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Original Article

The MILLER banding procedure as a treatment alternative for dialysis access steal syndrome: a single institutional experience☆,☆☆

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ABSTRACT

Objective: To describe a single institutional experience with minimally invasive limited ligation endoluminal-assisted revision (MILLER) for treatment of dialysis access steal syndrome (DASS).

Materials and Methods: Twenty patients were retrospectively identified that underwent 30 MILLER band procedures for DASS at our institution from March 2010 to December 2014. Technical success was defined by successful creation of MILLER band with preservation of flow for hemodialysis. *Clinical success* was defined as complete resolution of signs and symptoms with preservation of dialysis access in a 1-month postprocedural period. Primary MILLER band patency, postintervention-assisted primary access patency, and postprocedure secondary access patency are reported.

Results: Technical success was achieved in all patients. Clinical success was achieved in 75% of patients after one banding procedure and in 95% of patients after two banding procedures. One patient experienced access thrombosis following the initial banding procedure which was subsequently treated and did not lead to loss of access. MILLER band patency was 83% at 1 month and 77% at 6 months. Postintervention-assisted primary patency was 95%, 93%, and 92% at 3 months, 6 months, and 1 year, respectively. Postintervention secondary patency was 86%, 68%, and 59% at 3 months, 6 months, and 1 year, respectively.

Conclusions: MILLER banding offers a less-invasive alternative to surgical therapy that appears to be safe and permits preservation of dialysis access.

1. Introduction

Dialysis access steal syndrome (DASS) has been reported in up to 8% of patients following surgical creation of an arteriovenous shunt for hemodialysis access. Redirection of flow from the distal artery in the direction of the arteriovenous fistula (AVF) can result in ischemic steal [1]. Historically, standard of care for DASS was ligation of the AVF, which would result in loss of dialysis access [1]. Surgical banding, plication, and placement of a tapered graft can reduce flow through an AVF but have varied success in maintaining sufficient flow for dialysis and may result in complete loss of access [2,3]. More complex surgical techniques have been developed to redistribute blood but are invasive [4]. Therapy directed at occlusion of the distal radial artery, by ligation [5] or coil embolization [6], is only effective in the setting of palmar arch steal syndrome and requires adequate perfusion from the ulnar artery to support the palmar arch.

Goel et al. (2006) [7] and Miller et al. (2010) [8] describe a modification to the traditional open surgical banding procedure employing the use of an endolumninal balloon to attain a predetermined luminal diameter for specific, controlled reduction in shunt size. Minimally invasive limited ligation endoluminal-assisted revision (MILLER) banding reduces flow while preserving dialysis access. The aim of our study is to examine our institutional experience with the MILLER banding technique.

2. Methods

2.1. Study population and experimental design

The local institutional board review deemed this study exempt from full review due to its retrospective nature. We performed a chart review of patients that underwent the MILLER banding procedure for the treatment of DASS from March 2010 to December 2014. Demographic data, signs, and symptoms at presentation, type of anastomosis, band sizes, repeat or other access-related procedures, complications, and follow-up times were recorded.

Technical success was defined as the successful creation of a MILLER band with preservation of flow in the dialysis access at completion angiography and on postprocedure physical exam. *Clinical success* was defined as complete resolution of signs and symptoms of DASS with preservation of dialysis access in the 1-month postprocedural period. If sign and symptoms of DASS were present within 1 month of initial treatment, these patients were classified as having “persistent” DASS.

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Patients that presented after 1 month with signs and symptoms of DASS were classified as having "recurrent" DASS and were not designated clinical failures. *End of primary MILLER band patency* was defined as balloon dilation of existing bands for poor flow at dialysis, rebanding for persistent/recurrent symptoms, or access thrombosis, as reported in Miller et al. (2010) [8]. Patencies were calculated for individual bands rather than individual patients.

End of postintervention-assisted primary access patency (i.e., thrombosis-free access survival [9]) was defined as access thrombosis resulting in endovascular thrombolysis/thrombectomy as outlined in Reporting Standards for Percutaneous Interventions in Dialysis Access put forth by the Society of Interventional Radiology Technology Assessment Committee [10]. This analysis excludes other treated lesions in the access circuit not related to the MILLER banding or DASS. *End of postintervention secondary access patency* was defined as the time interval between initial intervention and surgically declot or fistula abandonment due to the inability to treat the DASS/surgeon choice/transplantation, or loss to follow-up [10]. Patients that did not follow up after the procedure were excluded from this study.

2.2. Procedure

All cases were performed on an outpatient basis in a stand-alone outpatient facility or hospital. Intravenous antibiotics were administered prior to each procedure. All procedures were carried out under moderate sedation using intravenous midazolam and fentanyl. Lidocaine was used as a local anesthetic. Standard skin prep with chlorhexidine and betadine solution was used.

Prior to treatment, an upper extremity angiogram was performed from the subclavian artery to the palmar arch to demonstrate sluggish or reversal of flow through a downstream artery (Fig. 1A). Arterial inflow lesions were corrected. Outflow lesions were also treated. The MILLER banding procedure was performed as outlined in Miller et al. [8]. In brief, a percutaneous angioplasty balloon was inflated across the juxta-anastomotic segment of the outflow vein approximately 2–3 cm beyond the fistula or graft anastomosis (Fig. 1B). Two small incisions were made along the medial and lateral aspects of the fistula outflow vein at this level. After careful blunt dissection with a Kelly clamp, a 2–0 Prolene suture was wrapped around the vein and tied with the

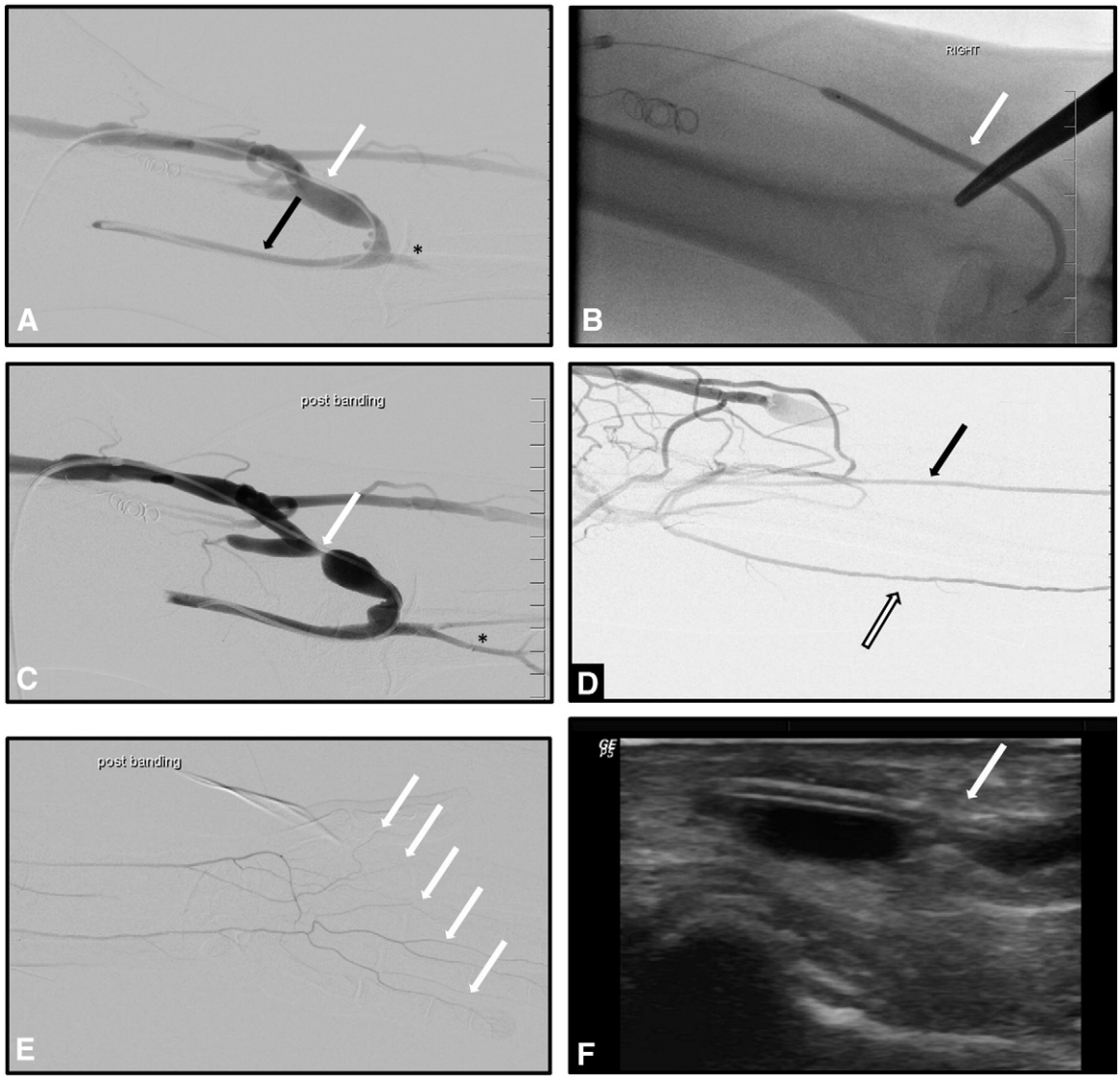

Fig. 1. MILLER technique. (**A**) preprocedure fistulagram demonstrating the anastomotic anatomy **(white arrow:** outflow vein, **black arrow:** inflow artery). Note absence of downstream arterial flow (**asterisk**); (**B**) balloon **(white arrow)** through anastomosis with clamp (outside of patient) overlying the juxta-anastomotic segment of the outflow vein approximately 2–3 cm beyond anastomosis; **(C**) postprocedure fistulagram demonstrates narrowing of the juxtaanastomotic outflow vein with the MILLER band **(arrow)**. Note redistribution of downstream arterial flow (**asterisk**); (**D**) postprocedure forearm angiogram demonstrates sufficient flow distally in the radial **(black outlined arrow)** and ulnar **(black arrow)** arteries; (**E**) postprocedure palmar arch angiogram demonstrates sufficient flow to the digital arteries **(white arrows)**; (**F**) postprocedure ultrasound demonstrates narrowing of the juxta-anastomotic outflow vein with the MILLER band **(arrow)** with no complication (i.e., hematoma).