Autologous and synthetic pediatric iliofemoral reconstruction: a novel technique for pediatric iliofemoral artery reconstruction

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ABSTRACT

Pediatric lower extremity arterial catheterization-related injuries can result in significant long-term morbidity. Revascularization is challenging due to concerns for long-term patency and growth accommodation with synthetic grafts. We describe a novel technique for iliofemoral revascularization using common iliac artery transposition and bridging polytetrafluoroethylene grafts. We treated two children who underwent femoral catheterization resulting in lifestyle-limiting claudication. Both patients experienced immediate resolution of symptoms. Postoperative imaging demonstrated widely patent vasculature. ASPIRE (autologous and synthetic pediatric iliofemoral reconstruction) is a method of pediatric iliofemoral artery revascularization that allows for an autologous artery to span the hip joint, reducing graft thrombosis risk and accommodating patient growth. (J Vasc Surg Cases Innov Tech 2024;10:101413.)

Keywords: Iliofemoral reconstruction; Novel technique; Pediatric revascularization

Pediatric femoral arterial injuries can have devastating long-term consequences.[1,2] The majority of severe pediatric vascular injuries are iatrogenic, with an incidence of femoral arterial occlusion after cardiac catheterization estimated at a rate of 0.7% in the United States.[1-6] The initial signs of occlusive femoral arterial injury include the loss of distal pulses.[6-8] However, detection can be difficult in children due to extensive collateralization.[3] As a result, children present years later with symptoms of chronic arterial occlusion, such as limb-length discrepancies and claudication.[3,5,8]

Arterial revascularization in children is challenging due to small vessel size and concerns over durability and patency.[1,8] We present a novel technique for pediatric arterial revascularization for chronic femoral artery occlusion using the common iliac artery (CIA) as an autologous bypass conduit to span the hip joint in combination with a bridging synthetic polytetrafluoroethylene (PTFE) graft within the iliac fossa.

The patients and their guardians provided written informed consent for the report of their case details and imaging studies.

CASE REPORT

Patient 1. Patient 1 is a 6-year-old boy with history of aortic stenosis and coarctation requiring balloon angioplasty on day of life 11, resulting in a chronically occluded left external iliac artery (EIA) causing activity-limiting left lower extremity claudication, atrophy of his left lower extremity muscles, and a 1-cm limb-length discrepancy. On examination, his left foot appeared warm and well-perfused, but he had absent pulses in the left groin. A computed tomography angiogram (CTA) revealed left EIA occlusion with significant collateralization and reconstitution of flow at the distal common femoral artery (CFA; Fig 1, *A*). Venous ultrasound showed bilateral saphenous veins measuring <2 mm in size. Given the lack of a suitable vein conduit for bypass and concerns for long-term patency with use of a synthetic graft across the hip joint, we proposed transposing the left CIA to the CFA as a bypass graft across the hip joint and placing a synthetic PTFE graft to bridge the gap from the transposed CIA.

Intraoperatively, an occluded left EIA was identified, with intact bilateral CIAs and internal iliac arteries (IIAs) maintaining pelvic perfusion. The occluded left EIA was resected to reduce tension. The CIA was ligated just distal to the aortic bifurcation and transposed under the inguinal ligament where an end-to-side anastomosis was performed between the transposed CIA and the CFA. The left IIA was ligated to facilitate transposition. To bridge the gap between the aortic bifurcation to the proximal end of the transposed CIA, a 6-mm PTFE graft was anastomosed in an end-to-end fashion. The graft was oversized to accommodate future growth.

Postoperatively, the patient experienced immediate relief of his claudication symptoms, without any additional symptoms of buttock claudication despite IIA ligation. Doppler signals were present at all levels, with palpable dorsalis pedis (DP) and posterior tibial (PT) pulses. Magnetic resonance angiography continued to show a widely patent bypass at the 6-month and 5-year follow-up visits (Fig 1, *B* and *C*, respectively). A depiction

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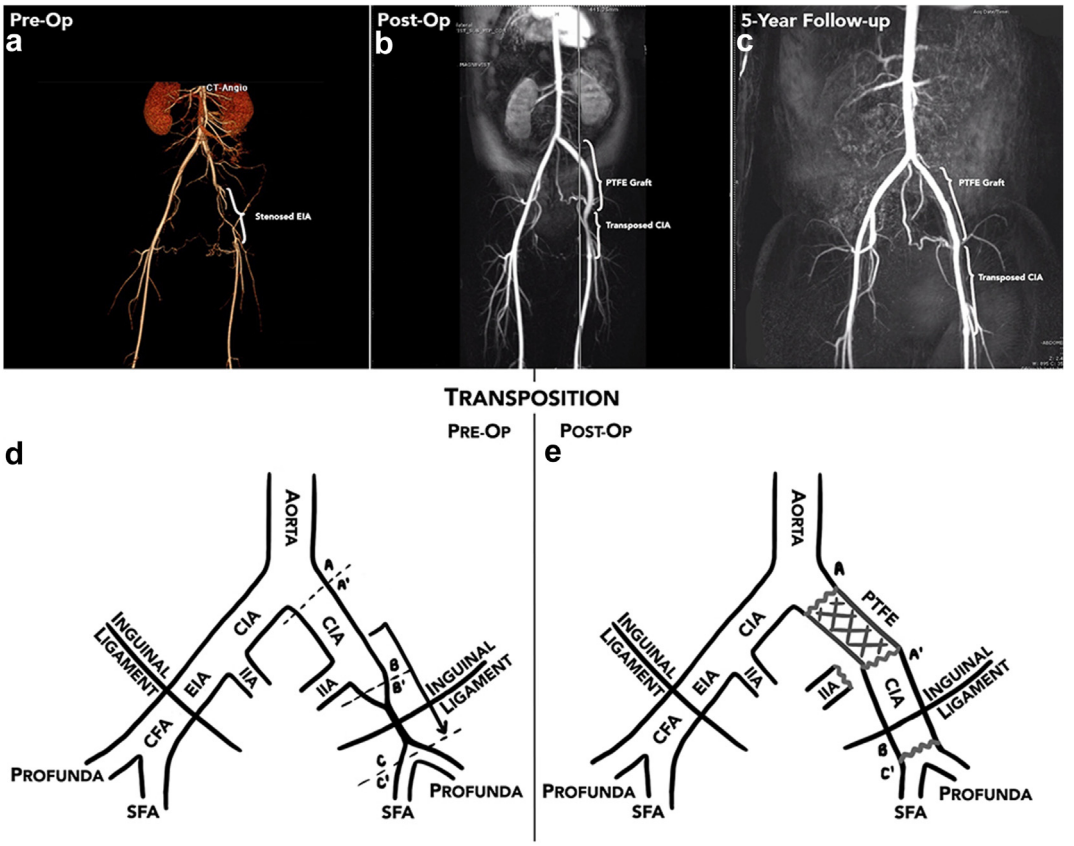

Fig 1. A, Patient 1 developed an occluded left external iliac artery (EIA) with an unaffected contralateral iliac system. **D,E,** The stenotic left EIA was resected. The common iliac artery (CIA) was ligated distal to the aortic bifurcation and transposed under the inguinal ligament, where an end-to-side anastomosis was performed between the transposed CIA and the common femoral artery (CFA). A polytetrafluoroethylene (PTFE) graft was anastomosed in an end-to-end fashion to bridge the gap between the aortic bifurcation to the transposed CIA. **B,** Postoperative imaging demonstrated widely patent bilateral lower extremity vasculature. **C,** At the 5-year follow-up, the previously oversized PTFE conduit appears to be of appropriate diameter and length. *IIA,* Internal iliac artery; *SFA,* superficial femoral artery.

of the pre- and postoperative anatomy is shown in Fig 1, *D and E*. Patient 1 continued to experience complete resolution of his claudication at the 5-year follow-up. Despite maintaining a 1-cm limb-length discrepancy, he enjoys an active, pain-free lifestyle.

Patient 2. Patient 2 is a 10-year-old girl with history of aortic coarctation who underwent multiple catheterization procedures throughout childhood for dilation of her coarctation and attempted dilation of her stenotic EIAs. As a result, she had bilateral EIA occlusion with collateralization and reconstitution of the CFAs distally. She presented to our clinic with symptoms of severe lower extremity pain awaking her from sleep and numbness and weakness that limited her walking. On examination, her feet were warm with good capillary refill, but she had nonpalpable femoral, PT, and DP pulses bilaterally. A CTA demonstrated bilaterally occluded EIAs with reconstitution of the CFAs bilaterally near the level of the inguinal ligaments (Fig 2, *A*). Because the patient had bilateral disease, preservation of at least one IIA was necessary to maintain pelvic perfusion. We proposed rotating the bilateral CIAs to the CFAs as bypass conduits across the hip joint and placing bilateral synthetic grafts to bridge the gap from the rotated CIAs to the aortic bifurcation.

Intraoperatively, the bilateral occluded EIAs were identified with intact bilateral CIAs and IIAs. The occluded EIAs were resected. Both CIAs were ligated just distal to the aortic bifurcation and rotated caudally under the inguinal ligament. End-to-side anastomoses were performed between the rotated CIAs and the CFAs. To bridge the gap between the aortic bifurcation to the rotated CIA, an oversized PTFE graft was anastomosed in an end-to-end fashion on each side. Both IIAs were maintained.

Postoperatively, patient 2 experienced immediate relief of her symptoms. Doppler signals were present at all levels, and her PT and DP pulses were palpable bilaterally. A CTA on postoperative day 5 demonstrated widely patent bilateral lower extremity vasculature (Fig 2, *B*). A repeat CTA at the 6-month follow-up continued to demonstrate patent flow through the grafts and in her bilateral lower extremities (Fig 2, *C*). A depiction of the pre- and postoperative anatomy is shown in Fig 2, *D and E*.

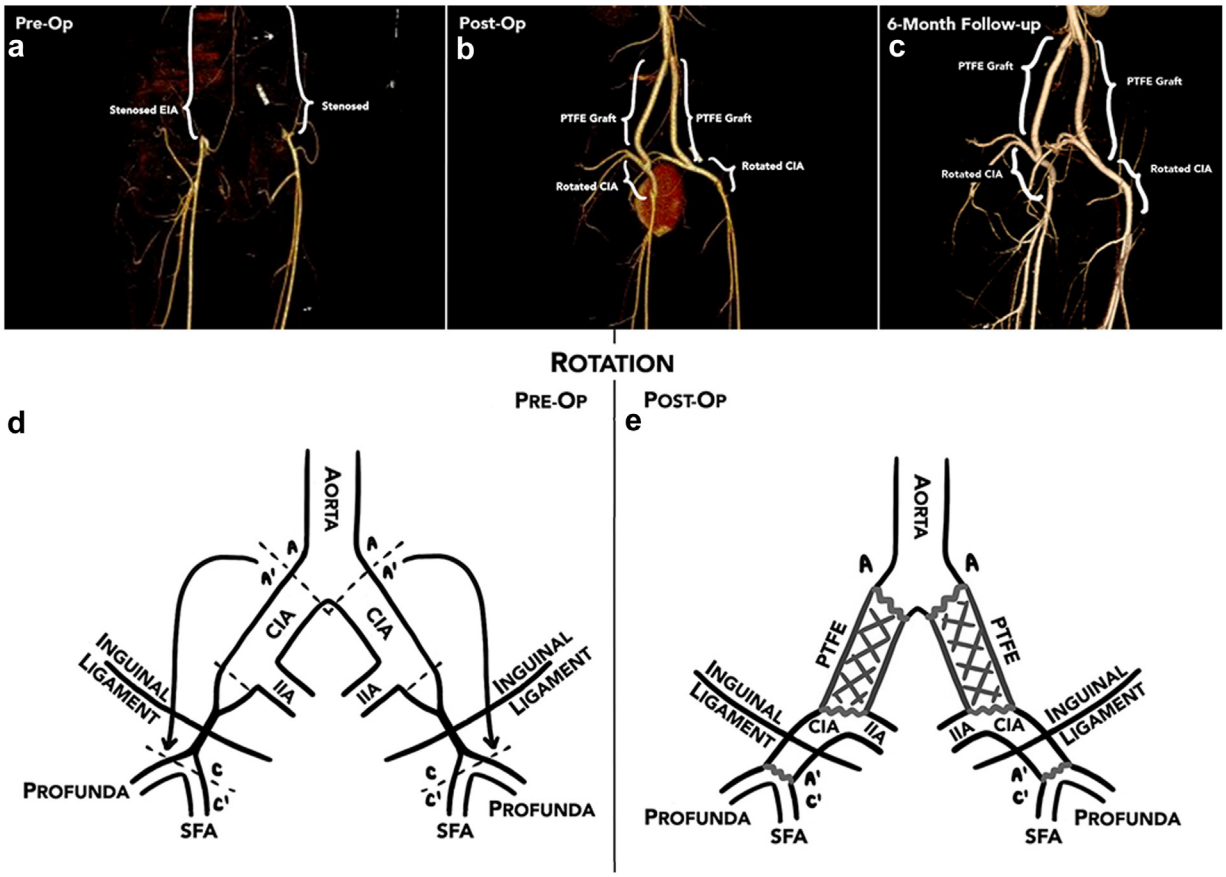

Fig 2. A, Patient 2 had bilateral external iliac artery (EIA) occlusion, which necessitated preservation of at least one internal iliac artery (IIA) to maintain pelvic perfusion. **D,E,** The stenotic EIAs were resected. Both common iliac arteries (CIAs) were ligated just distal to the aortic bifurcation and rotated caudally under the inguinal ligament. End-to-side anastomoses were performed between the rotated CIAs and the common femoral arteries (CFAs). To bridge the gap between the aortic bifurcation to the rotated CIAs, a polytetrafluoroethylene (PTFE) graft was anastomosed in an end-to-end fashion on each side. **B,C,** Postoperative imaging demonstrated widely patent bilateral lower extremity vasculature.

Patient 2 continues to experience significant improvement from her preoperative claudication pain.

DISCUSSION

Pediatric femoral arterial catheterization injuries can lead to long-term complications, such as limb-length discrepancies and function-limiting claudication.[1-3,5,8] Due to the small vessel size and concerns over durability and patency, pediatric arterial revascularization remains a technically challenging surgical problem.[1,8] Previous reports in the literature have indicated success in pediatric arterial revascularization using both autologous and synthetic bypass conduits.[3,9-13] Dilation, occlusion, and stenosis are known complications associated with great saphenous vein graft use, and occlusion is associated with synthetic PTFE graft use.[9,12,13]

We developed autologous and synthetic pediatric iliofemoral reconstruction (ASPIRE) to address concerns of graft durability and patency with pediatric arterial revascularization. Due to the proximity of the occluded vessel to the hip joint, placement of a synthetic PTFE graft across this joint space would subject the graft to the repeated stress of bending with each hip flexion action.[14] We believe that positioning the PTFE graft within the retroperitoneum in a nonmoving position could reduce the mechanical issues associated with spanning the hip joint. Furthermore, we intentionally oversize this graft to allow for future growth accommodation through estimation of the diameter and length that the vessel would need to be after our patients reach adulthood. In the absence of clinical symptoms, we limit ionizing radiation in our pediatric patients and perform imaging studies of our patients only as needed.

The limitations of ASPIRE include the need for an additional vascular anastomosis during repair, adding to the technical challenges and operative time of this procedure. Alternatives to ASPIRE include simple replacement of the stenotic EIA segments with a great saphenous vein or synthetic PTFE graft spanning the hip joint and nonoperative symptomatic management of

lifestyle-limiting claudication and limb-length discrepancy. We believe ASPIRE might be preferable to these options, because our patients remain free of their life-limiting claudication symptoms and continue to have patent vasculature despite continued growth. However, given the small cohort of patients treated with ASPIRE, further work is needed to definitively determine the optimal procedure for these patients.

CONCLUSIONS

ASPIRE is a novel surgical technique developed for the treatment of catheter-related vascular injuries that allows for an autologous artery to span the hip joint to improve patency and accommodate for growth over a lifetime.

DISCLOSURES

None.

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