

# Regional Anesthesia for Endovascular Intervention in Vascular Access

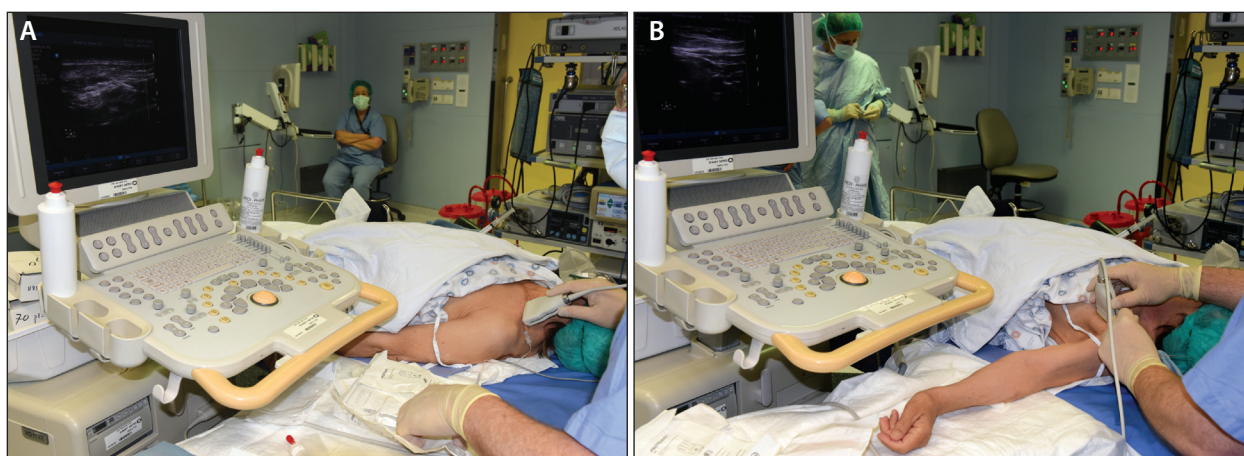
Ultrasound-guided brachial plexus blocks for arteriovenous access intervention are advantageous for the patient and operator.

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Patients with hemodialysis access who undergo angiography and/or endovascular procedures often have local anesthesia with or without conscious sedation. Local anesthesia seems to be a logical choice, because many of these patients are fragile with multiple comorbid conditions. The same applies to hemodialysis access construction. However, at our center, we have gradually moved from local

anesthesia to regional anesthesia for arteriovenous access construction for hemodialysis, and all of our patients now undergo these procedures using supraclavicular or infraclavicular brachial plexus blocks and conscious sedation.

Indications for endovascular procedures for hemodialysis access often mandate procedures including balloon dilatation and stenting remote to the entry



**Figure 1.** Ultrasound-guided brachial plexus block. In the supraclavicular approach (A), the anesthesiologist is sitting at the patient's head, with the ultrasound machine facing him on the ipsilateral side. The ipsilateral arm is adducted, and the transducer is parallel with the clavicle. The needle is inserted from lateral to medial with an in-plane approach. In the infraclavicular (B) approach, the anesthesiologist and ultrasound machine are similar to panel A, with the patient's arm adducted. The ultrasound probe is at 60° to 70° to the clavicle, and the needle is inserted from above.

site, which may be very prolonged. These prolonged, uncomfortable, and sometimes, painful procedures can lead to difficulty for the interventionist due to patient anxiety, as well as involuntary reactions and movement resulting from this discomfort. For this and other reasons discussed later in this article, brachial plexus blocks are a useful anesthetic modality in endovascular interventions in patients with hemodialysis access.

## HISTORY

The use of a brachial plexus block for regional anesthesia was first reported by Halsted using a surgical approach to the neck<sup>1</sup> in the late 19th century and was followed by percutaneous brachial plexus block in the early 20th century.<sup>2</sup> Initially, these blocks were directed by body landmarks such as bony prominences, muscle borders, skin folds, and arterial pulsations. This technique included the patient's sensation of tingling (paresthesia), which indicated the needle's proximity to the target nerve. The introduction of nerve stimulators enabled the addition of objective signs, such as muscle twitches induced by the current, as indicators of the proximity of the needle to the nerves (the lower the current needed to cause a twitch, the closer the needle was to the target nerve).

The administration of brachial plexus block for regional anesthesia has been spurred on by the increasing availability of ultrasound imaging technology and the increasing use of ultrasound by nonradiologists (eg, anesthesiologists) starting in the 1990s.<sup>3</sup> Ultrasound-guided nerve block enables precise injection of the brachial plexus around the axillary artery and vein, with direct visualization of the needle while it is being advanced, and of the anesthetic solution as it spreads, thus ensuring effective nerve blockade.

## ANATOMIC CONSIDERATIONS

The brachial plexus is divided into the roots, trunks, divisions, cords, and peripheral nerve branches, going from proximal to distal. Depending on the level of anesthesia required, injections can be carried out by four approaches: the interscalene and supraclavicular approaches above the clavicle and the infraclavicular and axillary approaches below the clavicle. The more proximal parts of the brachial plexus are anesthetized

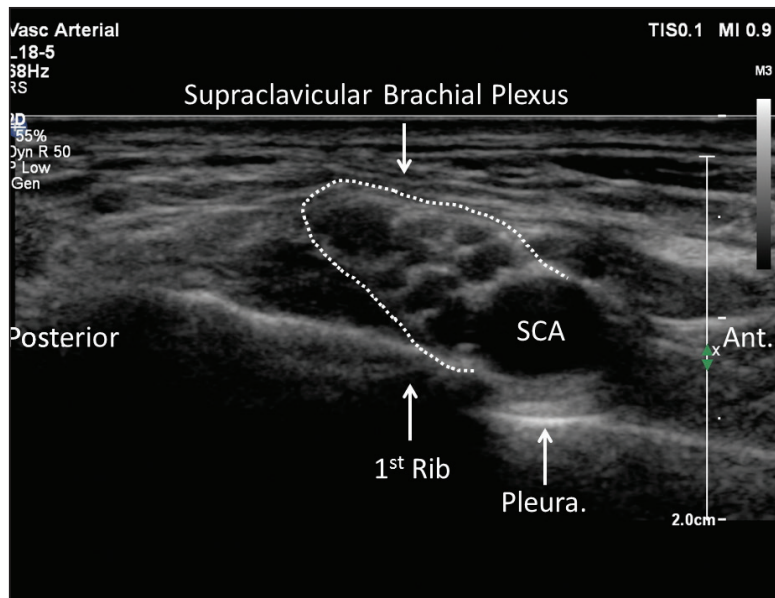


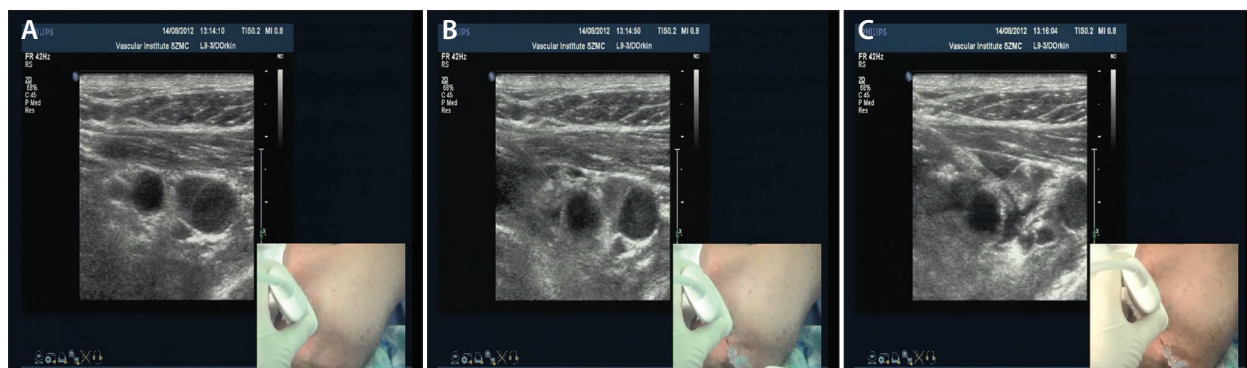
Figure 2. The supraclavicular brachial plexus is seen as a “honeycomb” structure adjacent to the subclavian artery. The brachial plexus is outlined by the dotted line, and the pleura appears as a hyperechoic white line that disappears posteriorly as it is blocked by a large dropout shadow generated by the first rib. SCA = subclavian artery.

by the higher approaches, with interscalene block anesthetizing the shoulder, whereas an axillary block will only induce anesthesia in the fingers, wrist, and forearm. Anesthesia from the upper arm down to the hand can be achieved with a supraclavicular or infraclavicular brachial plexus block,<sup>4</sup> making them the most versatile and commonly used for access-related regional anesthesia.

## TECHNICAL CONSIDERATIONS

Ultrasound-guided brachial plexus blocks are carried out with the patient supine or with the head and shoulders elevated for patients with dyspnea. The operator is seated behind the patient's head, which is turned to the opposite side. For supraclavicular blocks, the arm is adducted close to the trunk, whereas in infraclavicular blocks, it is abducted to 45° or more (Figure 1). The target nerves are identified by ultrasound as dark hypoechoic circles with a bright hyperechoic rim in proximity to the artery.

In supraclavicular blocks, the sonographic landmarks are the first rib and pleura with the artery running transversely. The trunks and divisions of the brachial plexus are seen lateral to the artery above the first rib and pleura (Figure 2). The needle is inserted in the triangle formed laterally by the brachial plexus, medially by the artery, and inferiorly by the first rib. After skin



**Figure 3.** Ultrasound-guided infraclavicular brachial plexus block. The cords of the brachial plexus surround the axillary artery (A). An injection of the anesthetic solution laterally appears as hypoechoic amorphous material around the artery, displacing the lateral and posterior cords (B). Redirection of the needle medial to the artery to complete the injection of the medial cord (C).

infiltration, a 22-gauge spinal needle, inserted under ultrasound guidance, is used to inject local anesthetic solution while observing the spread of the solution (which is hypoechoic) around and between the nerves, periodically aspirating to prevent inadvertent intra-arterial injection.

For infraclavicular blocks, the probe is placed inferiorly and almost perpendicular to the clavicle to identify the pectoralis major and minor muscles, with the axillary artery and vein seen transversely. The cords of the brachial plexus are seen as three roundish hypoechoic structures surrounding the artery laterally, medially, and posteriorly (Figure 3A). After skin anesthesia is administered, the spinal needle is guided by ultrasound toward the posterior cord while observing the spread of the anesthetic solution that separates it from the artery. The needle is then redirected to the lateral cord, and finally, if the solution has not already spread around the medial cord, the needle is directed above the artery to complete the block (Figure 3B and 3C).

### DRUGS FOR LOCAL ANESTHESIA AND SEDATION

A variety of local anesthetic agents may be used according to operator preference, but usually include long-acting anesthetics such as bupivacaine, with volumes of 25 to 30 mL being the usual injected amount. Motor function usually returns within 4 to 8 hours, and the sensory blockade usually lasts for 8 to 10 hours. Occasionally, motor and sensory function can take as long as 24 hours to return, but this should not affect patient discharge.

Conscious sedation is administered before the block is performed using short-acting drugs such as midazolam, fentanyl, and propofol, with additional increments being given as necessary during the procedure. Moderate or deep sedation may rarely be required.

### LOGISTICS

Operating time for the interventional radiologist is a valuable resource. Although the time required to perform a block is usually very short, they can be done by the radiologist or his/her assistant in the holding area of the angiography suite rather than in the suite itself. This will avoid holdups in the workflow of the angiography suite.

### SALUTARY EFFECTS OF BRACHIAL PLEXUS BLOCK

Brachial plexus block rapidly induces anesthesia in the upper extremity, and its prolonged duration allows for lengthy and uncomfortable procedures to be carried out in comfort for both the patient and the interventionist. The sympathectomy-like effects of the block cause venous dilatation and prevent spasm,<sup>5,6</sup> enhancing high flow after angioplasty and possibly preventing rethrombosis, contributing to the success of the procedure.

### ADVERSE EFFECTS OF BRACHIAL PLEXUS BLOCK

Toxicity due to systemic absorption of local anesthetic agents is a serious complication of their use, and care must be taken to avoid intravascular injection. These effects include neurotoxicity with tinnitus, blurred vision and convulsions, and cardiotoxic effects including hypotension and dysrhythmias. Fortunately, mepivacaine rarely causes serious toxicity, even when high doses are used.<sup>7</sup>

Permanent peripheral nerve injury appears to be very rare, with occasional case reports published,<sup>8-10</sup> although this may be underreported. Nerve injury from unintentional intraneural injection has also been reported<sup>11</sup> and should be avoided.

## CONCLUSION

Radiological intervention for vascular access is routinely performed under local anesthesia with mild sedation. However, there are certain interventions such as thrombolytic therapy of thrombosed grafts and, particularly, thrombosed fistulas, which are very painful and time-consuming procedures. Performing these procedures under local anesthesia is difficult and sometimes impossible. Brachial plexus block is especially advantageous for these patients. We already perform these interventional procedures under regional block specifically in the operating room setting as day cases with satisfying results for both the surgeon and patient. We recommend using brachial plexus block routinely for these patients in the radiology suite as well, for difficult and prolonged procedures. ■

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