Ultrasound Guided Vascular Access for CIED Implantation: A Step-by-Step Guide

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Abstract

Introduction Vascular access is required for most cardiac electrophysiology procedures. Over the past two decades, ultrasound guidance has increased in utilization as the primary method for assisting operators in gaining access for cardiac implantable electronic device (CIED) implantation. Methods Ultrasound guidance using a technique that includes both short-axis and long-axis views combined with a twisting needle motion after maximal tenting provides an extremely safe and reproducible technique for vascular access for all CIED procedures. Results and Conclusions In this manuscript and accompanying videos, the author will provide a step-by-step guide for optimal ultrasound guided visualization and needle maneuver technique to maximize safety and efficiency for vascular access in all CIED procedures.

Ultrasound Guided Vascular Access for CIED Implantation: A Step-by-Step Guide

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Introduction

Vascular access is required for most cardiac electrophysiology procedures. Over the past two decades, ultrasound guidance has increased in utilization as the primary method for assisting operators in gaining access for cardiac implantable electronic device (CIED) implantation.

Methods

Ultrasound guidance using a technique that includes both short-axis and long-axis views combined with a twisting needle motion after maximal tenting provides an extremely safe and reproducible technique for vascular access for all CIED procedures.

Results and Conclusions

In this manuscript and accompanying videos, the author will provide a step-by-step guide for optimal ultrasound guided visualization and needle maneuver technique to maximize safety and efficiency for vascular access in all CIED procedures.

Introduction

Ultrasound guided vascular access has been described for cardiac implantable electronic device (CIED) implantation for over two decades (1). The growing availability of ultrasound machines in cardiac procedure labs, improvement of imaging technology including the decreasing size of linear probe footprints, and increasing number of published descriptions has aided this technique in becoming a highly coveted skill amongst implanting cardiologists (2-9). Furthermore, there is now randomized trial data demonstrating safety and efficacy in operators who were never formally trained (10) which should encourage more operators to attempt to adopt ultrasound guided access. This step-by-step guide will describe a technique using both short-axis and long-axis ultrasound views and a twisting needle cutting motion, as opposed to the standard jabbing motion, all of which should enhance the efficiency and safety of vascular access for all CIED implants.

Participant Consent and Disclaimer

All patients video recorded or photographed, even those not used in this manuscript, provided written consents for both Sequoia Hospital and the Journal of Cardiovascular Electrophysiology to use the material for publication. All faces and names were anonymized. No cephalic veins were injured or sacrificed for the production of these videos.

Equipment

A standard linear array ultrasound probe (5-15 mHz) from any manufacture provides the adequate imaging fidelity needed to perform ultrasound guided vascular access. A long sterile ultrasound probe cover will be needed to ensure sterility in the surgical field. Either standard 18-gauge or 21-gauge needles can be used, but echogenic needles can be found for both gauges for various manufacturers. The latter are highly recommended to enhance the visibility of the tip of the needle and increase the safety of access. Standard length J-wires should be available for insertion for each planned venous stick. The rest of the standard equipment needed for a CIED implant should be set up as usual including scalpels, electrocautery, and x-ray equipment. An intravenous (IV) line should be placed preoperatively in the arm on the side of intended access in case saline or contrast is needed to aid in axillary vein visualization.

Step 1: Field Preparation

As with any procedure or surgery in medicine, the key to success starts with the preparation phase before the patient's skin is touched by a needle or scalpel. For ultrasound access, visualization is of utmost importance. Thus, the operator should drape the surgical field making sure that the clavicle is exposed up to its superior edge and that there is enough room available to create an adequate pocket. Having the clavicle within the field of view ensures the ability to image the axillary vein on ultrasound medially until it disappears under the shadow of the clavicle to become the subclavian vein. This gives the operator the ability to choose how medial or how lateral the access sites will be in relation to the clavicle (Video 1).

After the rest of the surgical draping is complete, the ultrasound probe should be dropped by an assistant into a sterile sleeve containing ultrasound gel held by the operator and then secured to the drape near the access site. The ultrasound machine should be placed where the operator can easily view the screen without having to strain or look over any obstacles. This is usually at the head of the bed or across the bed from the operator. All access wires should be within easy reach to minimize the operator's movements once access is obtained with the needle.

Step 2: Initial Ultrasound Survey with Anesthetic

Starting in short axis orientation (probe parallel with the spine), the axillary vein and artery can be identified as the probe is slid closer to the clavicle. Depth and gain should be adjusted appropriately by an assistant to optimize visualization. The vein is more anterior (i.e., closer to the probe) and caudal (closer to the feet) than the artery, collapsible with light pressure, and can sometimes contain valves that are visible on ultrasound. In addition, if the arm IV has saline flush infusing to keep the line open, saline bubbles can usually be visualized flowing centrally on ultrasound.

Once the vein is identified near the clavicular shadow, the probe should be turned 90 degrees clockwise to view it in long axis. Structures visible in this view should be the clavicular shadow superficially (top of the ultrasound screen), the medial axillary vein in long axis running across the length of the screen, and the shadow of the first rib posterior to the vein (bottom portion of the ultrasound screen). Frequently, the cephalic vein can be visualized inserting into the axillary vein. Long axis view allows the operator to choose whether to enter the axillary vein medial or lateral to this intersection. Administration of subcutaneous anesthetic with a 22-gauge needle during long axis ultrasound imaging allows the operator a preview of the angle of the needle course that will be needed. This is also a good time to anesthetize the future incision line, which should be medial and a few millimeters inferior to the skin access points (Video 2).

Step 3: Ultrasound Guided Access

After the skin has been adequately anesthetized, the access needle can now be introduced under long axis visualization with the bevel of the needle facing up at an angle of 45 degrees or less from the surface of the vein to ensure a smooth angle of insertion. The operator should focus on finding the tip of the needle on the ultrasound screen before advancing it past the initial first 5 millimeters under the skin. If the needle tip is not visualized, the needle should not be advanced. Instead, the operator must tilt the ultrasound probe and/or tilt the needle from side to side until it is found.

After identifying the needle tip, it should be slowly advanced towards the front wall of the axillary vein until tenting of the wall is encountered. Most operators at this point are taught to perform jabbing motions with backwards suction on the syringe to puncture the front wall. However, this type of aggressive motion can lead to inadvertent backwall punctures, which in turn could lead to arterial injury or pleural injury. Instead, once maximal tenting is achieved, a quick back-and-forth twisting motion of the access needle will facilitate a clean entry into the vein by taking advantage of the sharp edges of the bevel that will cut into the vein.

Sometimes the operator will find that the needle will tend to slide across the surface of the vein and not enter it. An advanced technique tip here would be to withdraw the needle slightly, then dip the tip of the needle to almost a 90 degree angle in relation to the anterior vein wall surface to try to catch the vein wall on the tip of the needle. When the anterior wall is caught on the tip of the needle, flattening out the needle back to a less than 45 degree angle combined with the twisting motion should result in a swift entry of the needle into the vein. The needle position inside the vein can either be verified by direct visualization on ultrasound or by aspiration of blood into the syringe.

A standard J-wire can now be advanced into the axillary vein either by feel or under direct ultrasound visualization. If this is a left infraclavicular approach, it is highly recommended to perform a quick fluoroscopic visualization of the wire at this point to ensure a normal course of the wire to the subclavian vein, brachiocephalic vein, and then superior vena cava. This will facilitate identification of a persistent left superior vena cava, in which case the operator now has the choice to either continue on with the implant or abandon the left sided approach and switch over to a right infraclavicular approach. A second and third access (depending on type of CIED) may now be obtained by the same technique with the needle puncturing the skin 1-2 millimeters lateral or medial to the first wire entry point (Video 3).

Step 4: Pocket Incision

The lateral border of the pocket incision should be 3-5 millimeters just inferior to the skin insertion points of the wires. Thus, the incision should be started about 4-6 centimeters (depending on the size of the CIED device) medial to this point on a horizontal line. Once the incision is taken down to the pre-pectoral fascia layer and the subcutaneous pocket is created through blunt dissection inferiorly and slightly superiorly, the operator will find that the wire will be located at the mid portion or slightly medial portion of the superior lip of the pocket. This position allows for the CIED leads enter nicely into the pocket and coil from there in a clockwise fashion (Video 4).

Step 5: Harvest the Wires

After creation of an appropriately sized pocket, the J-wires must be dissected out at the pre-pectoral fascia layer. The operator must first palpate where the wires are under the superior lip of the pocket, and then using Metzenbaum scissors with opening motions, bluntly dissect away the tissue until the metal wires can be clearly visualized. Then the closed Metzenbaum scissors can be inserted behind the wires to help backstop the wires as their back ends are fed into the pocket to harvest them. Now that the wires are harvested, the operator can proceed with the rest of the CIED implant per normal protocol starting with insertion of the first peel-away sheath (Video 5).

Conclusion

This step-by-step guide describes an ultrasound guided vascular access approach utilizing both short and long axis views for optimal visualization of the axillary vasculature, expected surrounding structures, and the approach of the needle tip as it tents and enters the front wall of the axillary vein. The description and videos also highlight the benefit of long axis ultrasound viewing angle in seeing the tip of the access needle and aiding the operator to angle the needle tip to catch the front wall of the vein, which augments the ease of a twisting motion cutting into the vein. This will hopefully aid the reader in adopting a technique that is efficient and provides an extremely safe route of access for all CIED implantation.

Video Titles and Captions

Video 1: Field Preparation

This video shows the proper placement of the surgical drape towels for optimal ultrasound guided vascular access (narration provided by Dr. Salcedo).

Video 2: Initial ultrasound survey with anesthetic

This video shows the initial short axis survey followed by a long axis survey while anesthetizing the subcutaneous tissue with a short 22 gauge needle to help preview the angle of the course of the access needle (narration provided by Dr. Salcedo).

Video 3: Ultrasound Guided Access

This video demonstrates two ultrasound guided punctures of the axillary vein using long axis ultrasound guidance and a unique twisting motion after catching the vein wall with the needle tip (narration provided by Dr. Salcedo).

Video 4: Pocket Incision

This video shows the creation of the pocket incision and how it should be positioned with relation to the wire skin entry points (narration provided by Dr. Salcedo).

Video 5: Harvest the Wires

This video displays how to harvest the wires into a newly created CIED pocket (narration provided by Dr. Salcedo).

References

1. Nash A, Bureell CJ, Ring NJ, Marshall AJ. Evaluation of an ultrasonically guided venepuncture technique for the placement of permanent pacing electrodes. Pacing Clin Electrophysiol. 1998;21(2):452–455.
2. Jones DG, Stiles MK, Stewart JT, Armstrong GP. Ultrasound-guided venous access for permanent pacemaker leads. Pacing Clin Electrophysiol. 2006;29(8):852–857.
3. Seto A, Jolly A, Salcedo J. Ultrasound-guided Venous Access for Pacemakers and Defibrillators. J Cardiovasc Electrophysiol 2013;24(3):370-4.

4. Esmaiel A, Hassan J, Blenkhorn F, Mardigyan V. The use of ultrasound to improve axillary vein access and minimize complications during pacemaker implantation. Pacing Clin Electrophysiol. 2016;39(5):478–482.
5. Lin J, Adsit G, Barnett A, Tattersall M, Field ME, Wright J. Feasibility of ultrasound-guided vascular access during cardiac implantable device placement. J Interv Card Electrophysiol. 2017;50(1):105–109.
6. Liccardo M, Nocerino P, Gaia S, Ciardiello C. Efficacy of ultrasound-guided axillary/subclavian venous approaches for pacemaker and defibrillator lead implantation: a randomized study. J Interv Card Electrophysiol. 2018;51(2):153–160.
7. Ahmed AS, Gilge JL, Clark BA, et al. Predictors of successful ultrasound-guided lead implantation. Pacing Clin Electrophysiol. 2020;43(2):217–222.
8. Chandler JK, Apte N, Ranka S, et al. Ultrasound guided axillary vein access: an alternative approach to venous access for cardiac device implantation. J Cardiovasc Electrophysiol. 2021;32(2):485–465.
9. Salcedo J. Integrating Long-Axis and Short-Axis Views With a Twist for Ultrasound-Guided Vascular Access, Part II: Axillary Approach. EP Lab Digest 2020;20(8):28-32,45.
10. Tagliari AP, Kochi AN, Mastella B, et al. Axillary vein puncture guided by ultrasound vs cephalic vein dissection in pacemaker and defibrillator implant: a multicenter randomized clinical trial. Heart Rhythm. 2020 Apr 29;S1547-5271(20)30361-1. doi: 10.1016/j.hrthm.2020.04.030.