Surgical Revision and Early Cannulation of the Arteriovenous Fistula in Hemodialysis Patients: An Effective Technique

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Arteriovenous fistula (AVF) dysfunction is a common problem in hemodialysis patients. After surgical revision for malfunction, we used AVFs early to avoid complications associated with central venous catheters. In this study, we report experience with surgical revisions of native AVFs with suspected arterial dysfunction as the cause of inadequate arterial inflow for dialysis. Exclusion criteria were presence of a central venous catheter as a hemodialysis access, and clinical or radiologic evidence of stenosis or thrombosis of the distal venous segment of the AVF.

We prospectively studied 50 patients (mean age 60.2 ± 10.5 years, 25 men and 25 women) with 59 revisions. The patients were followed until change in the modality of dialysis, transplant, or death. The types of AVFs revised were left wrist radiocephalic in 27 patients (54%), left forearm radiocephalic in 10 (20%), right wrist radiocephalic in 6 (12%), left antecubital brachiocephalic in 3 (6%), right antecubital brachiocephalic in 2 (4%), and right forearm radiocephalic in 2 (4%). The causes of inadequate arterial flow were juxta-anastomotic thrombosis in 20 patients (40%), inadequate arterial anastomotic flow in 16 (32%), inadequate anastomosis in 7 (14%), and juxta-anastomotic venous stenosis in 7 (14%). The primary surgical revision techniques were proximal neo-anastomosis using the semi-arterialized vein in 43 patients (86%), thrombectomy and re-anastomosis in 5 (10%), and resection and repair in 2 (4%).

Technical success, defined as successful cannulation of the revised AVF for hemodialysis and avoidance of central venous catheter, was achieved in 44 of 50 patients (88%). Technical failure occurred 6 cases, the causes being inadequate arterial flow in 3 patients, failure to cannulate the veins in 2 patients, and steal syndrome in 1 patient. After primary revisions failed, 9 re-revisions were done in 6 patients. The 1-year, 2-year, and 3-year primary and overall patency rates were 76.2%, 67.6%, 65.0%, and 85.7%, 75.7%, 65.0%, respectively.

In conclusion, surgical salvage of the AVF with inadequate arterial flow is an effective approach that can be performed as an outpatient procedure and allows early cannulation of the semi-arterialized veins, thus avoiding the use of central venous catheters.

(Hemodial Int., Vol. 5, 28–31, 2001)

Key words

Arteriovenous fistula, blood access, central vein catheters, surgical salvage

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Introduction

In 1966, Brescia and colleagues described the creation of an arteriovenous fistula (AVF) using the radial artery and an adjacent vein [1]. Dysfunction of the AV access is a significant problem, especially in prosthetic grafts, and is a frequent cause of hospitalization for hemodialysis patients [2]. Early reports of surgical salvage of thrombosed AVFs gave varying results [3–5], leading to the use of percutaneous treatment of thrombosed AVFs using interventional radiologic techniques [6–8]. Central vein catheters have been used as a bridge access after surgical revision. The use of central venous catheters is recognized to be associated with complications such as central venous stenosis, thrombosis, and infections [9]. This study reports our experience with the early use of surgically revised malfunctioning native AVFs without the interim use of central venous catheters.

Material and methods

All stable hemodialysis patients with native AVF arterial dysfunction were enrolled into the study. We defined AVF arterial dysfunction as AV anastomotic or juxta-anastomotic segment thrombosis or occlusion or inadequate access blood flow during dialysis. Inadequate access flow was assessed clinically by monitoring the dialysis flow sheets and was defined as an inability to maintain blood flow at ≥ 250 mL/min during a dialysis session, measured by the dialysis machine flow meter. An inadequate urea reduction ratio, Kt/V_{urea}, or recirculation supported the diagnosis of inadequate access flow in the absence of distal venous segment stenosis.

The first 5 cm of the vein adjacent to the AV anastomosis was arbitrarily designated as the juxta-anastomotic segment, beyond which, the vein was designated the distal venous segment. Inadequate access flow may be due to an inadequate feeding artery, inadequate anastomosis, or an anastomotic or juxta-anastomotic venous stenosis. An inadequate feeding artery was defined as the presence of a small feeding artery with reduced blood flow in the presence of an optimal anastomosis. An inadequate anastomosis was defined as the pres-

ence of an adequate feeding artery with blood flow limited by a small anastomosis.

The diagnosis of the etiology of inadequate access flow can usually be made clinically and confirmed intra-operatively by inspection of the feeding artery and anastomosis. When distal venous stenosis was suspected, a fistulogram was performed to exclude this diagnosis before a surgical revision was done. The exclusion criteria for the study were presence of a central venous catheter as a hemodialysis access, and clinical or radiologic evidence of distal venous stenosis or thrombosis.

The patients were referred to a single surgeon for surgical revision of the AVF. The surgical revision was performed as an outpatient procedure under local anesthesia whenever possible. In the case of fistula thrombosis, surgical revision was performed on the day of diagnosis or on the following day.

The AVF was cannulated using the semi-arterialized veins for the next scheduled hemodialysis whenever possible. "Semi-arterialized veins" refers to the veins of the original fistula that had partially enlarged and thickened and were suitable for cannulation. If a hematoma was overlying the neo-anastomosis, or the arterial flow was felt to be clinically inadequate, the hemodialysis might be delayed up to a maximum duration of 1 week after revision. Medical treatment and dietary measures were instituted for patients whose dialysis was postponed. If the revised AVF could not be used by the end of 1 week post-revision, a central venous catheter was inserted as an access. Anticoagulation was avoided if the first hemodialysis was conducted within 48 hours after revision; the second hemodialysis was performed with low-dose anticoagulation. No changes were made in the size of the fistula needles, and the blood flow rate was maintained at 250 mL/min.

All data were collected prospectively. Treatment outcomes were evaluated based on the immediate technical success and patency results after the surgical procedure. Technical success was defined as successful restoration of arterialized fistula flow ≥ 250 mL/min as measured by the dialysis machine flow meter. Technical failure was defined as the inability to restore arterialized fistula flow to 250 mL/min, or the need to use a central venous catheter as a hemodialysis access, or both. Primary patency was defined as adequate arterialized flow after the surgical procedure. Primary patency was considered to end when surgical re-intervention was required to correct AV fistula malfunction and re-establish arterial patency and function. Overall patency was defined as successful use of the initial salvaged AV fistula despite surgical re-interventions until the end of follow-up.

The patients were followed until a change in the modality of renal replacement therapy to chronic peritoneal dialysis, until transplant or death, or until a percutaneous intervention was required to correct the malfunctioning AV fistula. Primary and overall patency rates were calculated using Kaplan–Meier lifetable analysis.

Results

Between 1996 and 2000, a total of 59 surgical revisions were performed in 50 patients with malfunctioning AVFs and inadequate arterial flow. The group included 25 women and 25 men with a mean age of 60.2 ± 10.5 years. The causes of end-stage renal disease were diabetes mellitus in 27 patients (54%), chronic glomerulonephritis in 15 patients (30%), systemic lupus erythematosus in 2 patients (4%), urolithiasis in 2 patients (4%), and unknown in 4 patients (8%). The mean time to revision after the creation of the original AVF was 9.0 ± 4.1 months. Of the 59 procedures, 52 were performed on an outpatient basis; only 7 procedures were performed on an inpatient basis.

The types of AVFs revised were left wrist radiocephalic in 27 patients (54%), left forearm radiocephalic in 10 (20%), right wrist radiocephalic in 6 (12%), left antecubital brachiocephalic in 3 (6%), right antecubital brachiocephalic in 2 (4%), and right forearm radiocephalic in 2 (4%). The causes of inadequate arterial flow were juxta-anastomotic thrombosis in 20 patients (40%), inadequate arterial anastomotic flow due to a small or inadequate feeding artery in 16 patients (32%), inadequate anastomosis in 7 patients (14%), and anastomotic or juxta-anastomotic venous stenosis in 7 patients (14%). Of the 50 patients, 26 (52%) had AVFs less than 6 months old, and 24 of 50 patients (48%) had AVFs greater than 6 months old. The primary surgical revision procedures were neo-anastomosis a few centimeters proximal to the original anastomosis using the semi-arterialized vein in 43 patients (86%), thrombectomy and re-anastomosis in 5 patients (10%), and resection and repair in 2 patients (4%). The neo-anastomosis was performed using a 1.0 – 1.5 cm longitudinal arteriotomy. The arteriotomy was connected side-to-end of a well-mobilized vein; fascia or muscle tissue overlying the vein was dissected free to ensure that the vein was not kinked or strapped down after the neo-anastomosis. Repeat surgical revisions were required in 6 patients. Four patients required one repeat procedure, one patient required two repeat procedures, and one patient had three repeat procedures for repair of the AVF.

Technical success was achieved in 44 of 50 patients (88%). The AVF was successfully cannulated and functioned adequately for the next hemodialysis session without the need for a temporary central venous catheter. Of the 50 patients, 45 (90.0%) had their next hemodialysis treatment within 3 days of AVF revision, 3 patients (6.0%) received the next HD between 3 days and 5 days after revision, and only 2 patients (4.0%) were not dialyzed until 5 – 7 days after revision. Technical failures occurred in 6 of 50 patients (12%). The causes of technical failure were inadequate arterial flow after surgical revision in 3 patients, unsuccessful fistula cannulation in 2 patients, and steal syndrome in 1 patient. The primary patency rates were 76.2% at 1 year, 67.6% at 2 years, and 65.0% at 3 years. The overall patency rates were 85.7% at 1 year, 75.7% at 2 years, and 65.0% at 3 years.

Discussion

The AVF remains the most effective access for the hemodialysis patient and is the access recommended by the National Kidney Foundation Dialysis Outcomes Quality Initiative (DOQI) Work Group [10]. However, access dysfunction, particularly with AV prosthetic grafts, is a frequent problem and a main cause of hospitalization for hemodialysis patients, costing up to $0.5 billion annually in the United States [2,11]. Treatment of the thrombosed or failing fistula that does not provide adequate arterial flow can be managed by surgical or percutaneous intervention.

The literature on surgical treatment of thrombosed AVFs reports varying results. In 1979, Bone *et al.* [4] reported that simple thrombectomy was ineffective for treatment of thrombosed AVFs, because only 22% of salvaged AVFs functioned at the end of 6 months. In 1985, Palder *et al.* [3] reported a 2-year patency rate of only 50% for thrombectomies of thrombosed AVFs. Similarly, Romero *et al.* [12] found a 2-year cumulative patency rate of 50% after the creation of a new anastomosis proximal to a thrombosed original anastomosis. Diskin *et al.* [13] reported a mean access survival duration of 244 days after surgical thrombectomy of thrombosed AVFs in 45 patients. Finally, Oakes *et al.* [14] performed 27 surgical salvage procedures in 22 patients with failing or thrombosed AVFs and reported a cumulative primary patency rate of 47% at 18 months. However, they reported that a subgroup of patients with mature or semi-mature AVFs had excellent results after surgical salvage with a cumulative primary patency rate of 67% at 18 months and a secondary patency rate of 89% at 18 months.

With the development of sophisticated interventional radiologic techniques, percutaneous treatment of failing or failed AVFs has also been attempted. In 1989, Gmelin *et al.* [15] reported the use of transluminal angioplasty in malfunctioning or occluded native fistulae, and reported an 89% patency rate for correction of stenosis and 46% for occlusions. More recently, Turmel–Rodrigues *et al.* [6] used percutaneous de-clotting of forearm fistulae by manual catheter–directed thromboaspiration. They reported a success rate of 90%, and 50% primary and 80% secondary patency rates at 1 year. Haage *et al.* [7] used percutaneous treatment for acute thrombosis of native AVFs. Full restoration of flow was established in 89% of cases. The primary and overall patency rates were 27% and 51% at 1 year, respectively. Finally, Schon and Mishler [8] achieved a technical success rate of 94% and a long-term patency rate of 81% by treating thrombosed AVFs with a combination of thrombolytic agents and balloon angioplasty.

It is well recognized that central venous catheters have short-term technical and infective complications and long-term vascular complications [9]. The avoidance of the use of central venous catheters would be desirable. Therefore, as part of our management of failing or failed AVFs, we carefully explored the possibility of surgically salvaging the AVFs so that the mature or semi-arterialized veins could be used for cannulation after the surgical procedure. In the case of an acute thrombosis, a thrombectomy can be performed with or without a neo-anastomosis to the mature or semi-mature vein proximal to the thrombosed segment. In cases of inadequate arterial flow owing to a poor feeding artery, inadequate anastomosis, or an anastomotic or juxta-anastomotic venous stenosis, a similar neo-anastomosis is performed, mobilizing the artery to anastomose with the more proximal segment of the vein of the original AVF. By so doing, the revised fistula can be cannulated 1 – 3 days after the surgical revision for hemodialysis. Our treatment approach, with careful use of the veins of the original fistula, also avoided wastage of the patient's vessels. This approach gave our patients the benefits of avoiding the use of a central venous catheter as temporary access. Our study showed that this technique is feasible, and we were able to achieve primary patency rates of 76% at 1 year, 67% at 2 years, and 65% at 3 years. The overall patency rates were 86% at 1 year, 76% at 2 years, and 65% at 3 years. These results are comparable to those from recently published studies using interventional radiologic percutaneous techniques to treat thrombosed native AVFs [6,7].

Conclusion

Surgical salvage of the thrombosed or failing AVF is a cost-effective approach that can be successfully performed as an outpatient procedure. Careful inspection of the veins of the original AVF and planning of the salvage procedure will allow early cannulation of the veins after the revision, avoiding the use of a central venous catheter. This approach may be recommended for the treatment of selected cases of AVF dysfunction.

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