Radial Artery cannulation- Prevention of pain and Techniques of cannulation: review of literature

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Abstract

Radial artery cannulation during anesthesia and intensive care unit is one of the essential methods for monitoring. Pain control associated with invasive procedures is a major challenge. Discomfort and pain in an awake patient may lead to limb movement or uncooperation from the patient leading to difficulty in radial artery cannulation.
The technique of radial artery cannulation is accomplished comfortably in most of the patients. But sometimes, it becomes quite challenging and it can be of problem in critical ill patients. We review the literature regarding various techniques of pain management for radial artery cannulation. Also we present the review of literature regarding various aides and modifications described in the literature to ease the technique of radial artery cannulation.

INTRODUCTION

Radial artery cannulation during anesthesia and intensive care unit is one of the essential methods for real time monitoring of blood pressure allowing continuous monitoring, graphic display of the systemic arterial blood pressure and for analyzing arterial blood. The radial artery is the vessel of choice as it is readily accessible, extensive collateral circulation and anatomically stable because the radius acts as a natural splint to stabilize the radial artery [1] .

PREVENTION OF PAIN OF CANNULATION

Pain control associated with invasive procedures is a major challenge. Though under balanced general anesthesia, use of local block for analgesia may not be warranted but discomfort and pain in an awake patient may lead to limb movement or uncooperation from the patient leading to difficulty in radial artery cannulation.

Standard analgesia is usually subcutaneous infiltration with 2% lidocaine (without epinephrine) at least 1 min before cannulation [2] . Use of local anesthesia reduces the chance of patient movement. Also, local vasodilator effects of the local anesthetic can reduce vasospasm, making a successful catheterization more likely, helping ensure flow around the catheter and decreasing the chance of arterial thrombosis [1] . In contrast, subcutaneous infiltration of lidocaine can cause pain, hematoma, spasm and “blurring” of the radial pulse as well [3] .

Lidocaine has been delivered by iontophoresis and found to be effective and painless method of providing analgesia for radial artery cannulation [4] .

The application of a topical lidocaine-prilocaine cream (EMLA) has been suggested, two hours before the procedure on the puncture site. It produces derma1 anesthesia before venous and radial artery cannulation [3] . Topical analgesia with EMLA cream has been shown to shorten cannulation time, improve the success rate, and reduce the pain of radial cannulation [3] . Despite this finding, EMLA cream is not widely used for this procedure because of slow onset of action of EMLA (2 hr) [2] .

4% amethocaine gel has been applied under an occlusive dressing over the proposed puncture site at least 1h before attempted arterial cannulation. Compared with EMLA cream, 4% amethocaine provides a faster onset and longer duration of analgesia for venous cannulation [5] . Authors postulated that the vasodilator properties of amethocaine might further improve the speed and success rate of radial artery cannulation by arterial cannulation by arterial dilatation and prevention of reflex vasoconstriction but concluded from his study that amethocaine gel is equally effective to 2% lidocaine infiltration in providing analgesia for radial artery cannulation [2] . Success rate and speed of cannulation was also similar for both the methods.

The modified Allen's test should be performed to demonstrate collateral flow through the superficial palmar arch prior to cannulation though contradictory statements regarding its usefulness have been reported.

POSITION FOR RADIAL ARTERY CANNULATION

The arm is kept in supinated position with dorsiflexion at the wrist. Any suitable size material like gauze roll, intravenous fluid bottles, rolled towel, bandage roll can be used for extension at the wrist. The extension is adjusted so as to have good palpable arterial pulsation along with stabilization of the artery. Extreme dorsiflexion can tense the tissues overlying the artery and make palpation difficult and even obliterate the pulse. The 30-60º dorsiflexion seems to be appropriate.

Use of weight like 500 ml of iv fluid over the index finger has been used to maintain the extended position [6]. We apply adhesive tape over the fingers and arm rest after keeping an rolled towel below the wrist for maintaining the position of the arm.

Numerous methods have been described for insertion of arterial catheters, including direct cannulation with an over-the-needle approach, a modified Seldinger technique, the liquid stylet technique, a pressure curve-directed technique, use of an ultrasound stethoscope blood flow detector, doppler and transillumination [7]. In a large survey it was observed that 68.1% anesthetists preferred to use direct cannulation, 24.7% used transfixion and 7.2% used the Seldinger technique [8].

CONVENTIONAL TECHNIQUE

The radial artery can be palpated on the distal portion of the forearm between the radius and the tendon of the flexor carpi radialis. The area of maximal pulsation of the radial artery is located. Though the precise angle of needle puncture has not been reported but catheter may be directed toward the artery at an 30-45° angle, with the bevel of the needle up. Once pulsatile flow is apparent within the cannula, the needle can be brought closer to the hand to an angle of approximately 15° - 30° and advanced 0.5 mm farther into the lumen of the artery, and the catheter threaded into the artery. Successful placement of the catheter is verified by observing a transduced arterial blood pressure waveform [7].

However arteries are not visible from the skin surface and carrying out correct and exact puncture is still difficult in clinical setting. Moreover, the appropriate insertion of a soft catheter requires greater technical skill than making a puncture. These difficulties has led to different aides and modifications for radial artery cannulation.

AID FOR RADIAL ARTERY CANNULATION

Radial artery cannulation has been performed by a guidewire-assisted technique in which after the artery is punctured and confirmed by a flashback of blood, a guidewire is advanced into the arterial lumen. Then the needle is removed and the arterial catheter is advanced over the guidewire [7]. After catheter access into the artery, the guidewire is removed and the catheter fixed to the forearm.

Often when the artery has been entered but cannulation is difficult, a soft guidewire can be placed into the artery and used as a guide to advance the catheter in a coaxial fashion. Care must be taken during this maneuver because the guidewire itself can cause trauma to the intima of the artery, resulting in dissection and/or perforation [1].

The use of a guidewire-assisted radial artery cannulation technique has been preferred rather than a direct technique especially in pediatric patients [7]. The guidewire-assisted technique provided easy, safe, and quick cannulation and allowed for long-term satisfactory blood pressure monitoring and blood sampling because of the longer length of the Teflon catheter advanced into the artery over the guidewire, and a low rate of dissection of the radial artery. In a study of 69 critically ill patients reported that guidewire techniques yielded a lower failure rate, fewer passes, and more rapid cannulation than the direct-puncture method [9].

Identification of vessel using transillumination technique has also been used for radial artery cannulation in children [10].

In patients with pitting edema there is exudation of fluid in the interstitial space. Neonates and more so preterms have relatively more total body fluid (interstitial fluid). Displacement of perivascular interstitial fluid by pressure over the peripheral artery makes the course of the artery visible, rendering cannulation under direct vision easy in pediatric patients. Although the radial artery lies deep to the deep fascia, the overlying interstitial fluid can be displaced by applying pressure, making arterial palpation easy and facilitating cannulation [1112]. This artery can be made more prominent by projecting light obliquely from one side. The author mentioned that apart from rapid refill of the artery with respect to the interstitial space, dilation of artery due to mechanical stimulation (pressure) could also be responsible for the prominence of artery.

Localization of radial artery with a 26G hypodermic needle attached to a syringe barrel and puncturing skin at 2mm intervals until backflow is observed has been described [13]. The radial artery cannula is than inserted just distal to hypodermic needle. The hypodermic needle is removed from the artery as the catheter is being placed.

Pressure curve directed technique has also been described [14]. The radial artery cannula attached to pressure transducer after flushing it. This assembly is then inserted for radial artery cannulation in conventional technique. The arterial waveform suggests successful arterial cannulation.

The ultrasound-guided technique has also been used [15]. The radial artery is localized by ultrasound in its short cross section. The cannula is advanced to perforate the skin slightly distally to the transducer. It is then directed towards the vessel in an angle of approximately 45°. The further advancement is guided by minimal ultrasound scanning of the artery and its close vicinity. When the cannula appeared to be within the vessel, the transducer is removed and catheterization is accomplished.

Doppler has been used during radial artery cannulation. It improved the rate of successful cannulation in adults in whom the traditional percutaneous technique has failed. Apart from preinsertion localization of radial artery, a further refinement of this technique, the Doppler probe can be held over the artery throughout cannula insertion; the exact position of the artery is identified by a change or loss of Doppler tones as the cannula contacts and compresses the artery [1617]. Similar technique was described by Murray et al in which localization of artery was identified by change or loss of doppler tones as cannula contacts or compresses the artery [18].

Devices which incorporate a disposable ultrasound transducer within the lumen of a thin-wall vascular needle (Smart Needle) are used infrequently, but may be helpful in certain situations. As an example, hypotensive patients with nonpalpable pulses may be difficult to cannulate unless instruments or techniques are employed which use Doppler ultrasonography to localize the artery [19].

'Liquid stylet' for percutaneous radial artery cannulation has been reported [20]. Syringe with 3 ml saline is attached securely to a 20 gauge non-tapered cannula whose distal end is located in the radial artery lumen. When pulsatile backflow of blood is present 1-2 ml of blood is aspirated without moving the cannula, confirming location of the cannula in the vessel lumen. Slowly and steadily 1-3ml of fluid is injected from the syringe with one hand while the other slowly advances the catheter into the vessel lumen behind the "liquid stylet" created by the injection. When the hub of the catheter reaches the surface of the skin, 1-2 ml of blood is again aspirated to confirm location of the catheter tip in the artery.

A surgical exposure as suggested by Pfenninger and colleagues [21] is quite invasive and should only be used in cases where other methods fail.

Traditionally the radial artery is located by placing the tips of the left index and middle fingers in a longitudinal direction over the artery. The cannula is inserted by the right hand in a direction in which the radial artery is felt to be present. In a modified technique, the radial artery is located by placing the tips of the left index and long fingers side by side, straddling the artery at the right angles [22]. The tips of the fingers are moved so that the radial artery is in the groove between the left index and long fingers and adjacent surfaces of both the fingers feel the arterial pulsation equally. In this position, the gentle pressure is applied so that the radial artery stabilizes on the ventral surface of the radius in the groove between fingers.

MODIFIED TECHNIQUES

The radial artery has been cannulated into dorsum of the hand where it emerges from the anatomical snuff box instead of usual volar aspect [23]. The location of radial artery is determined by palpation of pulse on dorsum of the hand between the bases of 1 st and 2 nd metacarpals. The author mentions its advantage of preservation of the palmer branch of radial artery and thus sparing the collateral vessels and hence less chances of digital ischemia.

Although angiocatheters or other 1-wall needles are used for most cannulations of the radial artery, some clinicians advocate doing a through-and-through cannulation with the catheter being placed into the artery during withdrawal. Needles designed for a through-and-through puncture technique usually have an obturator that is removed after the needle containing the obturator has passed through the vessel. It is generally safer to use a 1-wall technique in which the artery is punctured on the first pass, especially when the relative size of the catheter to the vessel being cannulated is large, as is the situation for the radial artery. Use of a 1-wall technique reduces trauma to the back wall of the artery and the risk of arterial laceration [1].

Guidewire assisted radial artery cannulation technique is quite popular. The insyte-A, a newly developed instrument for arterial catheter insertion [24] . The guidewire is inserted in a freely moving plunger and is easily introduced into the lumen of the vessel.

Ultrasonography has been used as a rescue technique for failed radial artery cannulation [25] . The radial artery at a proximal location runs deep to the brachioradialis muscle and is difficult to palpate; however, it can be easily imaged using real-time ultrasonography. A needle-mounted cannula can then be advanced in the plane of the probe and the pulsating artery until the needle tip is within the artery. The cannula is advanced over the needle so that it lies within the arterial lumen. As the trajectory is in full view of the ultrasound probe, the technique has a very high success rate. Cannulating the radial artery proximally using ultrasonography provides an alternative to axillary or femoral artery cannulation after failed radial artery cannulation [26] .

Antegrade radial arterial cannulation has been used for pressure monitoring successfully after the cut down approach [27] . This was attempted after failed retrograde cannulation of the radial artery. During this, pressure measurement was of ulnar artery via palmer arch. antegrade arterial cannulation can be successfully used when radial arteries are obstructed and retrograde blood flow is observed during failed cutdown attempts at standard retrograde arterial cannulation.

CONCLUSION

Radial artery cannulation can be done in various aided techniques which needs to be invidualized. The success of radial artery cannulation depends not only on appropriate technique but also on the experience of the clinician in a particular technique.

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References

1. Lipsitz EC. Cannulation injuries of the radial artery. Am J Crit Care 2004;13:314-315.
2. Olday SJ, Walpole R, Wang JYY. Radial artery cannulation: topical amethocaine gel versus lidocaine infiltration. Br J Anesth 2002;88:580-582.
3. Joly LM, Spaulding C, Monchi M, Ali OS, Weber S, Benhamou D. Topical lidocaine-prilocaine cream (EMLA) versus local infiltration anesthesia for radial artery cannulation. Anesth Analg 1998;87:403-406.
4. Sherwin J, Awad IT, Sadler PJ, Liddle AM, Rowbotham DJ. Analgesia during radial artery cannulation: comparison of the effects of lidocaine applied by local injection or iontophoresis. Anaesthesia 2003;58:474-476.
5. McCafferty DF, Woolfson AD, Boston V. In vivo assessment of percutaneous local anaesthetic preparations. Br J Anaesth 1989;62:17-21.
6. Coates MB. Radial artery cannulation - a simple positioning aid. Anaesthesia 2002;57:311.
7. Yildirim V, Ozal E, Cosar A, Bolcal C, Acikel CH, Kilic S, Kurulay E, Guzeldemir E. Direct versus guidewire assisted pediatric radial artery cannulation technique. Journal of Cardiothoracic and Vascular Anesthesia 2006;20:48-50.
8. Williams DJ, Ahmed ST, Latto IP. A survey of venous and arterial cannulation techniques used for routine adult coronary artery bypass grafting. The Internet Journal of Anesthesiology 2003;6(2).
9. Beards SC, Doedens L, Jackson A, Lipman J. A comparison of arterial lines and insertion technique in critically ill patients. Anaesthesia 1994;49:968.
10. Davis FM, Stewart JM. Radial artery cannulation: a prospective study in patients undergoing cardiothoracic surgery. Br J Anaesth 1980;52:41-47.
11. Agarwal A, Sahu D, Bose N. Radial artery cannulation in edematous patients.Can J Anesth 2002; 49:109-110.
12. Raichur DV. Radial artery cannulation in neonates: a new method. Indian J Pediatr 2000;67:843-844.
13. Penland WA, Henthorn RW. A method to assist radial artery cannulation. Anesth Analg 1993;77:643.
14. Kondo K. Percutaneous radial artery cannulation using a pressure curve directed technique. Anesthesiology 1984;61:639-640.
15. Schwemmer U, Arzet HA, Trautner H, Rauch S, Roewer N, Greim CA. Ultrasound guided arterial cannulation in infants improves success rate. Eur J Anaesthesiol 2006;23:476-480.
16. Fukutoma T, Kojiro M. Doppler guided percutaneous radial artery cannulation in small children. Anesthesiology 1988;69:434-435.
17. Morray JP, Brandford HG, barnes LF, Oh SM, Furman EB. Doppler assisted radial artery cannulation in infants and children. Anesth Analg 1984;63:346-348.
18. Murray JP, Brandford HG, Barnes LF, Oh SM, Furmen EB. Doppler assisted radial artery canuulation in infants an dchildren. Anesth Analg 1984;63:346-348.
19. Maher JJ, Dougherty JM. Radial artery cannulation guided by Doppler ultrasound. Am J Emerg Med 1989;7:260.
20. Stirt JA. Liquid stylet for percutaneous radial artery cannulation. Can Anaesth Soc J 1982;29:492-493.
21. Ganesh A, Cahill AM, Kaye R, Watcha MF. Evaluation of ultrasound guided radial artery cannulation in children (abstract). Anesthesiology 2007; 107: A238
22. Thavanathan J, Heughen C. Modified technique for radial artery cannulation. Canadian journal of Surgery 1993;36:116-117.
23. Pyles ST, Scher KS, Vega ET, Harrah JD, Rubes LJ. Cannulation of the dorsal radial artery: a new technique. Anesth Analg 1982;61:876-878.
24. Adachi YU, Suzuki K, Itagaki T, Obata Y, Doi M, Sato S. Radial artery cannulation using the insyte-A holding the device in cigarette style. Journal of Anesthesia 2008;22:331-332.
25. Sandhu NS, Patel B. Use of ultrasonography as a resue

technique for failed radial artery cannulation. Journal of Clinical Anesthesia 2006;18:138-141.
26. Lanspa TJ, Williams MA, Heirigs RL. Effectiveness of ulnar artery catheterization after failed attempt to cannulate a radial artery. Am J Cardiol 2005;95:1529-1530.
27. Rhee KH, Rerg RA. Antegrade cannulation of radial artery in infants and children. Chest 1995;107:182-184.

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