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Point Of Care Ultrasound to Evaluate Peripheral Intravenous Catheters

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Abstract

Background: Several studies have described the use of ultrasound for the placement of peripheral intravenous catheters (PIV); however, visual and tactile inspection remains the primary clinical tool for the identification of infiltration. An improperly positioned PIV is an avoidable cause of significant morbidity and mortality to a patient.

Case: We describe a technique using point of care ultrasound for the assessment of two PIV to confirm functionality in a 68-year-old male scheduled for an above the knee amputation. This technique can be used for both superficial and deep peripheral veins where the detection of catheter infiltration by physical exam alone is often challenging.

Conclusion: The ubiquitous use of ultrasonography has revolutionized the field of medicine. Point of care ultrasound for the evaluation of questionable peripheral catheters can help prevent harm to a patient, especially during transitions of care.

Keywords

Peripheral Intravenous Catheter, Infiltration, Point of Care Ultrasound, Patient Safety, Deep Peripheral Vein, Sedation

Glossary of Terms

PIV – Peripheral Intravenous Catheter(s), HIPAA - Health Insurance Portability and Accountability Act, G – Gauge, TM – Trademark, UT – Utah, USA – United States of America, UK – United Kingdom, ASA – American Society Anesthesiologists, mg – milligrams, mcg – micrograms, MHz – megahertz, WA – Washington

Introduction

The reliable use of peripheral intravenous catheters (PIV) is essential for the safe practice of intraoperative anesthesia. The assessment of PIV functionality is therefore critically important with PIV complications resulting in 2.1% of all closed claims from 1970 through 2001 [1]. The current clinical assessment of PIV relies on visual and tactile inspection following a small bolus of normal saline. The combination of resistance to injection and subcutaneous tissue expansion often identifies an infiltrated catheter. Infiltration is more difficult to identify in obese, edematous, and pediatric patients as well as with catheters placed within deep peripheral veins. With the increasing ubiquity of high-quality ultrasound machines, point of care ultrasound has become an important tool for anesthesiologists. The use of ultrasonography has proven instrumental in the

facilitation of both central and peripheral vascular catheterization; however, point of care ultrasound for *in situ* catheter assessment has not been previously described. Previous work has evaluated the use of the subcostal 4-chamber view using transthoracic echocardiography to identify changes in flow patterns after a saline bolus [2]. With the increased incidence of ultrasound-guided PIV placement in deep peripheral veins, a reliable identification method for infiltration becomes important. We describe a technique utilizing point of care ultrasound for the quick, reliable assessment of two questionable PIV in a hospitalized patient before surgery. We obtained a written health insurance portability and accountability act (HIPAA) authorization to use and disclose protected health information.

Case Report

A 68-year-old male with a medical history significant for end-stage renal disease treated with hemodialysis, hypertension, and a below the knee amputation of the left lower extremity presented with sepsis secondary to left knee stump gangrene. The patient was scheduled for an above the knee amputation of the left lower extremity for primary infectious source control. Upon admission, a 20-gauge (G) peripheral intravenous catheter (BD Insyte™ Autoguard™, Sandy, UT 84070, USA) was inserted in the patient's right anterior forearm. A visual and tactile inspection following a small saline bolus was negative for resistance to injection or clinical signs of infiltration. The patient denied discomfort with injection and the PIV was connected to an infusion pump (CareFusion Alaris™, Hampshire 305 Ltd., RG22 4BS, UK) without increased pressure alarms.

On the day of surgery, the patient was transferred to the preoperative holding area for left sciatic and femoral nerve blocks prior to amputation. Standard ASA monitors were placed and the patient was administered oxygen by facemask. The patient was sedated with 2 mg of intravenous midazolam and 50 mcg fentanyl *via* the right forearm PIV. There was no resistance to injection or visual signs of infiltration with medication administration. Due to patient discomfort during positioning, an additional 50 mcg of fentanyl was administered. Given the persistent patient discomfort despite presumably adequate sedation, we considered possible PIV infiltration. In order to evaluate the PIV, a 13- to 6-MHz 38-mm linear array ultrasound transducer (Edge II; SonoSite, Bothell, WA) was used to examine the right forearm PIV. The transducer was placed just proximal to the catheter tip and a small normal saline bolus was rapidly injected into the PIV (**Supplemental Video-1**). Subcutaneous tissue expansion was evident on ultrasonography following the normal saline bolus, likely indicating infiltration. The right forearm PIV catheter was therefore removed. A new 20G PIV catheter was then inserted in the right antecubital fossa with ultrasound guidance. Again, the transducer was placed just proximal to the catheter tip and a small saline bolus was administered with no evidence of subcutaneous tissue expansion. In addition, intraluminal venous expansion at a position cephalad to the tip of the catheter was visualized, indicating an appropriately positioned catheter (**Supplemental Video-2**).

Supplemental Video-1 can be found online at **Supplemental Video-1 Infiltrated PIV**

A linear array ultrasound transducer is placed just proximal to the tip of a questionable intravenous catheter. Subcutaneous tissue expansion is evident upon the injection of a small normal saline bolus indicating catheter infiltration.

Supplemental Video-2 can be found online at **Supplemental Video-2 Intravenous PIV**

A linear array ultrasound transducer is placed at a position cephalad to the tip of an intravenous catheter. Intraluminal venous expansion and lack of subcutaneous tissue expansion are visualized following multiple small normal saline boluses indicating a functioning catheter.

The patient received additional sedation and the peripheral nerve blocks were completed successfully. Shortly following block completion, the patient became overly sedated and experienced an episode of large volume emesis. Given the concern for possible aspiration, the amputation was rescheduled.

Discussion

A functioning intravenous catheter is essential to deliver medications during anesthesia. PIV catheters can be difficult to place, requiring multiple attempts, causing discomfort and anxiety for the patient. The use of bedside ultrasound has significantly improved the ability of clinicians to place the catheters, even in cases where a peripheral vein cannot be felt [3]. When a patient arrives at the pre-surgical area with a PIV in place, it is often difficult to verify patency. While a clinical assessment consisting of visual and/or tactile inspection during an injection can be reassuring, the physical exam alone can be misleading – as in this case. Failure to recognize an infiltrated PIV catheter may lead to complications including tissue necrosis, nerve damage, infection, and compartment syndrome [4].

Best practice guidelines have been widely published for central venous, peripheral venous, and arterial cannulation [5,6]. Furthermore, there is extensive literature regarding ultrasound-based approaches for vascular access, with additional recommendations for safe use [7,8]. There is a demonstrable decrease in complications related to catheter placement - and subsequent cost-savings – when advanced imaging is utilized for intravenous catheter insertion [9]. However, there is little available in the literature on point of care ultrasonography for evaluation of PIV [2]. The use of ultrasound for confirmation and assessment of catheter location has been previously described primarily for central venous catheters [10-12].

This case illustrates how point of care ultrasound can quickly differentiate appropriately placed and infiltrated intravenous catheters. Since assessment by physical exam looking for leaking or a feeling of fullness around the tip of the catheter is unreliable, a direct visual demonstration of patency can provide the practitioner an easy tool to use to ensure a functional catheter. In this case, the patient became overly sedated and aspirated following an episode of emesis, shortly following the regional block. The subcutaneous reabsorption of sedative medications administered through the infiltrated catheter was likely the culprit, demonstrating an avoidable morbidity.

In summary, we have described a previously unreported technique using point of care ultrasound to determine the proper intraluminal placement of a PIV. Early recognition of infiltrated PIV has the potential to decrease morbidity and mortality. This technique may be considered when the placement of a PIV is in question and ultrasound is available.

Disclosures

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Drs. Girgis, Chopra, Greenberg: No additional conflicts

Contributions

Dr. Girgis and Dr. Chopra: Helped to write and edit the manuscript.

Dr. Finneran and Dr. Greenberg: Helped to write and edit the manuscript, helped to obtain the ultrasound assessment of intravenous catheters, and was the attending anesthesiologist who performed the regional blocks.

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Conflict of Interest

All authors have read and approved the final version of the manuscript. The authors have no conflicts of interest to declare.

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