

Ultrasound in Emergency Medicine

ULTRASOUND-GUIDANCE CAN REDUCE ADVERSE EVENTS DURING FEMORAL CENTRAL VENOUS CANNULATION

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Abstract—Background: Ultrasound-guidance for internal jugular central venous cannulation (CVC) has become the recommended best practice and has been shown to improve placement success and reduce complications. There is a dearth of studies that evaluate emergency point-of-care ultrasound guidance of femoral CVC. **Objective:** Our aim was to determine if point-of-care ultrasound guidance for femoral CVC decreases adverse events and increases the likelihood of successful placement when compared with the landmark technique. **Methods:** We conducted an Institutional Review Board–approved, prospective, observational study of consecutive patients who required CVC. Physicians who performed CVC completed a standardized, web-based data sheet for a national CVC registry. We evaluated single-institution data regarding CVC site, ultrasound usage, CVC indication, and mechanical complications (e.g., pneumothorax, arterial puncture, failed access, catheter misdirection, and hematoma). The study period was between January 2006 and June 2010. Analysis using Pearson's χ^2 and Agresti-Coull binomial confidence intervals was performed; significance was defined as $p < 0.05$. **Results:** We evaluated data for 143 patients who had femoral CVC in our institution. Sixty CVCs (42%) were performed under ultrasound guidance, 83 (58%) via landmark technique ($p = 0.0159$); 3.3% of femoral central venous lines placed by ultrasound guidance had recorded adverse events compared with 9.6% for the landmark technique ($p = 0.145$). There was no statistically significant difference in compli-

cations between ultrasound-guidance and landmark techniques. Our data showed a trend toward decreased rates of arterial puncture and reduced cannulation attempts resulting in improved placement success. **Conclusions:** Our experience shows that ultrasound guidance for femoral CVC might decrease complications and improve placement success, although we cannot recommend this approach without additional data. We recommend a larger study to further evaluate this technique. © 2014 Elsevier Inc.

Keywords—point-of-care ultrasound; bedside ultrasound; central venous catheterization; femoral; procedural guidance

INTRODUCTION

Physicians in the United States annually place an estimated 5 million central venous catheters in internal jugular, subclavian, and femoral veins (1). Common indications for central venous cannulation (CVC) include vasoactive medication infusions, hemodynamic monitoring, cardiac pacing, cardiopulmonary resuscitation, parenteral nutrition, and poor peripheral venous access. Although often necessary and beneficial, CVC is associated with significant risks that include arterial puncture, hematoma formation, pneumothorax, guidewire loss, line misdirection, and infection (1). Direct ultrasound visualization of the needle

Table 1. Central Line Emergency Access Registry Data Collection

Placement reason	Hospital site placed (ED, ICU)
Total number of attempts for success*	Operator training level†‡
Anatomic location of CVC	Operator specialty
Ultrasound guidance for CVC	Operator's total prior CVCs
Real-time US guidance vs. for vein/landmark identification	Total attempts and total skin punctures for each attempt
Reason if US not used for guidance†	Supervising physician presence (if applicable)
Patient age, sex, and weight	Sterile technique§
Use of anxiolysis, narcotics, or local anesthetic	Reason for failed attempt

CVC = central venous cannulation; ED = emergency department; ICU = intensive care unit; US = ultrasound.

* Attempt: one operator at one site successfully places a catheter. Failed attempt means another operator or another site was required to place successfully.

† Insufficient US set-up time, no access to US machine, insufficient training in US CVC.

‡ PGY-1, 2, 3, 4, or 5, fellow, attending physician, medical student.

§ Sterile gown, mask, gloves, full drape, face shield, and antiseptic preparation.

|| Arterial puncture, patient noncompliance, unable to identify vein, unable to flush ports, unable to thread guidewire.

tip and guidewire entering the vessel can mitigate these complications.

Ultrasound guidance for internal jugular CVC has become the recommended best practice and has been shown to increase successful catheter placement and to reduce complications (2–4). A 2006 study published by Leung et al. demonstrated that ultrasound guidance for internal jugular CVC improved successful placement by 15.4% and reduced complications by 12.3% (5).

There is a dearth of studies that evaluate emergency point-of care ultrasound guidance for femoral CVC. We sought to determine if ultrasound guidance for femoral CVC decreased adverse events and increased successful placement when compared with the standard landmark technique in the emergency department.

METHODS

We evaluated data from 143 patients at our institution who had femoral CVC performed. Emergency department attending, fellow, and resident physicians placed a femoral central line using maximal sterile barrier precautions, except in code or emergent situations. Choice of CVC location was at the discretion of physicians. Clinicians then completed a standardized, web-based data sheet for the Central Line Emergency Access Registry (CLEAR). The CLEAR registry comprised 13 academic centers that maintain an annual census of at least 35,000 patients. The centers were staffed by American Board of Emergency Medicine practitioners around the clock. Patients at least 18 years of age who had attempted CVC by an emergency medicine resident or physician were eligible for database entry. Pertinent data recorded in the registry are listed in the Tables 1 and 2 (6).

Statisticians analyzed data using SPSS-17 statistical software developed by the SPSS Inc. (Chicago, IL). Pearson's χ^2 and Agresti-Coull binomial confidence intervals were performed. Significance was defined as $p < 0.05$.

RESULTS

We evaluated data for 143 patients who had femoral CVC in our institution. Residents placed the majority of femoral lines ($n = 139$). Attending physicians performed three lines and supervised a medical student who placed one femoral CVC. Sixty CVCs (42%) were placed under ultrasound guidance and 83 (58%) were placed via landmark technique ($p = 0.0159$); 3.3% of central venous lines placed by ultrasound guidance had recorded adverse events compared with 9.6% for the landmark technique ($p = 0.145$). Ultrasound guidance might have reduced the total number of needle sticks, arterial punctures, and failed access; however, the study lacked power to show this effect. Table 3 and Figure 1 delineate adverse events associated with each technique.

DISCUSSION

A review of our institution's data from the CLEAR registry indicates that 99.3% of internal jugular vein CVCs was performed using ultrasound guidance, reflecting the national best practice. Femoral CVC stands in stark contrast: 43% of femoral CVCs were guided by ultrasound. Ultrasound-guided femoral CVCs had a 3.3% complications compared with 9.6% in the landmark technique group. This was not statistically significant, most likely due to the low number of femoral CVCs during the study period.

Clinicians might prefer the femoral location for CVC as opposed to the internal jugular or subclavian veins in several clinical situations. During cardiac or respiratory

Table 2. Central Line Emergency Access Registry Adverse Events

Air embolus	Arterial puncture
Cardiac dysrhythmia	Hemothorax
Hematoma formation	Pneumothorax
Guidewire misdirection/misplacement	Guidewire loss

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