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Original Article

Use of 1-ml hollow tube-assisted radial artery catheterization in clinical anesthesiology

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Abstract: Objective: To introduce a new modified technique for radial artery catheterization. Materials and Methods: A prolongated needle was made by using routine Vasocan Braunule needle and 1 ml syringe. A table of random digits was used for randomization of 32 interns. 14 interns were involved in group T and 18 interns were in group M. Each intern accomplished 20 cases. Then 640 patients were divided into 2 groups: group T included 280 patients with traditional direct technique, group M included 360 patients with 1 ml hollow tube-assisted technique. Results: Satisfactory results were obtained for 107 patients in group T and 292 patients in group M ($P < 0.05$). The success rates for catheter insertion after one attempt were 38.2% in group T and 81.1% in group M ($P < 0.001$). The blood flow times for observation were 1.7 ± 0.2 s in group T and 19.6 ± 1.8 s in group M ($P < 0.001$). Conclusion: The authors suggested the use of 1 ml hollow tube-assisted radial artery cannulation technique rather than a direct technique. This modified technique provided easy, safe, quick and less cost cannulation.

Keywords: Radial artery catheterization, modified, 1-ml hollow tube

Introduction

Radial artery catheterization is often used for perioperative monitoring of arterial blood pressure and blood gas analysis [1]. It is an important clinical operational skill for each anesthesiologist. However, insering into the radial artery is not an easy job, particularly for interns who have just entered clinical practice. Common complications include arteriospasm and hematoma, which can add difficulties to follow-up puncture. In addition repeatedly puncture at the same point may result in distal palm ischemia. Traditional direct technique and wire-guided technique are two principal techniques of catheter insertion. Blood flow time with T technique is so short that it doesn't leave operator with adequate time to make small adjustments in needle position that might make cannulation with catheter more successful. The latter one has higher success rate, but it is too expensive to be popular in undeveloped countries. Since 2009, we have begun to use 1 ml hollow tube-assisted technique in more than 1000 patients and obtained encouraging results. The authors would like to introduce this modified clinical approach.

Materials and methods

This study was approved by the Specialty Committee on Ethics of Biomedicine Research, Second Military Medical University (2009LL-027), and written informed consent was obtained from 640 patients who were divided into traditional technique (T) or 1-ml tube-assisted modified technique (M). All patients were 18 years of age or older. Allen's test was conducted on all patients for detecting adequacy of ulnar artery flow.

The patient's waist was immobilized with an arm board in a slightly hyperextended position. The insertion site was prepared with Anerdian, and the skin overlying the artery was anesthetized with 2% lidocaine.

Group T included 280 patients performed radial artery cannulations by a direct traditional

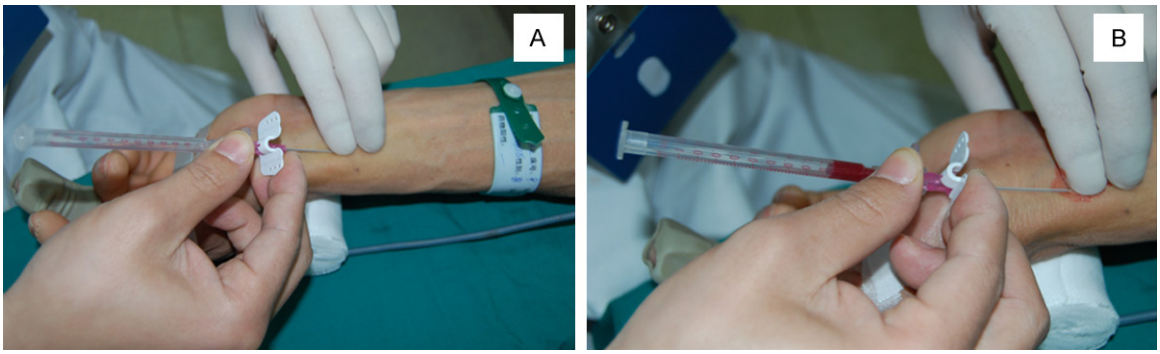

Figure 1. One-ml hollow tube-assisted radial artery catheterization technique used in clinical anesthesiology teaching. A. The modified needle was inserted through the skin and directed at a 30 angle towards the anterior wall of the radial artery. B. When the arterial blood flowed into the 1-ml hollow tube, the needle was lowered and advanced 1 mm to ensure that the catheter tip entered the lumen of the artery.

technique. An over-the-needle catheter (20 G, 1.25 in, 32 mm) was inserted through the skin and directed at 30 towards the artery with a single forward movement. After the anterior wall of the artery was punctured, as indicated by flashback of blood, the operator's hand was lowered, the needle was advanced 1 mm further into the lumen of the artery, and the catheter was threaded into the artery. Successful placement of the catheter was verified by observing a transduced arterial blood pressure waveform [2].

Group M comprised 360 patients who underwent cannulation using the modified 1-ml hollow tube-assisted technique with a 20 G, 1.25-in, 32-mm over-the-needle catheter. The technique was modified according to following steps: the needle and plunger were removed from the 1-ml injector; thus, only the hollow tube remained; the catheter-over-needle's collection reservoir was removed, and the 1-ml hollow tube was connected to the end of the needle to make "a new long needle". This modified technique is shown in detail in **Figure 1**.

All catheterizations were performed by 32 interns. A table of random digits was used for randomization of 32 interns. 14 interns were involved in group T and 18 interns were in group M. Each intern accomplished 20 cases. A failed attempt was defined as right find the artery, but the catheter could not be advanced into the artery. Operators were allowed one insertion attempt in each patient. Subsequent attempts by attending anesthesiologist constituted a separate insertion attempt in the statistical analysis.

Each operator completed a data collection for each insertion attempt. Each patient's blood flow time, attempt number, and any complications were also recorded.

The different success rates between the techniques were analyzed using the chi-squared test. The data were expressed as the mean ± standard deviation (SD) and analyzed using a t-test. For analysis, statistical software package SPSS v 18.0 (IBM Corp., Armonk, NY, USA) was used, and $P < 0.05$ was considered significant.

Results

Patients in the T and M groups were not fundamentally different with respect to systolic blood pressure, weight, height and body mass index. Satisfactory results were obtained for 107 patients in group T and 292 patients in group M ($P < 0.05$). The success rates for catheter insertion after one attempt were 38.2% in group T and 81.1% in group M ($P < 0.001$). The blood flow times for observation were 1.7 ± 0.2 s in group T and 19.6 ± 1.8 s in group M (**Figure 2**).

Discussion

Artery catheterization is one of the most difficult techniques in clinical anesthesiology. Many documents have introduced various ideas for improving radial cannulation, including a modified Seldinger technique, the liquid stylet technique, a pressure curve-directed technique, and the use of an ultrasound stethoscope bloodflow detector [3, 4]. However, "easy to puncture, hard to catheterize" is still quite com-

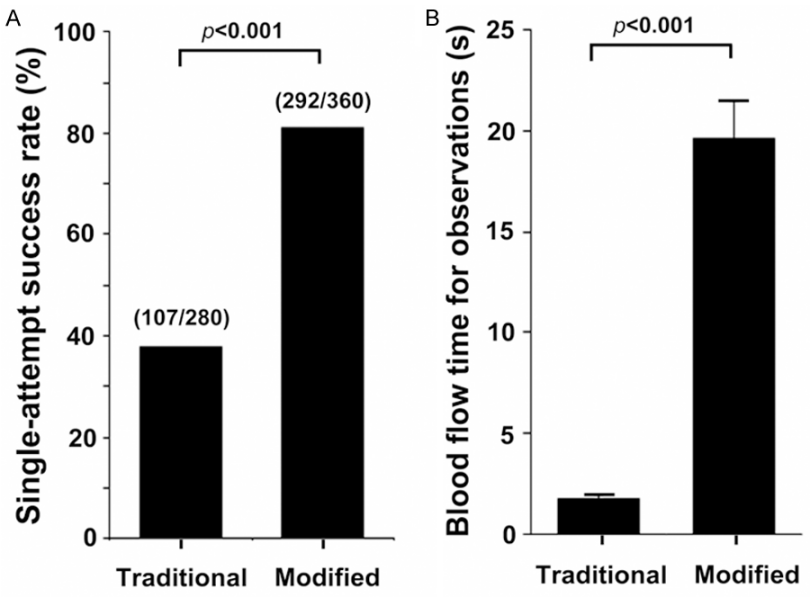

Figure 2. Single-attempt success rate and blood flow time for observation in both groups. A. The single-attempt success rate for group M was significantly higher compared to group T (81.11% *vs.* 38.21%) ($P < 0.001$). B. The mean blood flow time for observation was significantly longer in group M compared to group T (19.64 ± 1.78 s, n = 28 vs. 1.74 ± 0.24 s, n = 36) ($P < 0.001$).

mon [5]. If the first attempt fails, spasms or local hematomas can make subsequent puncture and catheterization more difficult [6]. Low success rates can easily trigger fear and the loss of self-confidence in interns and cause trauma and unnecessary economic waste for patients. Thus, it is important for us to actively explore new t methods to improve artery catheterization success rates.

In our clinical practice, we noticed that many interns complained that the distance relationships among the tip of the needle, the top of the catheter and the lumen of radial artery were too short to make accurate estimates. At times, even an advance of only 1-2 mm was sufficient to puncture the posterior wall of the artery. The length of the backflow blood reservoir of the needle was also particularly short. In our study, the blood flow time for observation of a 20 G needle was only 1.7 ± 0.2 s. It was too short for the operator to estimate the adjacent relations among the tip of the needle, the top of the catheter and the lumen of radial artery, when he wanted to advance the catheter. This problem was also the most common cause of "easy to puncture, hard to catheterize". Unsurprisingly, the single-attempt success rate for group T was only 38.2%.

How to increase this time? Reservoir of the blood had been mentioned in the chapters of artery cannulation in Miller's Anesthesia. We used a 1 ml hollow tube as reservoir for the blood, and connected it to the tail of a Vasocan Braunule needle to make the modified elongated artery puncture needle. The results of our study showed that the elongated reservoir offered enough time (19.6 ± 1.8 s) at most for students to determine the best manner to proceed with the catheterization. 1 ml hollow-tube had smaller inner diameter and was lightweight. It allowed visualization of the high-speed blood flow and was easy for the interns to hold. When the backflow of blood flowed along the walls of the syringe, the needle was lowered and then advanced 1-2 mm. When the student could still see the blood flowing smoothly in the tube, he had the opportunity to advance the catheter. If he could not see the blood flow, there was still enough time to withdraw or adjust the tip to the right or left until the blood flowed smoothly in the tube. The increased time simplified cannulation process and led to higher success rates even on the first attempt (81.1% in group M *vs.* 38.2% in group T, $P < 0.05$).

Wire-guided cannulation has also been used in clinical practice to achieve higher success rates. However, each wire-guided catheter (Arrow International, Quick Flash Radial Artery Catheterization Set) costs $26.5, which is too expensive to be widely used in developing countries, particularly in China.

Of course, in our modified technique, the syringe that was connected to the end of the needle was empty; therefore, there was a possibility of contamination. However, considering that the elongated needle was assembled during the procedure, the positive arterial blood pressure and the purified air in the operating

room, we are confident that the syringe was relatively sterile. In our clinical practice, we did not observe any infection that was caused by using the modified needle.

As part of our focus on the six ACGME core competencies for residents, we explored this modified technique and utilized it in our clinical anesthesiology. The technique originated from the Practice-Based Learning and Improvement competency and provided appropriate and effective patient care to promote patient health. In addition, this technique was less expensive and effectively utilized system resources to provide optimal value care.

In conclusion, the authors recommend using this 1-ml hollow tube-assisted radial artery cannulation technique. This modified technique enabled the interns to provide quick and easy cannulations at a lower cost. They were able to master the skill and accumulate experience quickly to provide better patient service.

Disclosure of conflict of interest

None.

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References

[1] Mangar D, Thrush DN, Connell GR, Downs JB. Direct or modified Seldinger guide wire-directed technique for arterial catheter insertion. Anesth Analg 1993; 76: 714-717.

[2] Yildirim V, Ozal E, Cosar A, Bolcal C, Acikel CH, Kilic S, Kuralay E, Guzeldemir ME. Direct versus guidewire-assisted pediatric radial artery cannulation technique. J Cardiothor Vasc An 2006; 20: 48-50.

[3] Brzezinski M, Luisetti T, London MJ. Radial artery cannulation. A comprehensive review of recent anatomic and physiologic investigations. Anesth Analg 2009; 109: 1763-1781.

[4] Ganesh A, Kaye R, Cahill AM, Stern W, Pachikara R, Gallagher PR, Watcha M. Evaluation of ultrasound-guided radial artery cannulation in children. Pediatr Crit Care Me 2009; 10: 45-48.

[5] Cuper NJ, de Graaff JC, Hartman BJ, Verdaasdonk RM, Kalkman CJ. Difficult arterial cannulation in children: is a near-infrared vascular imaging system the answer? Brit J Anaesth 2012; 109: 420-426.

[6] Cousins TR, O'Donnell JM. Arterial cannulation:a critical review. AANA J 2004; 72: 267-271.