Treatment of steal syndrome in a distal radiocephalic arteriovenous fistula using intravascular coil embolization

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Steal syndrome is a well-described complication of arteriovenous fistulas used for hemodialysis access. Although distal revascularization with interval ligation appears to offer the greatest likelihood of symptom relief and vascular access salvage, not all fistulas are amenable to this procedure, particularly distal radiocephalic arteriovenous fistulas. In this report, we describe the treatment of steal syndrome in a patient with a distal radiocephalic arteriovenous fistula using a percutaneous approach and endovascular coils. After coil embolization of the distal radial artery and multiple collateral vessels, steal was no longer visualized using angiography, and the patient’s symptoms resolved. (J Vasc Surg 2008;47:457-9.)

Although arteriovenous fistulas (AVFs) are the preferred vascular access for hemodialysis, both AVFs and arteriovenous grafts offer superior longevity and decreased morbidity compared with central venous catheters. Steal syndrome is a complication that may occur in >4% of patients with AVFs. The pathophysiology of steal syndrome is complex, but in the absence of a proximal arterial stenosis, ischemia distal to the arteriovenous anastomosis occurs as blood flows from the high-resistance circulation distal to the anastomosis to the low-resistance fistula outflow. This process results in retrograde flow of blood into the low-pressure AVF circulation, with subsequent distal ischemia.

Several techniques have been used for steal syndrome, including banding, access ligation, distal revascularization with interval ligation, and most recently, proximalization of the arterial inflow. In distal radiocephalic fistulas, ligation of the distal radial artery is often used to eliminate retrograde flow into the AVF.

In this report, we describe successful treatment of steal syndrome associated with a distal radiocephalic fistula using endovascular coil embolization of the distal radial artery and numerous branch arteries supplying the AVF. Distal radial artery ligation is unlikely to have resolved symptoms in this patient given her continued symptoms after coil embolization of the distal radial artery. To our knowledge, this is the first report to describe successful treatment of steal syndrome using endovascular coiling while maintaining a functioning vascular access.

CASE REPORT

Patient is a 46-year-old woman with end-stage renal disease secondary to type 1 diabetes mellitus and hypertension. A left radiocephalic AVF was placed 5½ years prior, and she received thrice weekly hemodialysis through this fistula for the past 5 years. Symptoms of steal syndrome developed, manifested by numbness and pain of her left hand on dialysis. These symptoms typically occurred 1 hour of dialysis initiation, were temporally related to the gradual drop in blood pressure during her treatment, and limited her ability to attain optimal postdialysis weight.

Her symptoms intensified, and angiography was performed (Fig 1). Angiography showed no evidence of proximal arterial disease but did demonstrate retrograde flow in the radial artery distal to the radiocephalic anastomosis. The palmar arch was intact, and retrograde radial artery flow was augmented from the ulnar artery. Antegrade flow was restored after temporary occlusion of the dialysis fistula venous outflow.

Because the palmar arch was intact and perfused by the ulnar artery, disruption of retrograde distal flow into the AVF was considered the best opportunity to alleviate her symptoms and salvage the AVF. An interventional approach was chosen because of the potential for continued ischemic symptoms after distal radial artery ligation from additional vessels supplying the AVF in a retrograde manner.

The venous outflow of the AVF was accessed in a retrograde fashion. A 5F vascular sheath (Boston Scientific, Natick, Mass) was placed, and a 5F angled Glidecath (Terumo, Somerset, NJ) was advanced into the distal radial artery. A balloon was temporarily inflated in the distal radial artery to confirm full perfusion of the palmar arch by the ulnar artery. A 4-mm diameter Tornado embolic coil (Cook, Bloomington, Ind) was then deployed, with resultant occlusion. Angiography revealed the recruitment of a carpal artery and the superficial palmar branch of the radial artery supplying the radial artery (Fig 2, A). Through a brachial artery approach, a Renegade microcatheter (Boston Scientific) was used to deploy 3-mm-diameter Tornado embolic microcoils (Cook), with resultant occlusion of each vessel.

The patient’s symptoms were alleviated for approximately 2 weeks, at which time her original symptoms returned. Repeat
angiography demonstrated a recruited carpal collateral and a hypertrophied distal branch of the interosseous artery supplying the dialysis fistula (Fig 2, B). The decision was made to embolize an obvious contributor to the steal, the carpal collateral. We chose a conservative approach because we believed the symptoms might be alleviated with occlusion of the obvious abnormality without endangering the interosseous artery supplying the wrist. The carpal artery was embolized using a 3-mm-diameter Tornado embolic microcoil (Cook). This intervention again resulted in short-lived improvement, with return of symptoms 2 weeks.

The patient returned for angiography through the antegrade brachial approach. Given her lack of long-term improvement after embolization of the carpal collateral, it was suspected that the hypertrophied branch of the distal interosseous artery noted at the time of the second intervention was likely contributing to her symptoms. Selective injection of the interosseous artery demonstrated an impressive supply to the AVF through the distal hypertrophied branch, raising the suspicion that the ischemia was partly related to this finding.

A 5F Kumpe catheter (Cook) was advanced into the interosseous artery and 3-mm-diameter microcoils (Cook) were deployed in three tiny branch vessels as well as in the main branch of the interosseous artery supplying the AVF. The final arteriogram revealed prompt filling of the AVF through the radial artery, without evidence of retrograde filling of the AVF through the coil-embolized vessels (Fig 3). The patient has experienced no further episodes of steal syndrome, her hand remains warm, and she has had uneventful dialysis treatments for the past 6 months.

**DISCUSSION**

Currently described therapies for steal syndrome include access ligation, banding, proximalization of the arterial inflow, and distal revascularization with interval ligation procedure. Distal radial artery ligation has also been used for patients with distal radiocephalic AVFs. The goal of any therapy is to resolve tissue ischemia, patient symptoms, and salvage the vascular access, if possible. Although banding has been attempted, thrombosis develops in the access in up to 90% percent of patients after this procedure.

Ligation of the access should be viewed as a last resort for patients with refractory symptoms or who could otherwise not tolerate surgical intervention. It is critical that every attempt be made to salvage an existing fistula or graft—while not endangering the patient—because there is a high rate of primary access failure when a new access is placed, and tunneled, cuffed catheters are associated with higher rates of infection and venous stenosis. Although distal radial artery ligation has been successfully used to treat ischemic symptoms in patients with distal radiocephalic fistulas, patients may experience continued ischemic symptoms despite interruption of flow in the distal radial artery. Distal radial artery ligation is unlikely to have been
successful in resolving the steal syndrome in this patient, because numerous other vessels were identified and coil-embolized before the patient’s steal syndrome resolved. Because this is the first patient in whom we have used this approach, and to our knowledge there are no similar reports in the literature, we approached these interventions in stages. The patient had an initial diagnostic angiogram, followed by three additional interventions. To minimize procedures in future patients, a coil could be placed in the distal radial artery at the time of the initial diagnostic arteriogram; or in patients with continued symptoms after distal radial artery ligation, arteriography with subsequent coiling of culprit vessels could be used to resolve ischemic symptoms and salvage AVFs that may otherwise need to be ligated.

Regardless of the therapeutic approach, evaluation of any patient with suspected steal syndrome should include angiography to evaluate proximal and distal arterial supply to the extremity because many patients with ischemia have inflow stenoses that contribute to tissue ischemia. It is not until any potential inflow stenosis has been addressed that other interventions should be attempted.

CONCLUSION

To our knowledge, this report is the first to describe coil embolization to treat hemodialysis AVF-related steal syndrome and maintain function of vascular access for hemodialysis. Because the procedure described in this report does not involve distal revascularization, it is critical that there is adequate blood supply from another source. In this patient, there was adequate flow to the distal extremity from the ulnar artery with an intact palmar arch, as visualized by arteriography. This procedure could not otherwise be safely performed without adequate ulnar artery perfusion of the hand.

Coil embolization of the distal radial artery and additional vessels supplying the fistula appears to be a safe and viable option to both alleviate steal syndrome symptoms and salvage hemodialysis access, if adequate collateral circulation is confirmed.

REFERENCES
