

ANESTHESIOLOGY™ 2014

OCTOBER 11-15 | NEW ORLEANS, LA

Session: L035
Session: L060

Anesthetic Options for Patients Undergoing Dialysis Access Procedures

Derek T. Woodrum, M.D.
University of Michigan Hospitals, Ann Arbor, MI

Disclosures: This presenter has no financial relationships with commercial interests

Stem Case and Key Questions Content

A 69 year old male is on the operative schedule for a “dialysis access procedure, right arm.” His medical conditions include end-stage renal disease which does not yet require dialysis. His comorbidities are hypertension, coronary artery disease and insulin-dependent diabetes mellitus. He had a small stroke two years prior without residual symptoms.

Key Questions: What are the anesthetic options for dialysis access procedures? Are there outcome data to support general vs. regional anesthesia for dialysis access operations? What are the potential benefits of regional anesthesia?

In the preoperative holding room, the surgeon stops by and says, “I don’t think I can do a Cimino because the vein isn’t big enough. I might place a forearm loop graft, but I may have to do a basilic vein transposition if the cephalic doesn’t match up size-wise to the gore-tex. We’ll just have to see once I’m in there.”

Key Questions: What on Earth *are* all of those operations?! What incisions are involved, and will a brachial plexus block actually “work” for the anesthesia?

After a discussion with the patient on the risks and benefits of general or regional anesthesia, the patient requests a peripheral nerve block. One of your colleagues from the regional anesthesia team places a supraclavicular nerve block in the preoperative holding area. Ten minutes later, the patient reports that his arm is “numb” and you head back to the operating room with a plan to proceed under this block and light sedation.

Things go well for the first 30 minutes while the surgeon operates through a transverse incision in the antecubital fossa. But then the surgeon says, “well, it looks like I’m going to have to do a ‘BVT’ after all.”

Key Questions: What is a BVT operation, and what does this acronym stand for? Can we predict any problems with regional anesthesia for this procedure?

A month later, you bump into the surgeon in the doctor’s lounge. He relates that the fistula has thrombosed, and he’s re-scheduling the patient for a HeRO catheter. The patient really liked you, and has requested that you be his anesthesiologist again.

Key Questions: What is a HeRO catheter? How is the operation performed, and where is (are) the incision(s)? Should you plan another regional anesthetic for HeRO catheter placement?

Model Discussion Content

I. Background and Outcomes

Patients undergoing dialysis access surgery are often complex and frequently challenging to care for. Dialysis access procedures themselves are relatively straightforward peripheral vascular surgeries with low blood loss, but patient comorbidities make perioperative care challenging. Coronary artery disease, severe hypertension, congestive heart failure, arrhythmias, hyper- or hypovolemia, brittle diabetes, obesity, anticoagulation, and polypharmacy frequently challenge simplistic decision making. Regional anesthesia is often employed for such procedures despite clear long-term benefits being difficult to demonstrate.

The sympathectomy that accompanies regional anesthesia has reported benefits. Hingorani¹ showed that vein diameters increase beyond what is achieved by tourniquet technique alone. Reynolds² and Laskowski³ reported that venodilation after peripheral nerve blockade may result in alterations in surgical strategy, allowing for a more preferable distal procedure.

It stands to reason that strategies which promote sympathectomy (vasodilatation and higher blood flow rates) would decrease the likelihood of AVF failure. Malinzak⁴ concluded after reviewing the literature that use of regional anesthesia improves success of vascular access procedures due to profound vasodilation, higher fistula flow rates and improved site and vessel selection. Despite these fistula-level benefits of regional anesthesia, large outcome studies of overall clinical outcomes have not been performed. Smaller studies⁵ have lacked power to detect differences between regional and general anesthesia, and we should currently assume a posture of clinical equipoise.

II. Definitions

Anesthesiologists frequently take a "one size fits all" approach to regional anesthesia for dialysis access, based in incomplete understanding of the actual operations and which peripheral nerve blocks would be effective for each procedure. This approach leads to predictable failures, patient discomfort, and extensive and frustrating local anesthetic supplementation on the operative field. Furthermore, many anesthesiologists have a limited fluency when discussing the actual procedure with the surgeon. Patient care and collegiality will improve with increased understanding.

1. Fistula - a surgically created, single anastomosis between an artery and a vein. After a maturation period, dialysis access needles are placed through the skin into the dilated, thickened venous outflow from the fistula.

2. Shunt - the placement of prosthetic graft material to shunt blood from an artery to a vein. There are two anastomoses; one end to the artery and one end to the vein. The graft material is tunneled subcutaneously between the two anastomoses, allowing hemodialysis needles to be placed through the skin and into the graft material for hemodialysis.

III. Anatomy

The thoughtful anesthesiologist should have a good understanding of the vascular anatomy of the arm. The name of the dialysis access operation frequently allows one to know the location of the incision, if a regional anesthesia technique could be utilized, and which block is most appropriate. We will review the key venous and arterial structures in the upper extremity:

1. Cephalic vein at the wrist, elbow, and arm. It is subcutaneous throughout its course.
2. Basilic vein at the elbow and arm. Note its subfascial location in the upper arm, and note specifically the transition point between superficial and subfascial depths in the mid-upper arm.
3. Axillary vein: the extension of the basilic vein under the pectoralis muscle. It receives variable contributions from the brachial vein(s) (which travel with the brachial artery)

4. Radial artery at the level of the wrist, well-known from arterial line placement.
5. Brachial artery at the elbow, and the brachial vein(s) that run along with it. The brachial veins are deep and are not used in dialysis access.

IV. Common Operations

1) Radiocephalic (Brescia-Cimino) fistula

The radial artery is surgically connected directly to the cephalic vein (the “intern’s vein”) at the level of the wrist. The venous anastomosis can be end-to-side or side-to-side. Either way, the incision is approximately 3-5cm long, oriented longitudinally, at the lateral volar aspect of the distal forearm (just lateral to the radial pulse).

2) Forearm loop graft:

A length of graft material, commonly polytetrafluoroethylene (PTFE; Gore-Tex™), is connected to the arterial inflow (brachial artery), then tunneled subcutaneously in a curved loop pattern on the volar surface of the forearm. Finally, it is attached to the outflow vein (commonly the cephalic vein) at the level of the antecubital fossa. There will be two incisions: one ~3cm in the volar antecubital fossa of the elbow, transversely oriented, and one ~1cm on the volar aspect of the mid-distal forearm (a “counter-incision”) to facilitate the U-turn of the graft material.

3) Brachiocephalic fistula

The brachial artery is directly anastomosed to the cephalic vein at the level of the antecubital fossa. The incision is approximately 3-4cm long, oriented transversely in the volar crease of the elbow. Remember the anatomy of the cephalic vein in the arm—it remains subcutaneous throughout its course in the upper arm until diving beneath the fascia after the pectoralis muscle to join the axillary vein. Its subcutaneous location facilitates easy cannulation for dialysis after fistula maturation.

4) Basilic vein transposition

A basilic vein transposition (BVT) is merely a brachial artery-to-basilic vein fistula at the level of the elbow, analogous to the brachial artery-to-cephalic vein fistula described above. However, there is an important difference in the outflow anatomy. The basilic vein takes a subfascial course a few centimeters proximal to the antecubital fossa. As such, its depth from the skin makes cannulation of a brachiobasilic fistula in the native position quite difficult. To overcome this difficulty, the basilic vein is dissected out along its length and elevated to a more superficial depth (in a subcutaneous pocket or tunnel). This is referred to as “transposing” the position of the basilic vein to a more superficial location, purely for ease of access by the hemodialysis needles. Hence, the operation’s name of basilic vein transposition. It should really be called a “brachio-basilic fistula with subsequent superficialization of the basilic vein,” but “BVT” is easier to say!

5) Brachial-axillary graft

This procedure is employed when the above four options are not available due to poor outflow vein targets. A piece of PTFE tubing is attached to the brachial artery via a 3-4cm transverse incision at the elbow, tunneled subcutaneously and then attached to the axillary vein for venous outflow. Because the proximal incision (for the axillary vein anastomosis) is high in the axilla, regional techniques are not useful for this operation. A general anesthetic is almost always required.

6) Hemodialysis with reliable outflow (HeRO) catheter

This approach to dialysis access⁶ is a newer procedure, used when the patient does not have a suitable axillary vein to use as outflow for a brach-axillary graft. The catheter is a two-piece unit. One end is sewn to the brachial artery, and the other end is placed into the right atrium. The two pieces are attached and tunneled in a subcutaneous location on top of the biceps muscle to facilitate hemodialysis needle placement. The procedure is performed as:

1. An antecubital incision is made to dissect out the brachial artery for inflow
2. A venipuncture is made over the IJ for placement of the outflow portion
3. A separate incision is made over the deltopectoral groove to connect the two pieces

Note that fairly long-distance tunneling is required. Because of the location of incisions and tunneling required, a general anesthetic is employed for this procedure.

V. The Nerve Block Distributions

An interscalene brachial plexus block is a root level block which is most useful for procedures on the shoulder. It does not reliably cover the ulnar nerve distribution, which limits its applicability to dialysis access procedures at or distal to the elbow.

Supraclavicular and axillary brachial plexus blocks reliably produce anesthesia for procedures at and distal to the elbow, and they are routinely utilized for dialysis access procedures in those locations. The musculocutaneous nerve supplies sensory innervation to the lateral forearm. It branches away from the brachial plexus at a location distal to where a supraclavicular block is performed, but proximal to where an axillary brachial plexus nerve block is performed--it must be separately blocked within the coracobrachialis muscle for dialysis access procedures performed under axillary brachial plexus block.

Importantly, the sensory innervation of the proximal medial arm is supplied by the medial brachial cutaneous and intercostal brachial cutaneous nerves which often originate from the ventral primary ramus of T2 (outside of the brachial plexus). As such, surgical anesthesia in this cutaneous area is not reliably obtained by a brachial plexus block alone.

References

1. **Hingorani AP**, Ascher E, Gupta P, Alam S, Marks N, Schutzer RW, Mulyala M, Shiferson A, Yorkovich W, Jacob T, Salles- Cunha S. Regional anesthesia: preferred technique for venodilatation in the creation of upper extremity arteriovenous fistulae. *Vascular* 2006;14:23–6
2. **Reynolds TS**, Kim KM, Dukkitpati R, Nguyen TH, Julka I, Kakazu C, Tokhner V, Chauvapun JP Pre-operative regional block anesthesia enhances operative strategy for arteriovenous fistula creation. *J Vasc Access*. 2011 Oct-Dec;12(4):336-40
3. **Laskowski IA**, Muhs B, Rockman CR, Adelman MA, Ranson M, Cayne NS, Leivent JA, Maldonado TS. Regional nerve block allows for optimization of planning in the creation of arterio- venous access for hemodialysis by improving superficial venous dilatation. *Ann Vasc Surg* 2007;21:730–3
4. **Malinzak EB**, Tong JG. Regional Anesthesia for Vascular Access Surgery. *Anesth Analg* 2009;(109) 3: 976-980
5. **Solomonson MD**, Johnson ME, Ilstrup D. Risk factors in patients having surgery to create an

ANESTHESIOLOGY™ 2014

OCTOBER 11-15 | NEW ORLEANS, LA

arteriovenous fistula. *Anesth Analg* 1994;79:694 –700

6. **Katzman, HE** et al. Initial experience and outcome of a new hemodialysis access device for catheter-dependent patients. *J Vasc Surg* 2009;50:600-7