Analysis of Radial Artery Catheter Placement by Respiratory Therapists Using Ultrasound Guidance

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BACKGROUND: The use of ultrasound (US) guidance for radial artery cannulation has been shown to improve first attempt success rate, reduce time to successful cannulation, and reduce complications. We sought to determine whether properly trained respiratory therapists (RTs) could utilize US guidance for the placement of radial artery catheters. Primary outcome measurements were successful cannulation and first attempt success rate. Secondary outcomes included the effect of systolic blood pressure, prior attempts, palpable pulse strength, and gender in relation to US-guided radial artery cannulation success rates. METHODS: RTs certified in arterial catheter insertion were trained in radial artery catheterization using US by emergency medicine physicians. Subjects were enrolled based on the need for an arterial catheter placement. The catheters and US devices used were standardized. Data recorded included pulse strength, systolic and diastolic blood pressure, number of attempts, and successful/unsuccessful artery cannulation. All catheterization attempts were performed according to institutional policy and procedure. RESULTS: One hundred twenty-two radial artery catheter insertion attempts were made between December of 2008 and October of 2011, in patients in whom the treating physician requested RT radial artery cannulation. The overall success rate was 86.1%, whereas the first attempt success rate was 63.1%. There was no difference found between the overall mean success rate for weak or absent pulses, age, systolic blood pressure, gender, or prior attempts. Conclusion: RTs can effectively utilize US technology to place radial artery catheters. Systolic blood pressure, prior attempts, and gender are not reliable predictors of success for US-guided radial artery cannulation. Training on the use of US should be strongly encouraged for all practitioners who place radial artery catheters. Key words: radial artery cannulation; ultrasound guidance; respiratory therapist; radial artery catheter.
the vessel and then directly advancing the catheter into the artery.

The traditional method for locating the radial artery is via palpation of the pulse in conjunction with anatomic landmarks. However, the location of the artery may be variant in up to 30% of patients and thus difficult to find. Moreover, in patients with severe hypotension, morbid obesity, arterial scarring, edema, and atherosclerosis, locating the artery via palpation may be difficult or impossible. Additional difficulties encountered when attempting the placement of radial artery catheters include: inability to thread the wire, hematoma formation, and arterial spasm. More recently, imaging techniques have been developed to facilitate catheter placement. One imaging technique that is portable, easy to use (after proper training), and readily available is direct vessel visualization with 2-dimensional ultrasound (US) guidance (Fig. 1).

In 2008, we began a respiratory therapist (RT) training program on the use of US to facilitate radial artery catheter placement. Training included: US equipment operation, identification of the radial artery, demonstrations of the transverse and longitudinal methods of visualizing the artery, proper sterile technique, and proper hand technique to prevent probe movement during attempts. The purpose of this report is to describe our initial experience with RTs using US guidance to place radial arterial catheters.

Methods

Consecutive subjects from December 2008 to October 2011 (35 months) in whom radial artery catheter placement using US guidance was attempted were studied. These subjects were mostly emergency department patients in whom the physician requested RT radial artery cannulation. Ten RTs participated in this service with a wide range of experience placing radial artery catheters (2–30 y). The decision to use US guidance was at the discretion of the RT. Data on US use was tracked as part of ongoing departmental quality assurance evaluations of RT performance with radial artery cannulation. Institutional review board approval was obtained for the review of the recorded data.

All data were recorded by the RT performing the cannulation attempt and included: age, strength of pulse, systolic blood pressure, number of cannulation attempts, gender, and ultimate successful or unsuccessful artery catheter placement. Pulse strength was recorded as absent, weak, or normal by the RT before initial cannulation attempt. Systolic blood pressure was the most recent blood pressure recorded by automatic or manual cuff before US-guided cannulation attempt. Hypotension was defined as a systolic blood pressure < 90 mm Hg. As a comparison, the success rate for our RT radial artery cannulation without US guidance during all of 2011 was calculated. Fisher exact test and unpaired t test were performed where appropriate. A P value < .05 was considered statistically significant.
Hypotensive

- Data on age were not recorded for 9 subjects.

**Discussion**

Our results demonstrate that properly trained RTs can insert radial artery catheters via US guidance with an overall success rate better than our routine non-US techniques (86.1% vs 77.8%, respectively). Moreover, our first attempt success rate with US was equal to or better than those reported by other ICU clinicians (including physicians) in a systematic review (our observed first attempt success rate was 63% vs 43% in the pooled results of the review). In that systemic review, the authors also concluded that US guidance significantly improves first attempt success rate versus non-US technique, with a number needed to treat of six. A narrative review by the same group summarized the results of three randomized, controlled trials and also concluded US guidance resulted in fewer attempts and less time for successful catheter placement than non-US techniques.

Higher first attempt success rates using US guidance should translate into better outcomes. For example, catheter-related infections should decrease, and the likelihood of nerve damage should decrease with a reduction in cannulation attempts and higher overall and first attempt success rates. Indeed, a number of studies have shown that US guidance has been proven to reduce complications and increases success rates for radial artery catheter placement.

Our study is limited because we did not systematically record the US technique used (transverse, longitudinal, or static), the subject’s body habitus, or the indication for arterial line placement. In addition, our assessment of pulse strength was subjective and intrapractionitioner variability is possible. Finally, the decision to use US to assist in the cannulation attempt was determined by the RT placing the arterial catheter and was likely biased toward using US in more challenging patients where difficulty was anticipated or had been encountered by another clinician. This is supported by the fact that 82.7% of our US cannulation attempts were done in subjects with a weak or absent radial pulse.
Although US guidance could be considered for most clinical settings, it should especially be considered in patients without palpable radial pulses, coagulopathy or abnormal clotting factors, severe hypotension, or when the radial artery is the only site available. The use of US may also be useful in initial training of healthcare providers in radial artery catheter placement. Guidance by US is the standard of care for placement of central venous catheters; in the future, US guidance may become the standard of care for radial artery cannulation as well.

In conclusion, US guidance can be utilized effectively by RTs. Systolic blood pressure, prior attempts, and gender are not reliable predictors of success for US-guided radial artery cannulation. Training on the use of US should be strongly encouraged for all practitioners who currently place radial artery catheters.

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REFERENCES