SCIENTIFIC LETTER

MODIFIED MILLER BANDING TECHNIQUE FOR ISCHEMIA IN NATIVE FISTULAE

Authors
Pinto, D.[1], Marenchino, R.[1], Montalvo, F.[1], Prado, R.[2]

[1]*Cardiovascular Surgery Service.*
[2]*Nephrology Department.*

Private Community Hospital, Mar del Plata, Argentina.

Corresponding author:
Diego E. Pinto
vasculardpinto@gmail.com

ABSTRACT

Treating upper limb ischemia or dialysis access-associated steal syndrome (DASS) is controversial. Many treatments have been described for this pathology; one of the techniques of preference in our institution is banding with the technique described by Miller et al. of minimally invasive endoluminal-assisted limited ligation revision (MILLER), in which we have modified to avoid the intercurrences it causes.

Four cases of stage II steal are presented in which the Miller technique is performed in which, instead of banding with a 2-0 Prolene suture, it is surrounded with a 1 cm wide PTFE segment. An angioplasty balloon is used to calibrate the desired diameter of the banding, and a Doppler ultrasound is performed to evaluate the flow before and after the procedure, as in the Miller technique.

The procedure allowed ischemia to be resolved, and the fistulas were found to be permeable without evidence of the complications usually described.

Keywords: *Miller banding, hemodialysis, fistula theft, ischemia associated with dialysis fistula*

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INTRODUCTION

Treating dialysis access-associated steal syndrome (DASS) in the upper limb is controversial. Many treatments have been described for this pathology; one of the techniques of preference in our institution is banding with the technique described by Miller et al. of minimally invasive endoluminal-assisted limited ligation revision (MILLER)[1]. In the MILLER technique, one or two incisions are made on the sides of the arteriovenous fistula, surrounded in a minimally invasive manner with a 2-0 Prolene suture. A lateral introducer is placed from the proximal region, and an angioplasty balloon of the intended diameter (generally between 2.5 and 6 mm) is advanced to calibrate the flow. Once the balloon is dilated, the Prolene ligature is tightened over the balloon. The complications described in the medium term include the suture in the autologous vein, failure of the banding for flow control (which requires a new procedure), and pseudoaneurysms[2,3]. We have performed a modification of the technique to avoid these intercurrences.

CASE PRESENTATION

We present four cases of patients with stage II steal in whom the MILLER technique is performed, but instead of banding with a 2-0 Prolene suture, it is surrounded with a 1 cm wide PTFE segment. An angioplasty balloon is used to calibrate the desired diameter of the banding, and a Doppler ultrasound is performed to assess the pre- and post-procedure flow, as in the MILLER technique.

Creating a low-resistance flow system when making a dialysis fistula can lead to dialysis-associated ischemia (ischemia) steal syndrome (DASS). This is due to poor perfusion of distal tissues, either because of flow reversal (steal per se), hypoperfusion, or other causes (e.g., distal arteriopathy). Its incidence is 2.7-4.3% in prosthetic accesses and 1% in native fistulas[4]. Ischemia syndrome presents with different clinical stages, characterized by mild pain to tissue loss[5].

Different risk factors have been identified, such as using the humeral artery as an inflow, diabetes, female sex, use of prostheses, cardiovascular disease, smoking, and age over 60 years[6].

The ideal access should maintain adequate flows and pressures to allow effective hemodialysis, usually between 600 and 1500 ml/min. Symptomatology depends on the interrelationship between fistula flow, distal bed status, and compensatory methods (e.g., vasodilatation and collateral development). Consequently, the entire circuit must be evaluated for treating ischemia associated with vascular accesses to define its best treatment.

The procedure resolved the ischemia, and the fistulas were permeable without evidence of the complications described in the literature. The average flow rate before the procedure was 260 ml/min and 950 ml/min afterward. One patient required banding angioplasty at 339 days due to decreased flow during dialysis.

METHOD

In our service, the usual treatment of dialysis-associated steal is fistula banding (except in cases of low flow). We usually perform the technique described by Miller in cases where the fistula is prosthetic. In cases where the fistula is native, we modified the MILLER technique, which consists of banding with a PTFE segment instead of a 2-0 Prolene ligature; in this way, the possibility of inclusion in the tissue is reduced.

Figure 1 shows the passage of the Halstead forceps through the two incisions, behind and in front of the fistula, close to the anastomosis, and under ultrasound control. In this way, the fistula is then surrounded by the PTFE segment. Then, retrograde puncture and placement of the lateral introducer are performed, where the angioplasty balloon is used to calibrate the fistula and pre- and post-procedure angiographic controls (*Figures 2 and 3*).

Between June 2020 and June 2023, we performed the procedure on four patients. All accesses were humerocephalic fistulas. All four patients had pain during dialysis (stage II). The success rate of the technique was 100%. All patients resolved symptoms from the day of the procedure. The average pre-procedure flow rate was 2600 ml/min and 950 ml/min after the procedure. In three cases, we performed the approach through one incision and, in one case, through two parallel incisions.

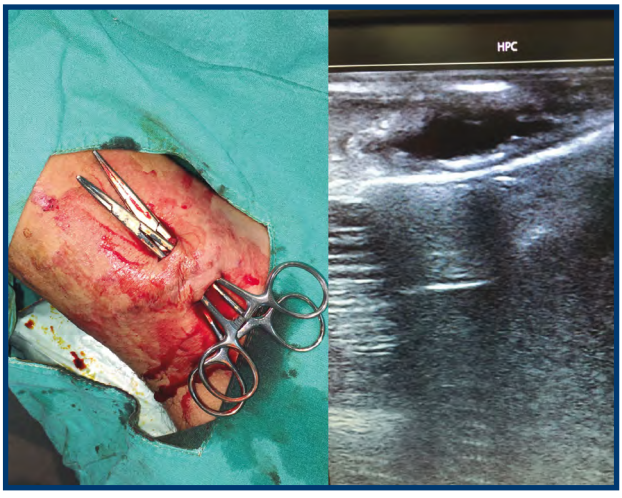

FIGURE 1. A AND B: Passage of the Halstead forceps through the two incisions, behind and in front of the fistula, under ultrasound guidance.

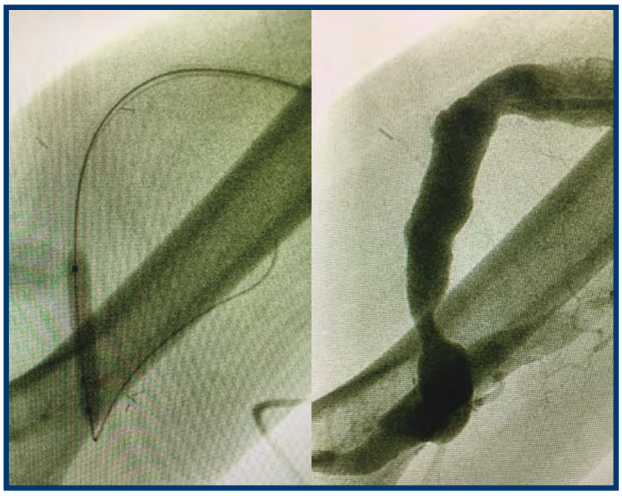

FIGURE 2. Banding with PTFE before calibration.

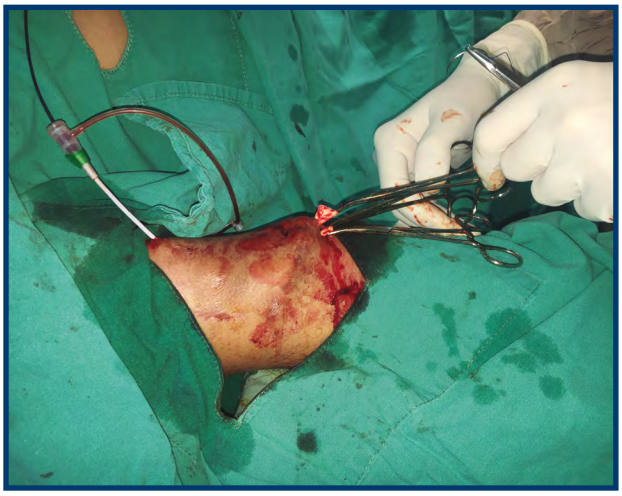

FIGURE 3. Calibration of the fistula on the angioplasty balloon.

RESULTS

In one case, it was necessary to repeat the procedure after five months due to the recurrence of symptoms. Another case required angioplasty at 339 days due to stenosis at the banding site, with consequent fistula dysfunction during dialysis. They remain patent to date without other associated treatments (average follow-up of 447 days, with a range of 231 to 507 days). There were no intraoperative or postoperative complications within 30 days. All patients were able to receive dialysis through access after this treatment.

DISCUSSION

Many treatments have been developed to solve DASS, all with their different risks and benefits, where the morbidities of the procedure are weighed against the patency of the vascular access.

To avoid fistula ligation, the first option described was banding or flow reduction by calibrating the fistula[7]. It has been performed in different ways: with clips, with continuous sutures, and using PTFE coating, as we have done in our institution[8]. For many years, there was the inconvenience that the patency of the fistula decreased significantly, which led to its use being replaced by other techniques. Doppler ultrasound is essential to evaluate the flow before and after the procedure and reduce the risk of this complication, as well as the size nomogram (*Figure 4*)[9]. In this way, the decision-making process is simplified to create a narrowing that results in a 60-80% reduction in lumen diameter.

The minimally invasive option described by Miller1 allows it to be performed without major surgical maneuvers. One incision is made over the fistula or two incisions parallel to the fistula, and the fistula is surrounded with a 2-0 Prolene suture. The fistula is then accessed percutaneously in a retrograde fashion, and an angioplasty balloon is used to calibrate the ligation to the desired diameter, with ultrasound control before and after the procedure and using the nomogram. This technique has a 100% success rate with very low morbidity. The thrombosis rate described is 0.20 per access/year for prosthesis and 0.9 access/year for native fistulas (similar to that described for other methods), and secondary patency of 90% at 24 months. Other less frequent complications described with this banding technique include the suture in the fistula with consequent thrombosis, failure in treating ischemia[2], and the formation of a pseudoaneurysm at the suture site[3].

To avoid this situation, we have modified Miller's technique with PTFE banding, as already described in 1981[8]; this reduces the possibility of alteration of the tissue structure of the native fistula due to the beats and tension generated by the suture.

Other options to solve the ischemia syndrome involve the confection of different bridges to redirect the flow. Distal arterial ligation revascularization was one of the first emerging options after banding. This is a more complex technique, where a bypass maintains distal tissue flow and directs all inflow to the fistula, generating two parallel resistance circuits instead of the series pattern[10]. Arterial inflow proximalization, where a prosthetic bridge is made from the humeral or axillary artery to the fistula, has good long-term results without ligating the native vessels that perfuse the distal tissue[11]. Another option that does not compromise the native vessels is revision using distal inflow[12]. This is exclusively used for humeral fistulae since, in this case, the humeral anastomosis is ligated, and a bridge is made to a distal artery (usually the radial artery). All these techniques involve

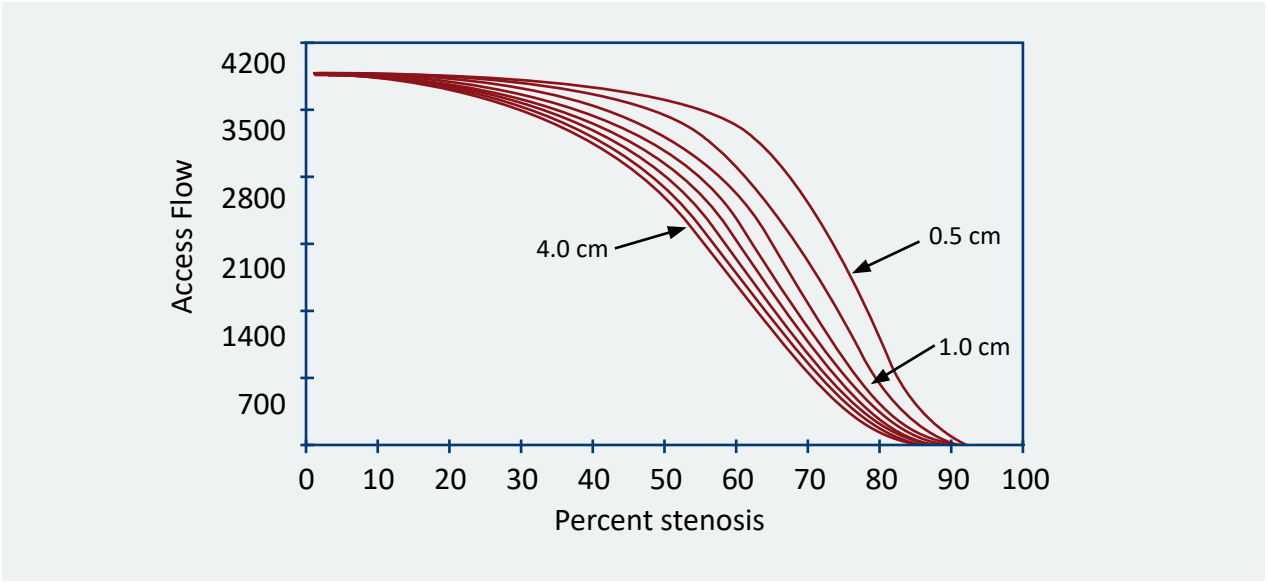

FIGURE 4. Flow nomogram. **Fuente:** Adapted from Murray BM, Rajczak S, Herman A, et al. Effect of surgical banding of a high-flow fistula on access flow and cardiac output: intraoperative and long-term measurements. Am J Kidney Dis 2004; 44: 1090-1096.

vascular surgical skills, longer surgical times, more morbidities, and patencies similar to banding, so our first choice was to perform the MILLER technique.

CONCLUSION

We believe that this modification of the original MILLER technique with a PTFE banding avoids the inclusion of the suture in the native fistula, which reduces the probabilities of thrombosis, reinterventions, and eventual pseudoaneurysms.

Declarations

The authors declare no conflict of interest.

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