Interventions for Dialysis Access Steal Syndromes

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DISCLOSURE

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No Relevant Financial Relationship Reported
First described by Storey et al in 1969

Extremity ischemia induced by the shunting of significant arterial flow through an AV access thereby reducing distal perfusion.
Introduction

• Digital blood flow reduced in 80% of access cases.
  – Only few with symptoms.
  – 10% with coolness and tingling that often resolves.

• Clinically significant steal.
  – Autologous 1-2%
  – Brachial 4-8%
Blood flow in large fistulas is independent of the fistula diameter and depends more on the resistance of the inflow artery, the peripheral circulation, and the collateral network.
Pathophysiology

• Low resistance venous outflow and high resistance arterial bed.

• Distal disease with stenosis or inability to vasodilate.

• Augmentation of symptoms by hypotension and decreased cardiac output accompanying dialysis.
Classification

• **Grade 0**: No Symptoms

• **Grade 1: Mild** – cool extremity, few symptoms, flow augmentation with access occlusion

• **Grade 2: Moderate** – intermittent ischemia only during dialysis, claudication

• **Grade 3: Severe** – ischemic rest pain, tissue loss
Risk Factors

• Diabetes
• PAD
• CAD
• Brachial based access
• Pre-op DBI < 0.6
• Digit pressure <60mmHg
Steal Symptoms

• Symptoms present either <24hrs or weeks to months post-op.
• Burning
• Numbness
• Paresthesias
• Weakness
• Coolness
Steal Signs

- Cyanosis
- Delayed cap refill
- Pallor
- Absent pulses/signals
- Diminished sensation
- Weakness
- Ulcers/Gangrene
- Improvement with access occlusion
Differential Diagnosis

- Ischemic Monomelic Neuropathy (IMN) must be considered for acute post-op presentation.
- Carpal Tunnel Syndrome.
- Venous hypertension.
Evaluation for Steal: PPG

Fig 1. Digital plethysmography of patient with severe ISS. Left, Monophasic digital waveform with patent uncompressed arteriovenous fistula. Right, Markedly improved digital waveform with fistula compression.
Evaluation for Steal: Duplex

- High flow (>900ml/min)

- Retrograde flow
Evaluation for Steal: Angiography

Fig 2. Upper extremity arteriogram in patient with polytetrafluoroethylene forearm loop arteriovenous fistula and ischemic rest pain. A, Without compression, no filling of infrabrachial arteries is seen. B, With manual compression, forearm vasculature is well demonstrated.
Treatment

Aim

• Reduce access flow
• Augment peripheral flow

Goal

• Resolve symptoms.
• Preserve access.
Treatment Options

- Banding.
  - Miller Procedure.
- DRIL.
- RUDI.
- PAI: Proximal arterial inflow.
- Ligation.
Banding

• Variable success rates reported

• Flow monitoring

• Miller/Modified-Miller techniques.
Minimally Invasive Limited Ligation Endoluminal-assisted Revision (MILLER)

- Used for fistula revision in the setting of steal syndrome.
- Controlled ligation (non-absorbable suture) of the fistula with the aid of a balloon.
Minimally invasive limited ligation endoluminal-assisted revision (MILLER)

• 57 year old woman with right hand pain and numbness, worse during dialysis.

• Right radiocephalic fistula created 5 months prior.
MILLER procedure

Fistula open

Fistula occluded
MILLER procedure
(photo’s from recent pt)
MILLER procedure
Distal Revascularization-Interval Ligation (DRIL)

- Creates a bypass proximal to the arterial anastomosis and to the vessel distal.
- Ligation to the vessel distal to arterial anastomosis.
- Prevents retrograde flow from the distal vessel.
- Lower resistance pathway distally.
Revision Using Distal Inflow (RUDI)

- Ligation of fistula at the arterial anastomosis.
- Inflow moved to a more distal vessel.
- Decreases flow through the access due to diameter reduction in the fistula and smaller inflow artery.
Proximalization of the arterial inflow: A new technique to treat access-related ischemia

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Objective: Arteriovenous access-related ischemia is an uncommon but serious and occasionally devastating complication. Distal revascularization-interval ligation (DRIL) has been established as a standard treatment procedure; however, an axial artery is ligated and the distal perfusion is maintained by the construction of an arterial bypass. Because such an approach, in principle, appears undesirable, we developed and applied an alternative technique referred to as proximalization of the arterial inflow (PAI). This procedure converts the arterial supply of the arteriovenous access to a more proximal artery with higher capacity by using a small-caliber polytetrafluoroethylene graft as a feeder.

Methods: From January 1999 to June 2005, the PAI technique was applied in 30 patients. The indication was seen in patients with severe distal ischemia who had a flow volume rate of <800 mL/min in a native fistula and <1000 mL/min in prosthetic access.

Results: Pain was the dominant symptom of ischemia in most patients before surgery. In 37%, a tissue loss was observed. The symptoms of access-related ischemia disappeared completely in 84% of patients and improved significantly in 16%. The significant hemodynamic improvement was confirmed by an increase of the intraoperatively measured mean distal arterial pressure from 32 ± 9 mm Hg to 63 ± 8 mm Hg. The digital-brachial index increased from 0.40 ± 0.10 to 0.83 ± 0.07. The mean access flow rate was 658 ± 80 mL/min after PAI and did not differ significantly with the preoperative value (634 ± 181 mL/min). With a mean follow-up interval of 26.1 ± 19.1 months, the primary and secondary patency rates were, respectively, 87% and 90% at 1 year and 67% and 78% at 3 years.

Conclusions: The PAI procedure represents a well-suited alternative to the DRIL technique for the treatment of patients who develop ischemia after creation of an arteriovenous access. Results for access salvage and disappearance of ischemic symptoms are equivalent to the DRIL technique. In contrast to the DRIL procedure, the PAI technique preserves the natural arterial pathway. Hence, PAI is preferable for surgeons who are reluctant to ligate an axial artery and are concerned about potentially disastrous consequences. (J Vasc Surg 2006;43:1216-21.)

Maintains arterial continuity.

Operative configurations

- DRIL and RUDI usually autologous conduit.
- PAI usually prosthetic conduit.
Treatment Algorithm for Steal

Figure 19.1 Algorithm for the treatment of DASS. DBI, digital brachial index; AVG, arteriovenous graft; AVF, arteriovenous fistula; RUDI, revision using distal inflow; PAI, proximalization of arterial inflow; DRIL, distal revascularization with interval ligation. (Adapted from Beathard GA, Spergel LM. Hand ischemia associated with dialysis vascular access: An individualized access flow-based approach to therapy. Sem Dial. 2013;26(3):287–314.)
Ligation

- Definitively resolves steal symptoms.
- Sacrifices functional access.
- Last resort for steal.
- First line for Ischemic Monomelic Neuropathy (IMN).
Summary

• Clinically significant access related hand ischemia can be a serious threat to a functioning dialysis access.
• There are numerous successful strategies to manage and preserve access in patients with steal syndrome.
Selected References

- Rutherford’s Vascular Surgery and Endovascular Therapy, 9th Edition Elsevier
RUDI vs. DRIL

A comparison of revision using distal inflow and distal revascularization-interval ligation for the management of severe access-related hand ischemia

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Objective: Access-related hand ischemia (ARHI) is a potentially limb-threatening complication of arteriovenous access for dialysis. The distal revascularization-interval ligation (DRIL) and revision using distal inflow (RUDI) procedures both allow treatment of ischemic symptoms while maintaining fistula patency. Although outcomes with the DRIL are well established, experience with the RUDI for ARHI remains preliminary. We compared outcomes in these procedures with respect to cumulative patency, resolution of symptoms, and patient survival.

Methods: A large, prospectively maintained database was used to identify all patients after autogenous arteriovenous fistula construction at two hospitals between 2005 and 2015. Patients with severe Society for Vascular Surgery grade 3 ARHI were included for analysis.

Results: A total of 2035 autogenous accesses were created during the study period, and 58 (3%) developed grade 3 ARHI. Of this cohort, RUDI was performed in 20 and DRIL in 21. The indication for intervention was tissue loss (61%) or ischemic rest pain (39%). Mean age was 57.5 years, and 54% of patients were female. Most patients had diabetes (86%) and symptomatic peripheral arterial disease (63%). The mean preoperative digital-brachial index was 0.25 ± 0.12. There were no preoperative differences in patient comorbidities between the RUDI and DRIL cohorts. Primary patency between the RUDI and DRIL cohorts at 12 months (58% ± 11% vs 55% ± 12%) and 36 months (51% ± 12% vs 41% ± 12%) were similar (P = .841). Cumulative secondary patency at 12 months (84% ± 8% vs 94% ± 6%) and 36 months (78% ± 9% vs 86% ± 9%) showed no significant difference (P = .398). Resolution of ischemic symptoms, including resolution or improvement in pain or healing of ischemic ulcers or amputations, occurred in 90% with RUDI and in 81% with DRIL (P = .131). Survival for patients who underwent RUDI or DRIL procedures at 1 and 3 years was 85% vs 86% (P = .948) and 55% vs 49% (P = .278).

Conclusions: In this preliminary study, the RUDI demonstrated similar patency, symptom resolution, and survival compared with the DRIL for patients with severe ARHI. All-cause mortality after any procedure for severe steal syndrome is high, and the particular intervention for management of steal must account for anatomic, patient, and disease-related considerations. (J Vasc Surg 2016;63:1574-81.)