BYPASS SURGERY IN LIMB SALVAGE: INFLOW PROCEDURES


J. Bismuth, M.D.,


C. Duran, M.D.

Jean Bismuth, M.D.; Cassidy Duran, M.D.

Methodist DeBakey Heart & Vascular Center, The Methodist Hospital, Houston, Texas

Abstract

Proper management of lower-extremity inflow vessel disease is critical to the success of distal interventions. Aortobifemoral bypass is the most effective means of treating aortoiliac disease, but this invasive procedure is not always ideal for a patient population that often has diffuse vascular disease and multiple comorbidities. Technologic advances and increasing experience have fundamentally altered the management algorithm for lower-extremity vascular lesions, and endovascular options have become the first-line therapy for Trans-Atlantic Inter-Society Guidelines (TASC) class A and B lesions. In fact, an endovascular first approach is being endorsed even for highly complex TASC C and even TASC D lesions. Other alternatives include minimally invasive (laparoscopic or robotic) options or extra-anatomic bypass procedures. Inadequate outflow can compromise any inflow procedure, but inflow treatment failures are the crux of all limb salvage in patients with lower-extremity vascular disease.

Introduction

The key to a successful lower-extremity intervention is the establishment of satisfactory inflow. Without such inflow, all interventions in the leg will fail, and amputation is likely to occur. Inflow vessels for the lower extremity are the aorta and the iliac arteries. Disease of these vessels is classified according to the TransAtlantic Inter-Society Consensus II (TASC II) system that described expected outcomes based on anatomic distribution of disease. The aortobifemoral bypass (AFB) remains an extremely efficacious and durable operation and is the procedure against which all other iliac procedures are benchmarked. It has been shown that primary patency rates are better for bypass at 1, 3, and 5 years when compared to iliac stenting.[1] This trend may be more pronounced as interventionalists push the envelope further and not only treat iliac lesions of TASC II type B and C, but also type D.[2] However, if one thinks of an open procedure, such as an endovascular procedure, as consisting of both a "delivery system" and a therapeutic component, the delivery system for AFB remains unappealing and in many instances a very high-risk operation in patients with significant comorbidities. Consequently, endovascular management of aortoiliac disease has moved to the front line of the treatment algorithm. While the durability of the therapeutic component may be less optimal, the appeal of the delivery system more than compensates. There are multiple potential predictors of failure for endovascular procedures involving the aortoiliac segment; these can include a stenotic ipsilateral superficial femoral artery, ulcer/gangrene, smoking history, and chronic renal failure with hemodialysis. Additionally, there is some indication that patients with these risk factors who do undergo endovascular procedures in the aortoiliac segment should be considered for primary stenting.[3, 4]

A catheter-based approach is recommended as first-line therapy for TASC A and B lesions and likely is the preferred option for initial revascularization of type C lesions. Whether a patient receives an endovascular procedure or an operation for a TASC D lesion in great part depends on the treating clinician's experience, expertise, and comfort in either open procedures or advanced endovascular techniques. In a study covering 5,738 patients treated by AFB, 778 by iliofemoral bypass (IFB), and 1,490 by aortoiliac endarterectomy (AIE), Chiu et al. demonstrated an operative mortality rate for AFB, IFB, and AIE of 4.1%, 2.7%, and 2.7%, respectively, while the operative morbidity rate was 16% for AFB, 18.9% for IFB, and 12.5% for AIE. In further analysis according to clinical symptoms, the 5-year primary patency in cases of critical limb ischemia was 79.8%, 74.1%, and 81.7% for AFB, IFB, and AIE, respectively—significantly worse in comparison to 5-year patency rates for patients with intermittent claudication.[5]

The AFB remains the superior treatment of these lesions, and the advent of minimally invasive approaches to this procedure has enabled more acceptable deliveries, either by a totally laparoscopic or robotic abdominal procedure. These approaches not only reduce the convalescence period but also lead to fewer operative complications. It is important to note, however, that minimally invasive aortic surgery is technically demanding, and there are few individuals with expert skills in these operations.[6] We have initiated a training paradigm for robotic repair at The Methodist Hospital, with approximately 2 years of training that includes expert instruction and proctoring. However, this has not yet led to any clinical cases as we are still in the process of getting FDA approval. European experience with this procedure is certainly greater than it is in the United States, with the most extensive experience coming from Stadler and colleagues in the Czech Republic, who have reported encouraging outcomes for 150 robotic aortic repairs.[7] There is currently no U.S.-based program that performs these operations routinely; subsequently, only a handful of cases have been performed across the country.

The other major aortic inflow procedure is the descending thoracic aortofemoral bypass, which, due to its higher morbidity and mortality rates and lower patency rates, is strictly reserved as a last-resort option.

Some patients who require limb salvage inflow procedures are not treatable by endovascular techniques and may not necessarily be candidates for one of the more invasive aortic procedures described above due to physiologic reasons. These situations call for a less invasive operative procedure generally consisting of an extra-anatomical bypass with or without an adjunctive endovascular procedure, the so-called "hybrid" procedure. One such procedure is the femoral-femoral bypass (FFB), which historically was thought to have early failure due to an iliac stenosis on the donor side. A recent study of 247 patients with FFB demonstrated an increased usage of adjunctive iliac percutaneous transluminal angioplasty (PTA)/stent from 0% to 54% (over a period from 1984-2010), while the rate of axillofemoral bypass or no inflow stenting procedure decreased from 100% to 46%. Iliac PTA/stenting is associated with a decreased 5-year primary graft patency of 44% compared with 74% for axillofemoral bypass patients and 71% in patients who required no adjunctive inflow procedure. Patients with inflow iliac PTA/stents also have diminished 5-year assisted primary patency of 61% compared with 85% for axillofemoral bypass patients and 87% in patients who had no need for inflow revascularization. Five-year primary patency among claudicants and critical leg ischemia patients is similar at 65% and 68%, respectively, therefore extent of disease does not appear to impact patency.[8] Passman et al. found that axillobifemoral bypasses were comparable in patency to AFB at 5 years, but since patients who receive axillobifemoral bypasses are generally significantly more debilitated, their survival at 5 years is 45% versus 72% for ABF.[9]

There is a paucity of good data comparing covered versus bare expandable stents in the aortoiliac segment. The single prospective randomized controlled trial, the COBEST trail, found that lesions treated with covered stents were significantly more likely to remain free of restenosis than those treated with bare-metal stents (HR 0.35). Further subgroup analysis showed that while there was no difference for TASC B lesions, the difference was significant for both TASC C and D lesions.[10]

Failed Aortoiliac Stenting

Prior to embarking on endovascular interventions in the aortoiliac segments, it is imperative that the operator understands the pathophysiology and severity of inflow and/or outflow compromise. If there is inadequate flow in the infrainguinal segment, then early failure may occur. Similarly, if all proximal disease is left untreated, then the stent is more likely to be compromised. It has been shown in a 10-year follow-up that if one fails to extend treatment into the aorta for lesions that are at the aortic bifurcation, outcomes are generally inferior.[11] Figure 1 presents a patient who was treated initially with balloon angioplasty and then had covered stents placed in both common iliac arteries (CIA) extending into the external iliac arteries. Early stent occlusion and failure was simply due to incomplete management of the inflow disease. An aortic stenosis (Figure 1, solid black arrow) was demonstrated, and the patient underwent an AFB and a simultaneous femoral-popliteal bypass. This approach addressed all inflow issues and improves long-term prognosis for patency and limb salvage. In this setting, the aortic segment could likely have been treated successfully by a stent.

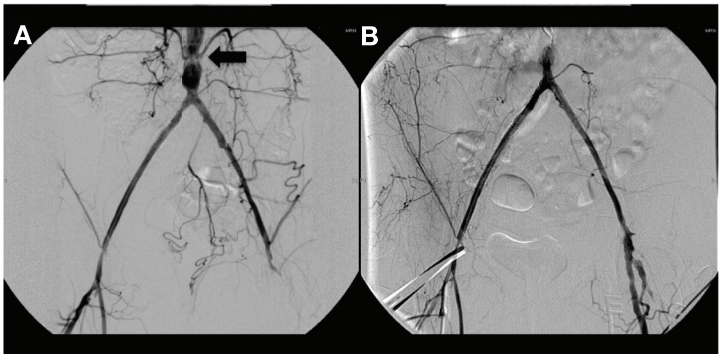

Figure 1. Patient with inadequately treated aortic disease. (A) Solid black arrow indicates an aortic stenosis. (B) Despite adequate treatment with iliac stents, failure persisted due to aortic inflow disease.

Treatment of Iliac Lesions to Support a Bypass

In this next example, an 83-year-old female presented with severe rest pain having had two prior failed femoral-femoral crossover bypasses performed by separate surgeons over an 8-month period. Basic principles dictate that inflow should always be corrected before performing a downstream bypass. Figure 2 shows a flush occlusion at the left common iliac artery. What the previous surgeons had failed to identify is a high-grade stenosis in the distal CIA as well as diffuse severe disease extending up into the distal aorta as determined by intravascular ultrasound (IVUS), which may not have seemed significant by angiography. The treatment approach undertaken for this patient, who actually had adequate outflow, was to attempt recanalization of the left side and then treat the right side with a balloon-expandable stent. Despite a re-entry device, recanalization of the left side was not fruitful. However, adequate treatment of the common iliacs (Figure 3) on the right side with a new femoral-femoral bypass was sufficient to provide the patient with adequate lower-extremity reperfusion.

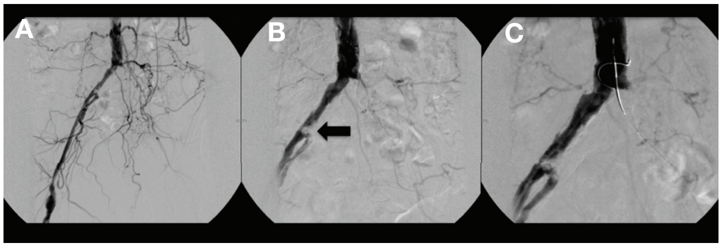

Figure 2. Patient with iliac disease and failed recanalization of left iliac. (A) Occluded left common iliac. (B) Solid arrow identifies high-grade right common iliac lesion. (C) Dedicated re-entry catheter used to cross left iliac occlusion.

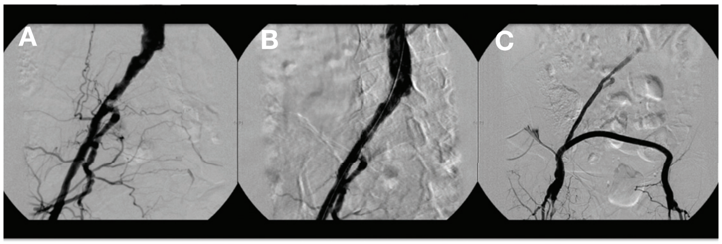

Figure 3. Right iliac stent with femoral-femoral bypass. (A) Lesion in distal right common iliac artery. (B) Lesion treated with balloon-expandable iliac stent. (C) Femoral-femoral bypass to perfuse left lower extremity.

Conclusions

As endovascular devices improve and vascular surgeons gain experience and confidence treating complex disease, limb salvage procedures will continue to trend towards an "endovascular first" approach. However, open procedures remain the gold standard against which all endovascular procedures will be measured. For successful limb salvage, it is imperative that physicians carefully evaluate each patient, taking into account the individual risks and benefits of the chosen procedure, and always keep in mind the basic tenets for successful interventions. Here we have described these basic tenets and given examples that highlight the important considerations in treating inflow disease. Addressing inflow to the lower extremities is fundamental to the management of peripheral arterial disease, since without inflow infrainguinal procedures are destined to fail.

Conflict of Interest Disclosure: All authors have completed and submitted the *Methodist DeBakey Cardiovascular Journal* Conflict of Interest Statement and none were reported.

Funding/Support: The authors have no funding disclosures.

Keywords: Iliac, aortoiliac, occlusive, ischemia, artery, inflow

References

1. Timaran CH, Prault TL, Stevens SL, Freeman MB, Goldman MH. Iliac artery stenting versus surgical reconstruction for TASC (TransAtlantic Inter-Society Consensus) type B and type C iliac lesions. J Vasc Surg. 2003 Aug;38(2):272-8.
2. Hans SS, DeSantis D, Siddiqui R, Khoury M. Results of endovascular therapy and aortobifemoral grafting for Transatlantic Inter-Society type C and D aortoiliac occlusive disease. Surgery. 2008 Oct;144(4):583-9; discussion 589-90.
3. Kudo T, Chandra FA, Ahn SS. Long-term outcomes and predictors of iliac angioplasty with selective stenting. J Vasc Surg. 2005 Sep;42(3):466-75.
4. Galaria II, Davies MG. Percutaneous transluminal revascularization for iliac occlusive disease: long-term outcomes in TransAtlantic Inter-Society Consensus A and B lesions. Ann Vasc Surg. 2005 May;19(3):352-60.
5. Chiu KW, Davies RS, Nightingale PG, Bradbury AW, Adam DJ. Review of direct anatomical open surgical management of atherosclerotic aorto-iliac occlusive disease. Eur J Vasc Endovasc Surg. 2010 Apr;39(4):460-71.
6. Duran C, Kashef E, El-Sayed HF, Bismuth J. Robotic aortic surgery. Methodist Debakey Cardiovasc J. 2011 Jul-Sep; 7(3):32-4.
7. Stádler P, Dvoracek L, Vitasek P, Matous P. Robotic vascular surgery, 150 cases. Int J Med Robot. 2010 Dec;6(4):394-8.
8. Huded CP, Goodney PP, Powell RJ, Nolan BW, Rzucidlo EM, Simone ST, et al. The impact of adjunctive iliac stenting on femoral-femoral bypass in contemporary practice. J Vasc Surg. 2012 Mar;55(3):739-45; discussion 744-5.
9. Passman MA, Taylor LM, Moneta GL, Edwards JM, Yeager RA, McConnell DB, et al. Comparison of axillofemoral and aortofemoral bypass for aortoiliac occlusive disease. J Vasc Surg. 1996 Feb;23(2):263-9; discussion 269-271.
10. Mwipatayi BP, Thomas S, Wong J, Temple SE, Vijayan V, Jackson M, et al.; Covered Versus Balloon Expandable Stent Trial (COBEST) Co-investigators. A comparison of covered vs bare expandable stents for the treatment of aortoiliac occlusive disease. J Vasc Surg. 2011 Dec;54(6):1561-70.
11. Zukauskas G, Ulevicius H, Janusauskas E. An optimal inflow procedure for multi-segmental occlusive arterial disease: ilio-femoral versus aorto-bifemoral bypass. Cardiovasc Surg. 1998 Jun;6(3):250-5.