces and better final placement of the catheter tip [7-10]. Possibly, even more importantly, SC catheter placement is associated with fewer infections and thromboses than are IJ or femoral central lines [11].

Unfortunately, both the supraclavicular and the infraclavicular approaches are difficult to visualize with US because of the location of the SC vein under the clavicle and the inability to place the linear array probe in position to visualize the vessel. For this reason, US-guided SC access is often described using an axillary approach and cannulating the vein inferior to the clavicle and lateral to the first rib [6]. Ideally, the literature suggests that a supraclavicular US-guided approach would be optimal with regard to fewer adverse outcomes and better catheter placement [7,8,10,11]. Recognizing these advantages, we have developed a novel approach for placement of a US-guided supraclavicular central line using the standard high-frequency endocavitary probe. To test the applicability of this technique, we taught the procedure to a group of residents at the University of Utah and tested them on their ability to perform the procedure.

2. Methods

To perform US-guided supraclavicular SC catheterization, the endocavitary probe is placed in the supraclavicular fossa, just lateral to the clavicular head of the sternocleidomastoid muscle (Fig. 1). The SC vein is best found in the

long axis. Fig. 2 displays a long axis view of the SC vein merging with the IJ vein to form the right innominate vein. The small footprint of the probe allows for direct visualization of SC cannulation via the traditional US-guided Selinger technique. This procedure is typically performed on the right because of the insertion of the thoracic duct on the left. The SC is found to be best visualized if the patient's ipsilateral arm is placed behind his/her back. This maneuver rocks the shoulder cradle and clavicle anteriorly, which allows a greater portion of the transverse section of the SC to be visualized. The procedure can be performed with the SC vein visualized in long or short axis, although we have found the short axis to be more familiar.

Fifteen residents at the University of Utah volunteered for this study. These residents had varying degrees of US experience ranging from virtually none to that expected of a senior resident. A 15-minute formal presentation including a review of the anatomy and probe placement was performed. The residents then underwent a brief practical in which they attempted to visualize the SC vein using the endocavitary probe. Residents were graded on their ability to visualize the SC vein and artery in transverse and longitudinal sections and answered several subjective questions regarding understanding of anatomy, comfort, and likelihood of performing a US-

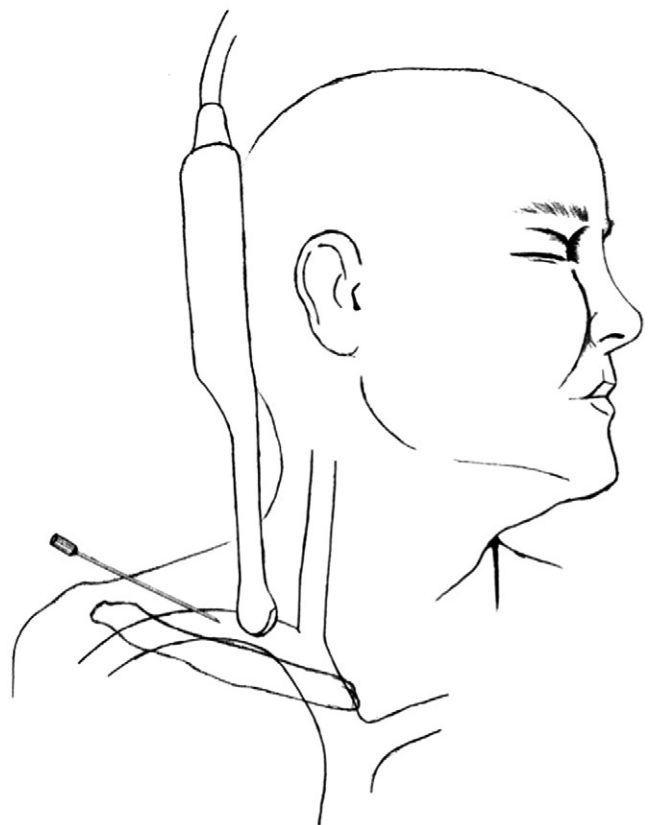


Fig. 1 Artistic rendition of the location and placement of the endocavitary probe and the needle during the supraclavicular ultrasound-guided approach to cannulation of the right subclavian vein. Drawing by Mike Mallin.

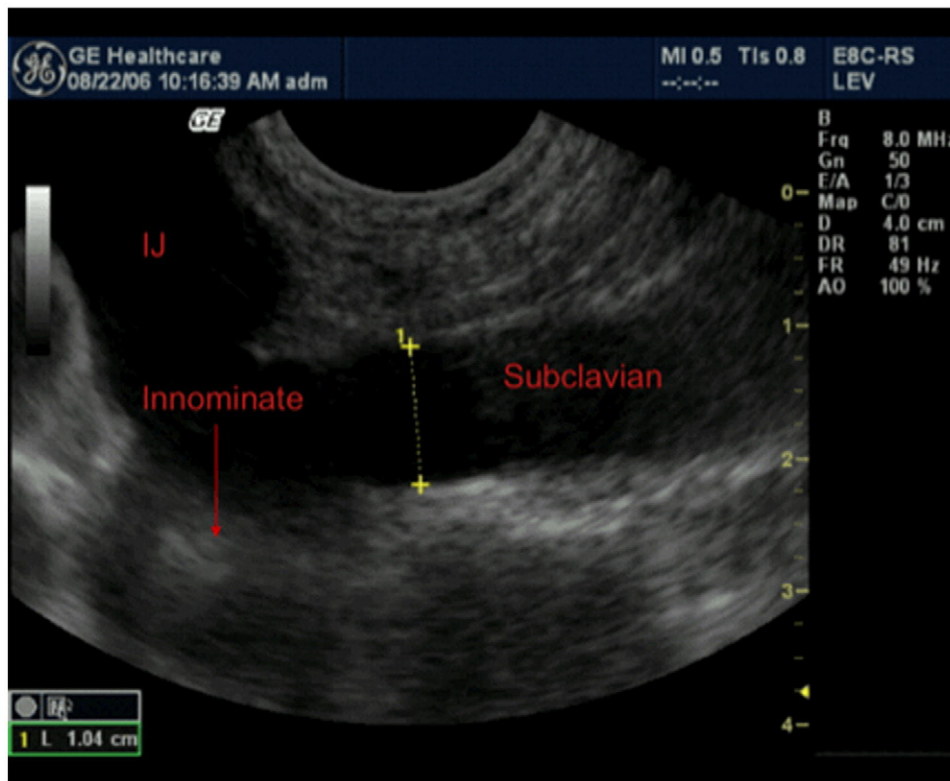


Fig. 2 Long axis view of the subclavian vein. The IJ vein can be visualized merging with the subclavian vein to form the innominate vein.

guided SC central line before and after the training course. The questions were answered on a Likert scale from 1 (poor, uncomfortable, or unlikely) to 5 (excellent, comfortable, or very likely). Descriptive statistics and paired-samples *t* test were used, with *P* < .05 considered statistically significant and 95% confidence intervals (95% CIs) reported.

3. Results

Fifteen participants completed the entire training course including the formal presentation, a practical examination

using the US machine to visualize the SC vein, and a posttest survey analyzing subjective measures. None of the participants had previously placed a supraclavicular SC line or visualized the SC on US.

After the short didactic session, each participant was individually graded on his/her ability to visualize the SC vein using the endocavitary probe. To pass, the SC vein had to be identified in the short and long axes. All 15 participants correctly identified the SC vein from the supraclavicular fossa using the endocavitary probe.

Before and after the educational intervention, participants completed a short survey measuring their experience, understanding, and willingness to perform the procedure.

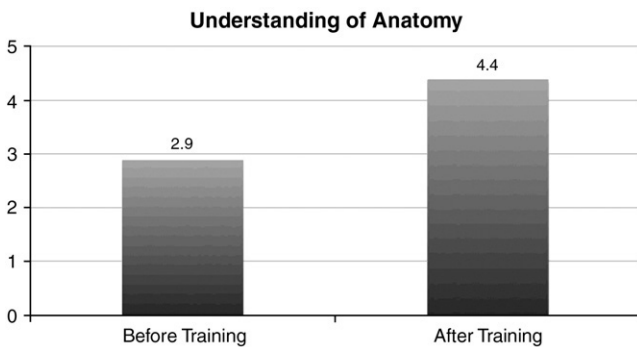


Fig. 3 Participants rated their understanding of the supraclavicular anatomy before and after the training. Average score was 2.9 before training and 4.4 after the teaching session (95% CI of the difference, 1.1-1.9; *P* < .001).

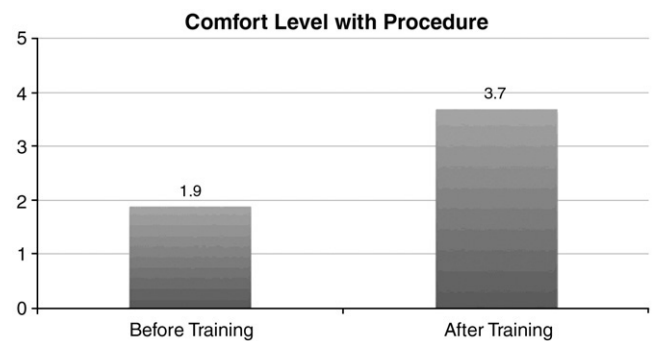


Fig. 4 Participants reported their comfort level with attempting a US-guided supraclavicular central line with an average score of 1.9 before the teaching session and 3.7 after the teaching session (95% CI of the difference, 1.1-2.5; *P* < .001).

None of the participants had previously placed an SC central venous catheter. In addition, no participant had previously visualized the SC vein with US. Participants rated their understanding of the supraclavicular anatomy before and after the training; average score was 2.9 before training and 4.4 after the teaching session (Fig. 3; 95% CI of the difference, 1.1-1.9; $P < .001$). Participants reported their comfort level with attempting a US-guided supraclavicular central line with an average score of 1.9 before the teaching session and 3.7 after the teaching session (Fig. 4; 95% CI of the difference, 1.1-2.5; $P < .001$). The participants rated their ease of visualization of the vein at 4.2 on a scale of 1 to 5 (5, easiest visualization; range, 3-5). Finally, the residents reported the likelihood that they will use US-guided supraclavicular SC cannulation for their next method of central venous access as 3.2 (range, 2-4).

4. Discussion

Ultrasound-guided supraclavicular SC central access using the endocavitary probe is a novel technique that may be technically advantageous because of the relatively small probe footprint and seemingly “perfect fit” into the supraclavicular fossa. This procedure can be used to ensure normal anatomy, locate the ideal site for needle insertion, visualize the cannulation process in real time, and confirm correct placement of the guide wire and catheter. In addition, residents can be taught this procedure quickly using a short didactic session and brief hands-on experience with the US. Through this study, we have shown that residents were able to identify the anatomy after our education intervention. Furthermore, their subjective perception of the procedure and anatomy significantly improved when comparing comfort levels before and after the procedure.

The primary limitation of this study is that the participants’ ability to visualize the SC vein from the supraclavicular fossa was tested rather than their ability to successfully perform cannulation of the vein on actual patients. Although there is presumably a direct correlation between the 2 end points, there would be significant benefit from future research where the procedure was actually

performed on patients. Future investigation should concentrate on enrolling patients and analyzing outcomes of US-guided SC venous catheterization. Ideally, this could be compared with other methods of venous cannulation such as landmark-guided SC or US-guided IJ venous cannulation.

5. Conclusion

Ultrasound-guided SC venous cannulation can be performed just as it is for IJ or femoral central lines by simply using the endocavitary probe and a supraclavicular approach. This procedure has tremendous implications regarding ACEP’s policy statement to perform all central lines under US guidance. Furthermore, we have shown that this procedure can be taught to emergency medicine residents through a short education session.

References

- [1] Fry WR, Clagett GC, O’Rourke PT. Ultrasound-guided central vein access. *Arch Surg* 1999;134:738-40.
- [2] Miller AH, Roth BA, Mills TJ, Woody JR, Longmoor CE, Foster B. Ultrasound guidance versus the landmark technique for the placement of central venous catheters in the emergency department. *Acad Emerg Med* 2002;9(8):800-5.
- [3] ACEP board of Directors. ACEP policy statement: emergency ultrasound imaging criteria and compendium. April 2006.
- [4] Phelan MP. A Novel use of the endocavitary (transvaginal) ultrasound probe: ventral venous access in the ED.
- [5] Shannon P Patrick MD, Marius A Tijunelis MD, Sonia Johnson MD, Mel E Herbert MD. Supraclavicular subclavian vein catheterization: the forgotten central line. *West J Emerg Med* 2009;10 No. 2, Article 14.
- [6] Hedges, Roberts: Clinical procedures in emergency medicine Vol 4. Elsevier 2004: 415-29.
- [7] Knopp R. Dailey: central venous cannulation and pressure monitoring. *JACEP* 1977;6:358.
- [8] Garcia JM. Percutaneous supraclavicular superior vena caval cannulation. *Surg Gynecol Obstet* 1972;134:839.
- [9] Brachos GJ. Central venous catheterization via supraclavicular approach. *J Trauma* 1977;17:872.
- [10] Yoffa D. Supraclavicular subclavian cenopuncture and catheterization. *Lancet* 1965;2:614-7.
- [11] McGee DC, Gould MK. Preventing complications of central venous catheterization. *N Engl J Med* 2003;348:1123-33.