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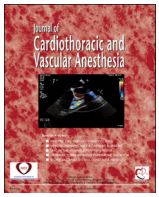

Original Article

Ultrasound Guided Out-of-Plane Versus In-Plane Transpectoral Left Axillary Vein Cannulation

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Objective: The primary objective was to compare the frequency of first-attempt successful axillary vein cannulation by the Seldinger technique using out-of-plane ultrasound guidance versus in-plane imaging. Between the two ultrasound imaging planes, this study also compared the number of attempts that were necessary for the cannulation of the left axillary vein along with the number of needle redirections that had to be done for final cannulation of the vein. Incidence of complications and the number of times the procedure was abandoned also were compared between the two imaging planes.

Design: Prospective, randomized, interventional study.

Setting: Tertiary care cardiac center.

Participants: Cardiac surgical patients.

Interventions: Left axillary vein cannulation under ultrasound guidance by Seldinger technique.

Measurements and Main Results: The left axillary vein was accessed under ultrasound guidance in 86 consecutive adult cardiac surgical patients. They were randomized to out-of-plane (Group I, n = 43) and in-plane (Group II, n = 43) groups. In group I, the number of first-attempt cannulations was very high ($p < 0.01$). The number of attempts to access the vein was significantly lower in this group ($p < 0.05$). The duration for completion of the procedure was also less in group I with out-of-plane ultrasound guidance ($p < 0.01$). The number of needle redirections and the incidence of complications (arterial puncture, pneumothorax hematoma formation) were similar between the groups. There was no difference in the number of times the procedure was abandoned between the two groups. With an assumption that the first 10 patients in each group would suffice for overcoming the learning curve, the above aspects were analyzed further in each group. The first-attempt cannulation success continued to be significantly higher in the out-of-plane group.

Conclusions: Out-of-plane ultrasound imaging during axillary vein cannulation increased the chance of first-attempt successful cannulation. Axillary vein cannulation under out-of-plane ultrasound imaging also appeared to be quicker and was preferable in terms of the fewer number of attempts that were necessary for a successful vein cannulation.

Key Words: axillary vein/ultrasonography; catheterization; central venous/methods; clinical competence; axillary vein access; ultrasound imaging plane evaluation

CENTRAL VENOUS CANNULATION is performed routinely in critically ill patients and those undergoing major surgical procedures for hemodynamic monitoring, infusion of vasoactive substances, and for rapid fluid resuscitation or rapid blood replacement therapy. The axillary vein is an easily accessible vessel that can be used for ultrasound-guided central vascular access and offers an alternative site to the internal

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jugular and subclavian veins.[1] Ultrasound guidance has been shown to improve the chances of successful axillary vein cannulation while minimizing complications, and both out-of-plane (short-axis) and in-plane (long-axis) ultrasound views were evaluated albeit in a mannequin.[2] In this clinical study, an attempt was made to seek an answer to the query as to the superiority of one approach over the other taking various factors into consideration. The hypothesis was that both approaches offered similar success rates of first-attempt cannulation. The primary objective of this study was to compare the frequency of first-attempt axillary vein cannulation under out-of-plane ultrasound guidance against in-plane ultrasound guidance. The secondary endpoints were to compare the number of attempts that were necessary for successful axillary vein access, the total time taken for completion of the procedure, the number of needle redirections that were made during the first skin puncture, incidence of complications (ie, arterial and pleural punctures), and the number of times the procedure was abandoned while using one of the ultrasound planes for axillary vein access.

Materials and Methods

After institutional Medical Ethics and Scientific Research Committee (MESSRC15/2015) approval, 90 consenting adult cardiac surgical patients posted for surgery at a single tertiary cardiac care center were included prospectively in the study. Patients with deranged coagulation parameters and patients with body mass index (BMI) of > 30 were excluded from the study. After premedication, the right radial artery was cannulated under local anesthesia with lidocaine infiltration. General anesthesia was administered under the standard American Society of Anesthesiologists recommended monitoring guidelines. Patients were randomized with the help of a computer-generated randomization program (http://stattrek.com/statistics/random-number-generator.aspx) in equal numbers to 2 groups. In group I, the left axillary vein cannulation was performed under out-of-plane ultrasound imaging (Fig 1; Videos 1 and 2). In group II, in-plane imaging was used to access the left axillary vein (Fig 2; Videos 3 and 4). In each patient, the imaging technique specified for the group was only used with no crossover. All patients were positioned with hands by the side, with no elevation under the shoulders, and the neck kept in a neutral position. As the axillary vein and artery lie further apart and further away from the rib cage on moving laterally, the left axillary vein was accessed in all patients lateral to the midclavicular point to improve the safety margin of the procedure. Under strict aseptic precautions, the left axillary vein was visualized using a 12L-RS linear array transducer from GE (frequency range: 5-15 MHz; field of view: 192 mm) compatible with a Logiq E ultrasound machine (GE Healthcare, Wauwatosa, WI). The axillary vein was accessed by Seldinger method under guidance of either of the indicated ultrasound planes. A 7-Fr, 20-cm length, 3-lumen central venous catheter (CV-25703-E, Arrow International Inc. Reading, PA) was used in all patients. Topographic measurements were used to determine the depth of insertion of the catheter.[3] This was done by placing the catheter with its own curvature over the draped skin starting from the point of insertion of the needle to the insertion point of the second right costal cartilage to the manubriosternal joint. The position of the catheter was deemed to be acceptable if the tip of the catheter was found to be at the superior vena cava/right atrium junction. The position of the tip of the catheter was assessed by the bicaval view on transesophageal echocardiography and by postoperative chest radiography. Two anesthesiologists were involved throughout the procedure. All attempts at cannulation in the study were performed by the same anesthesiologist who was proficient in ultrasound-guided venous cannulations. This anesthesiologist was blinded to the procedural data being recorded. A second anesthesiologist observed the procedure and recorded the demographics as well as details of the procedure. First-pass accessing of the vein was defined as venous cannulation on the first skin puncture with no redirections of the needle and this was recorded if achieved. The number of attempts was signified by the number of times the operator removed the needle from the skin puncture site and reinserted it. Time to completion in both groups was the time taken from the first insertion of the needle into the skin to the successful placement of the central venous catheter. The number of needle redirections was defined as the number of times the needle was withdrawn and redirected without taking

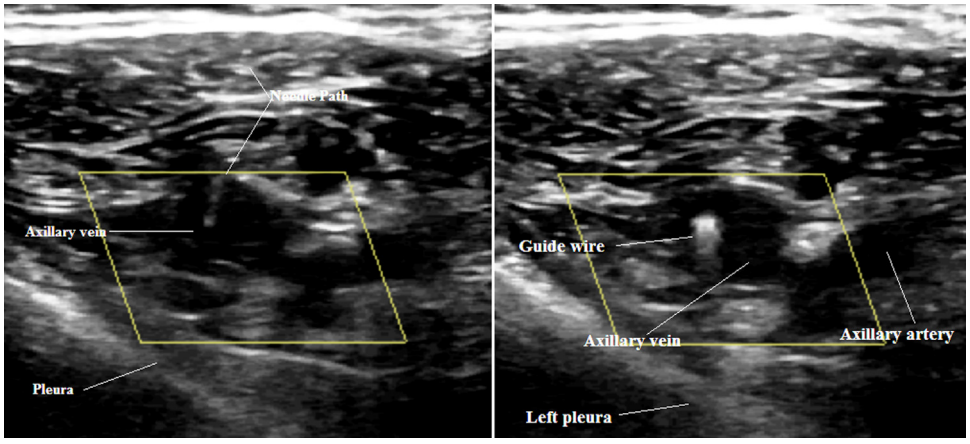

Fig 1. Short-axis ultrasound view of axillary vein showing the needle path (left image) and the guidewire in the lumen of the vein (right image).

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