The Apex-Puncture Technique for Mechanical Thrombolysis of Loop Hemodialysis Grafts

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THE techniques for performing endovascular thrombectomy procedures continue to evolve. A variety of different methods have been described for the treatment of thrombosed hemodialysis grafts. These include pulse-spray pharmacomechanical thrombolysis, balloon thrombectomy, and the use of different mechanical thrombectomy devices. The first step in performing any of these percutaneous thrombectomy procedures is to obtain access into the occluded graft. The classic technique of crossed-catheter pulse-spray thrombolysis, and the more recently described methods using mechanical thrombectomy devices, all utilize two separate puncture sites to gain entry into the graft (1-4). The initial puncture is made into the arterial limb in an antegrade direction, and the second puncture is made into the venous limb in a retrograde direction. These bidirectional entry sites provide the interventionalist with access to remove thrombus from the entire length of the graft and allow for treatment of both the venous and arterial anastomoses. But this dual entry approach can be less than ideal (5). When the vascular entry sites are located directly over the graft, the operator’s hands may enter the imaging field, incurring exposure to the radiation beam. In addition, the use of two vascular sheaths can create peri-sheath “protected” areas within the graft lumen where thrombus or intragraft stenoses may be difficult to treat. Finally, on completion of the thrombectomy procedure, there are two puncture sites, both located directly over the graft, which need to be manually compressed or otherwise managed to achieve hemostasis.

We describe an alternative approach for entry into a thrombosed loop-configuration hemodialysis graft. A single puncture site located at the apex of a loop hemodialysis graft can provide access to the entire graft, both anastomoses, and the native venous outflow tract. We believe that this technique has greatly simplified our thrombectomy procedures and has eliminated several of the disadvantages inherent to the dual access method.

MATERIALS AND METHODS

During an 8-month period, from October 1997 to June 1998, we utilized the apex-puncture technique to obtain vascular access for 88 mechanical thrombectomy procedures performed in 57 patients (19 men; 38 women) referred to our service with thrombosed loop polytetrafluoroethylene hemodialysis grafts. Two patients had grafts placed in the upper thigh. The remaining patients all had forearm grafts. No patients had straight grafts or grafts in the upper arm.

All patients gave written informed consent. Conscious sedation with use of midazolam hydrochloride (Versed; Hoffman-LaRoche, Nutley, NJ) and fentanyl citrate (Abbott Laboratories, Chicago, IL) was utilized as needed. Preprocedural antibiotics were not routinely given.

The patients hemodialysis graft was prepped and draped in a standard sterile fashion. A subcutaneous injection of 1% lidocaine was
administered prior to puncture. The optimal needle entry site was located 1–2 cm distal to the apex of the loop graft (Fig 1). An 18-gauge percutaneous vascular entry needle (Cook, Bloomington, IN) was advanced horizontally beneath the skin to enter the middle (equator) of the graft (Fig 2a). Entry into the middle of the graft was performed to allow for easier manipulation when changing directions from limb to limb. On puncturing the graft, the needle was rotated in the horizontal plane until the tip was directed into the venous limb. A 0.035-inch guide wire (Bentson; Cook) was advanced into the venous limb and subsequently manipulated across the venous anastomosis. A pull-back venogram of the native veins and venous anastomosis was then obtained with a 5-F multipurpose angiographic catheter (Mallinckrodt, St. Louis, MO) to assess for the presence of significant stenoses. A short 6- or 7-F vascular sheath (DialEase; Mallinckrodt) was fully inserted into the graft through the skin entrance site and directed toward the venous anastomosis. Heparin (3,000–5,000 units) was routinely administered into the graft through the sheath before the mechanical thrombectomy procedure. Mechanical thrombectomy was performed to remove the thrombus from the venous limb of the graft. The vascular sheath was partially withdrawn from the graft, as needed, to remove residual thrombus from the graft apex. The Arrow percutaneous thrombolytic device (Arrow International, Reading, PA) was used in 59 procedures, the Amplatz thrombectomy device (Microvena, White Bear Lake, MN) was used in 11 procedures, the AngioJet rheolytic thrombectomy system (Possis Medical Inc, Minneapolis, MN) was used in 11 procedures, the Cragg thrombolytic brush (Micro Therapeutics, San Clemente, CA) was used in five procedures, and the Castaneda brush (Micro Therapeutics) was used in two procedures.

After mechanical thrombectomy of the venous limb, a fistulogram was obtained. Any significant (>50%) stenoses were dilated with a high-pressure angioplasty balloon (Tru Trac; Bard Medical, Covington, GA). After successful thrombectomy and angioplasty of the venous limb, the vascular sheath was then redirected into the arterial limb. This was accomplished by inserting the introducer into the vascular sheath and backing the sheath out of the puncture site over the introducer. A curved hydrophilic guide wire (Glidewire; Medi-tech/Boston Scientific, Watertown, MA) was advanced through the introducer until the tip was near the end of the introducer. Under close fluoroscopic observation, the introducer was carefully withdrawn until the tip could be rotated horizontally toward the arterial limb of the graft. The guide wire was then advanced out of the introducer toward the arterial anastomosis. The sheath was reinserted into the arterial limb of the graft over the introducer. The introducer and guide wire were removed. Mechanical thrombectomy was performed to remove the thrombus from the arterial limb of the graft. The arterial plug was dislodged with an over-the-wire balloon thrombectomy catheter (Thru-Lumen Fogarty; Baxter Healthcare, Irvine, CA). The arterial plug was allowed to wash away into the venous outflow. A completion fistulogram was obtained and any residual thrombi or stenoses were treated as needed by rotating the access sheath back and forth between the venous and arterial limbs of the graft.

After restoration of brisk blood flow through the graft, a purse-string stitch was placed around the skin entrance site of the vascular sheath with use of an 0-silk suture (6,7) (Fig 2a). Hemostasis was achieved by tightening the stitch after removal of the vascular sheath. A completion pull-back venogram across the venous anastomosis was obtained and any residual thrombus was treated as needed by rotating the access sheath back and forth between the venous and arterial limbs of the graft.

RESULTS

Technical success, defined as the ability of the patient to undergo at least one subsequent hemodialysis treatment, was achieved in 78 of 88 procedures (88.6%). This is comparable to our success rate of 85% achieved in a series of 42 patients at our institution using bidirectional crossed-catheter access for pulse-spray thrombolysis (8). This is also comparable to the 85% technical success rate that is suggested by the Dialysis Outcomes Quality Ini-
will become trapped in the graft. When using the apex puncture technique, the thrombus can be more readily removed from both limbs of the graft, unencumbered by the presence of vascular sheaths. If residual thrombus is caught on the sheath it can be dislodged by momentarily removing the sheath over a guide wire and allowing the thrombus to wash away (Fig 4).

Similarly, the presence of vascular sheaths can interfere with the treatment of intragraft lesions. Pseudoaneurysms or intragraft stenoses can develop at sites of repeated needle punctures, most frequently in the straight portions of the arterial and venous limbs of a hemodialysis graft. These same graft segments are often utilized as the entry sites for the dual-access approach. Because the apex of a loop graft is rarely used for routine hemodialysis, this segment tends to be relatively unmarrned by the effects of repetitive needle punctures (Fig 5). By utilizing the apex for vascular access, those segments of the graft that are most likely to be abnormal can be avoided.

Finally, grafts constructed with a “tight” apex can be difficult to treat with mechanical thrombectomy devices. A mechanical device may not easily negotiate a tight turn at the graft apex. Those devices with drive shafts, such as the Amplatz thrombectomy device, the Cragg brush, and the Castenada brush, may have a reduction in rotational speed and power when forced around a narrow radius of curvature. Entering the graft apex eliminates this problem by allowing passage of the device directly into the relatively straight portions of the graft.

We have found that with experience, the process of redirecting the vascular sheath from the venous limb to the arterial limb can be performed with minimal effort and time expenditure, even when multiple repositionings are required during a single procedure. Early in our experience, access was occasionally lost during the sheath repositioning. Access could almost always be recovered by gently probing the puncture site with a vascular dilator and guide wire. With practice, we have become very comfortable with the technique of sheath repositioning and now rarely lose access. While we have occasionally encountered intragraft stenoses or treatment-resistant clot adjacent to the sheath entry site at the graft apex, we have found that this problem occurs much less frequently than when using the dual-access method.

We believe that it is important to enter the middle (equator) of the graft in the horizontal plane (Fig 2a). This provides advantageous geometry for rotating the vascular sheath and introducer from one limb of the graft to the other. In addition, the 1–2 cm subcutaneous tunnel created during graft entry allows for safer manual compression when obtaining hemostasis at the completion of the procedure when compared with the usual dual-access technique. The puncture sites created during dual-ac-
cess procedures are usually located directly over the graft. Applying manual compression to this type of puncture site may compress or occlude the graft, potentially reducing blood flow and causing rethrombosis. At the completion of the apex-puncture technique, pressure is applied to the subcutaneous tunnel and not to the graft itself, thereby minimizing the risk of rethrombosis (Fig 2b).

A pseudoaneurysm can develop after any needle puncture into a hemodialysis graft or native vessel. Fistulograms obtained during subsequent endovascular procedures revealed small pseudoaneurysms at the apex puncture site in three of our patients, the largest measuring 5 mm in diameter. Small pseudoaneurysms are commonly found in polytetrafluoroethylene hemodialysis grafts and are secondary to suboptimal compression after removal of hemodialysis needles, particularly when venous outflow problems exist. Although these pseudoaneurysms can occasionally become quite large, they are generally not surgically repaired unless they cause skin erosion or become cosmetically unacceptable to the patient. While neither of these scenarios occurred in our three patients, two pseudoaneurysms were surgically patched because the surgeon’s balloon thrombectomy catheter became repetitively caught in the pseudoaneurysms during subsequent surgical thrombectomy procedures. We believe that if adequate compression is applied to the subcutaneous tunnel at the conclusion of the procedure, this problem may be avoided.

In conclusion, we believe that the apex-puncture technique is an effective and time-saving alternative to dual-access for performing mechanical thrombectomy procedures on occluded loop hemodialysis grafts.

References