JACC: CASE REPORTS VOL. 30, NO. 34, 2025

CASE REPORT

HOW WE DID IT

Kidney Autotransplantation and "Debranch-First" Technique for Thoracoabdominal Stent-Graft Infection

Surgical Management of a 22-Year-Old Man With Midaortic Syndrome and Infection of Aortic and Renal Stent Grafts

Pietro Dioni, MD, Apollonia Verrengia, MD, Andrea Melloni, MD, Franco Nodari, MD, Stefano Bonardelli, MD, Luca Bertoglio, MD

ABSTRACT

OBJECTIVE To present the surgical management of a 22-year-old patient with midaortic syndrome, symptomatic for claudication and renovascular hypertension, with infected aortic and renal stent grafts.

KEY STEPS Procedures were performed as follows: 1) right renal autotransplantation through a transperitoneal approach and midline abdominal incision; 2) thoracotomy with left visceral rotation and visceral vessel exposure; 3) left-heart bypass and "debranch-first" technique, with warm blood perfusion for the splanchnic vessels and cold Custodiol solution for renal perfusion; 4) aortic replacement with a tubular xenopericardium graft; and 5) separate reattachment of visceral vessel to the main tubular graft.

POTENTIAL PITFALLS Recurrent infections of the xenopericardium graft, kidney parenchyma loss, and major complications such as spinal cord ischemia, represent potential pitfalls to this procedure.

TAKE-HOME MESSAGE Kidney autotransplantation allows right renal–infected stent graft removal before in situ thoracoabdominal reconstruction through left thoracoabdominal access, preserving renal function against renovascular hypertension. (JACC Case Rep. 2025;30:105530) © 2025 The Authors. Published by Elsevier on behalf of the American College of Cardiology Foundation. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

Midaortic syndrome (MAS) is a unique disease whose etiology is often unknown, representing 0.5% to 2% of aortic stenotic lesions in the young population.[1] It is one of the rarest causes of secondary hypertension and chronic kidney disease,[2] and its main feature is stenosis of the proximal abdominal aorta and its side branches. Extrarenal symptoms are caused by insufficient blood flow to the abdominal organs and increased resistance and include intermittent bilateral claudication abdominal angina and heart failure.[3,4] We present the clinical and surgical approach used in a young man with complicated MAS and infected aortic and renal stent grafts.

From the Division of Vascular Surgery, Department of Experimental and Clinical Sciences, University of Brescia, Brescia, Italy.
The authors attest they are in compliance with human studies committees and animal welfare regulations of the authors' institutions and Food and Drug Administration guidelines, including patient consent where appropriate. For more information, visit the Author Center.

Manuscript received October 17, 2024; revised manuscript received May 6, 2025, accepted August 11, 2025.

ISSN 2666-0849 https://doi.org/10.1016/j.jaccas.2025.105530

ABBREVIATIONS AND ACRONYMS

FDG-PET = 18F-fluorodeoxyglucose positron emission tomography

MAS = midaortic syndrome

CASE SUMMARY

A 22-year-old man with MAS was treated at a peripheral hospital in 2018 with aortic and bilateral renal stenting in multiple operations. A self-expandable 14-mm stent was deployed in the stenotic visceral aortic lumen to improve kidney function in the first place. In 2019, recurrent bilateral renal restenosis required renal stenting, and in 2020, recurrent symptoms required proximal extension above the splanchnic vessel origin using cover stents owing to intraoperative aortic rupture. Lastly, in 2021 the patient underwent drug-eluting balloon angioplasty, with suboptimal angiographic result. After initial improvement, his blood pressure became uncontrollable despite 5 hypertensive medications, and creatinine clearance decreased by 50% in <1 year. Moreover, he experienced bilateral short-interval intermittent claudication and a weight loss of 10 kg in 9 months. The patient was referred to our department owing to recurrence of fever of unknown origin, sepsis, and 2 aortic pseudoaneurysms.

INVESTIGATION

Blood cultures tested positive for methicillin-resistant *Staphylococcus aureus*, and transesophageal echocardiography ruled out endocarditis. Imaging showed proximal occlusion of the celiac trunk and critical stenosis of the superior mesenteric artery, with the inferior mesenteric artery being the largest splanchnic artery supplying the abdominal organs (**Figure 1**, Video 1). Angiography revealed bilateral renal artery involvement in severe in-stent restenosis (**Figure 2**, Video 2). Two 1.5-cm aortic blebs were identified, one at the proximal edge and the other at the distal edge of the aortic stent. An 18F-fludeoxyglucose positron emission tomography (FDG-PET) scan showed increased metabolism around the proximal edge of the aortic stent and around the renal arteries (**Figure 3**). Aortic and renal stent-graft infection was suspected, and the patient was scheduled for stent-graft explant and aortic replacement.

PROCEDURAL STEPS

Procedures were performed in the following order.

RIGHT RENAL NEPHRECTOMY. We employed the technique proposed to resolve renovascular hypertension in patients with MAS.[5] Blood pressure in the right femoral artery was monitored to assess whether the iliac artery was adequate to receive the autotransplant. Dissection and partial clamping of the aorta and vena cava was performed after the Kocher maneuver. Simultaneously, dissection of the right iliac axis was performed, accessing the retroperitoneum. The common, internal, and external iliac vessels were isolated, ensuring preservation of the distal segment of the ureter.

BENCH PREPARATION AND AUTOTRANSPLANTATION. After nephrectomy, the right kidney was perfused with 4 °C Custodiol solution (**Figure 4A**). Venous anastomosis was performed on the right common iliac vein, followed by arterial anastomosis to the right common iliac artery (**Figure 4B**). The ureter was reconstructed in an end-to-end fashion using absorbable sutures, and a double-curved ureteral stent was left in place for 7 days postoperatively. The midline abdominal incision was provisionally sutured, as the patient was transferred to the intensive care unit, and a cerebrospinal fluid drain was positioned the day before aortic repair to maintain fluid pressure below 10 mm Hg.

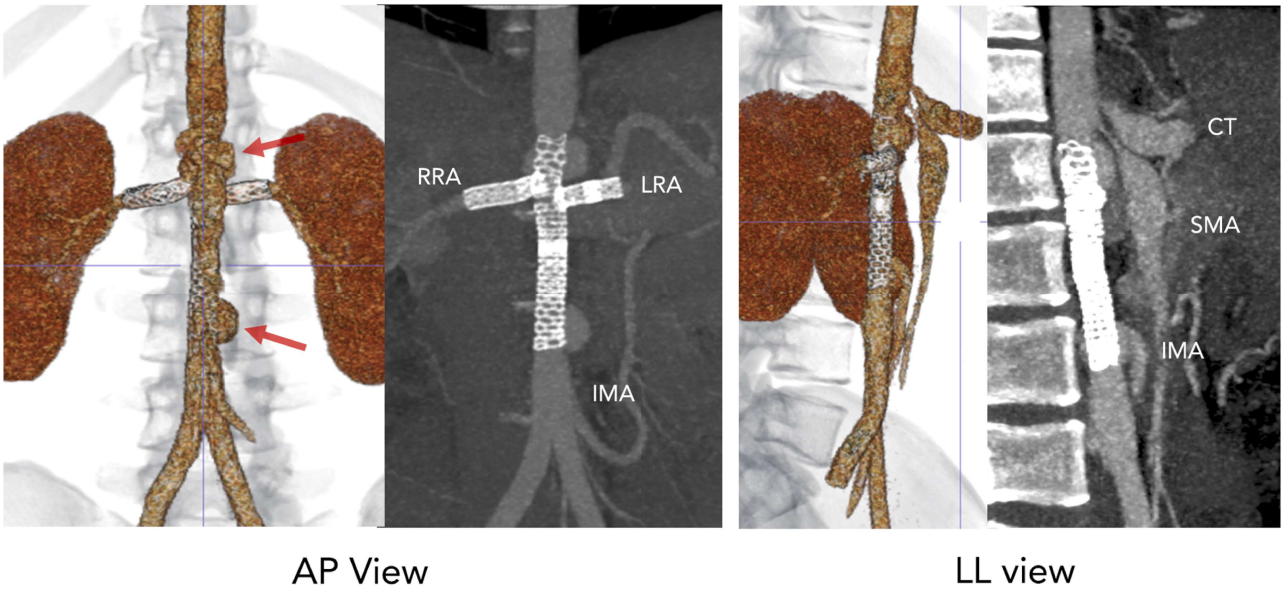
THORACOTOMY. The next day, the abdominal incision was extended proximally and laterally into the 7th intercostal space through thoraco-phreno-laparotomy. Cryoablation of 4 intercostal nerves (2 above and 2 below the incision) was performed for postoperative pain control. The diaphragm was partially sectioned, sparing the central tendon and main nerve roots, exposing the descending thoracic aorta. Left visceral rotation allowed vascular control of the abdominal aorta and its visceral branches (Video 3).

DEBRANCH-FIRST TECHNIQUE AND LEFT HEART BYPASS SEQUENCES. Contrary to the classic thoracoabdominal repair technique, which features aortic sewing followed by vessel cannulation and anastomoses, the debranch-first technique allows visceral vessel perfusion and bypass before aortic resection (Video 4).[6] Uninterrupted pulsatile blood flow to the right iliac axis during reconstruction of visceral

TAKE-HOME MESSAGE

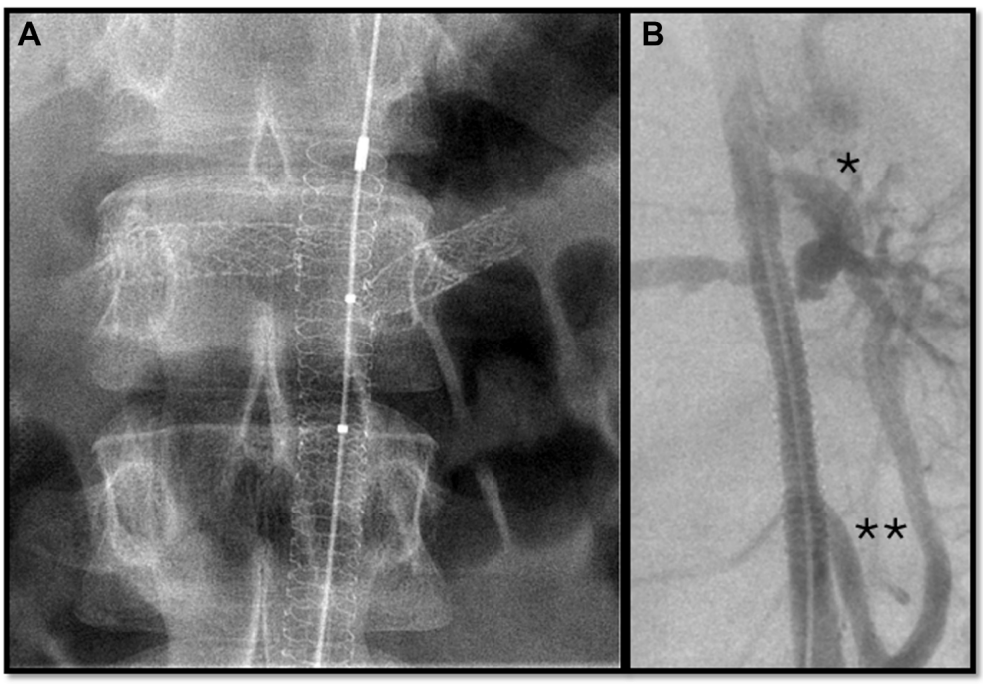
- The "debranch first" technique can be safely applied to visceral aorta reconstruction and, together with kidney autotransplantation, can be part of the surgeon's portfolio in the management of complex thoracoabdominal graft infections after complex endovascular reconstruction.

FIGURE 1 Images Obtained From CTA



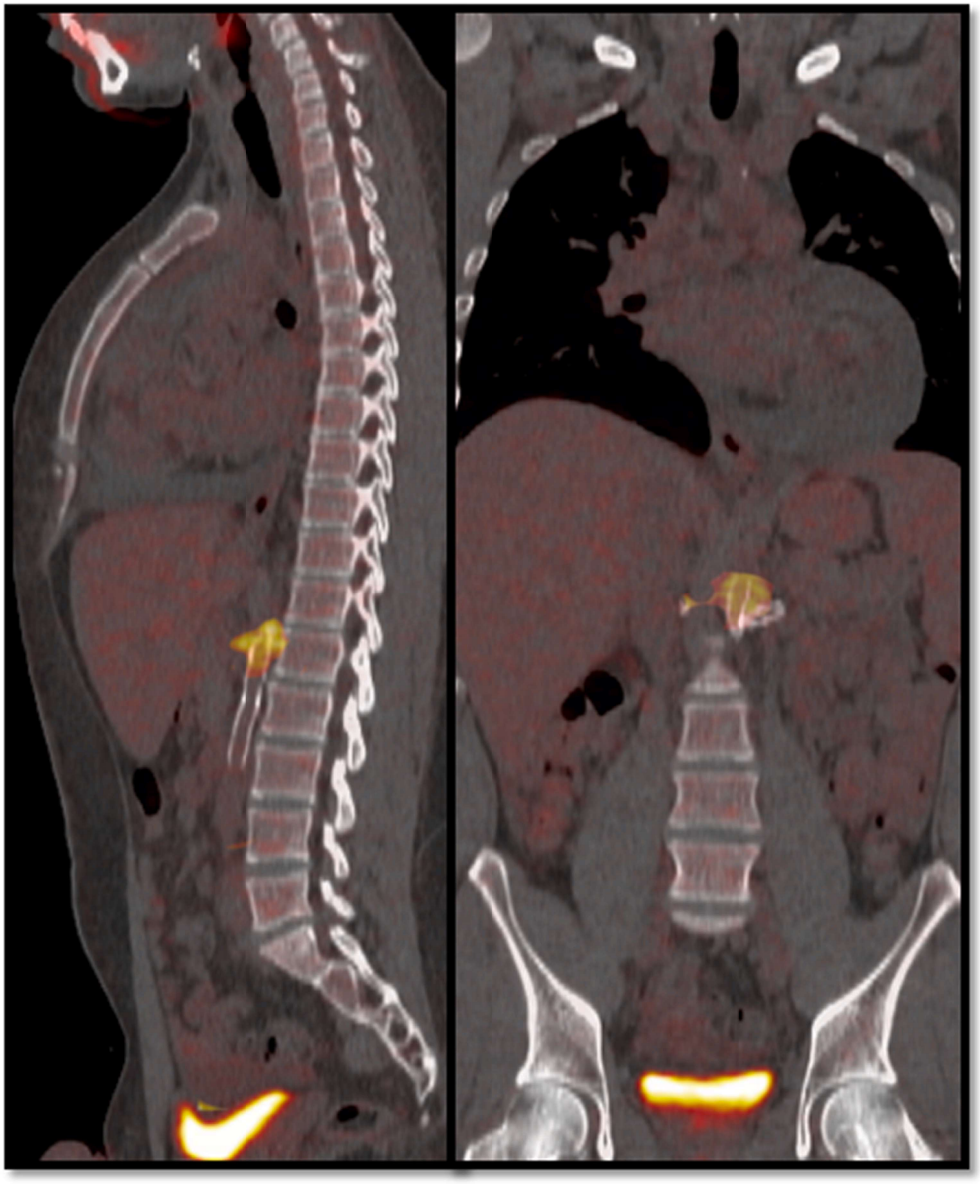
(Left) AP view showing 2 aortic pseudoaneurysms (arrows) and in-stent restenosis of the right and left renal arteries. (Right) LL view showing stenotic origin of the celiac trunk and superior mesenteric artery as well as hypertrophic inferior mesenteric artery. AP = anteroposterior; CT = celiac trunk; CTA = computed tomography angiography; IMA = inferior mesenteric artery; LL = latero-lateral; LRA = left renal artery; RRA = right renal artery; SMA = superior mesenteric artery.

FIGURE 2 Angiographic Preoperative Findings



(A) Bilateral renal artery stent and aortic stent graft. (B) Angiography showing superior mesenteric artery stenosis (*) and Inferior mesenteric artery hypertrophy (**).

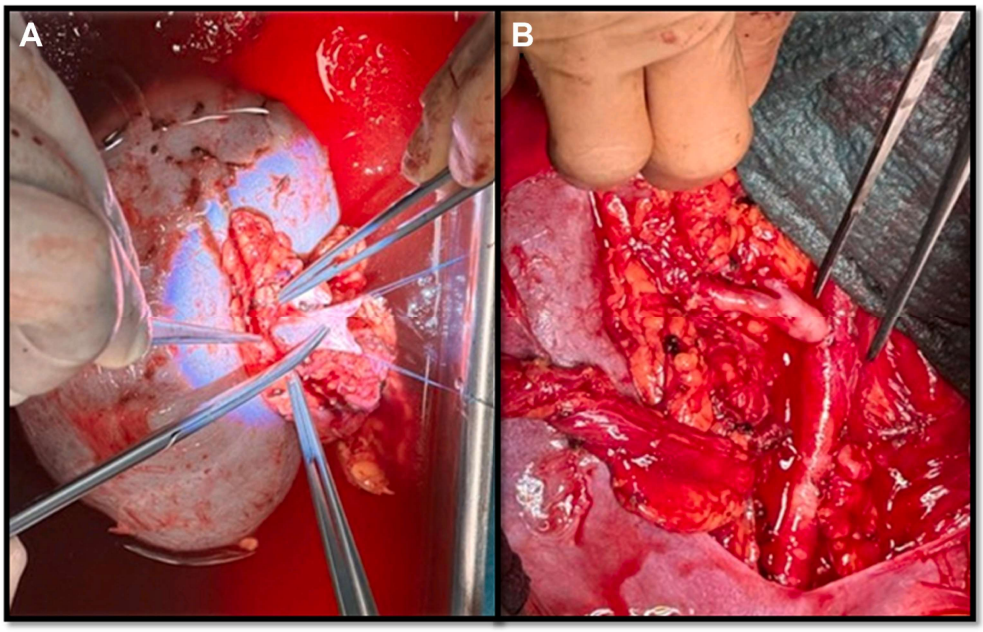
FIGURE 3 **Augmented Metabolism Around Aortic and Renal Stent Grafts Shown on FDG-PET**



FDG-PET = 18F-fluodeoxyglucose positron emission tomography.

vessels favored the preservation of the transplanted kidney and ensured distal preparation of the stenotic visceral vessels without prolonged organ ischemia. Blood from the left inferior pulmonary vein was suctioned with a 20-F cannula and reinfused into the right femoral artery to ensure continuous flow to the autotransplanted right kidney and the pelvis, reducing the risk of spinal cord ischemia. The femoral reperfusion was obtained by using an 8-mm Dacron conduit, which was sutured to the femoral artery and connected to a 20-F cannula to avoid direct femoral cannulation and its possible interferences with kidney perfusion. The splanchnic vessels were sequentially sectioned and elongated

FIGURE 4 Right Kidney Bench Preparation



(A) Right renal artery reconstruction. (B) End-to-side anastomosis of the right renal artery on the right common iliac artery.

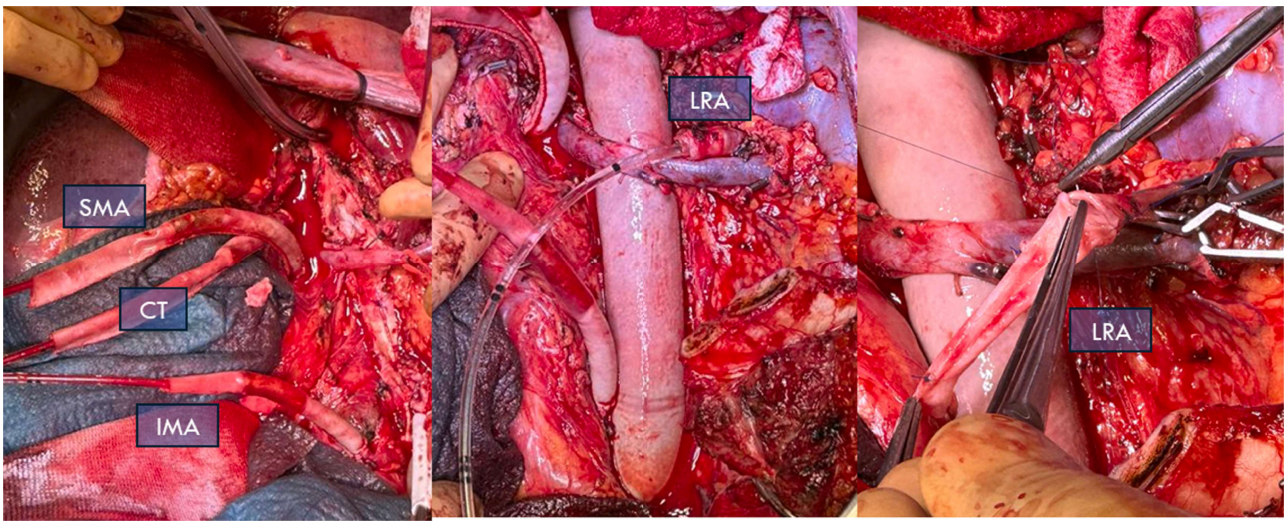
with 6-mm pericardium tubes, as the autologous great saphenous veins were inadequate in both caliber and length (**Figure 5**). Warm blood selective perfusion was initiated with Pruitt-Inahara 9-F perfusion/occlusion catheters (LeMaitre Vascular, Inc). Lastly, the left renal artery was transected distally to the stent, perfused with Custodiol solution, and elongated with a great saphenous vein graft to address the caliber mismatch between the pericardium tubule and the renal artery. The procedure was conducted using a blood cell saver and rapid infusion to minimize blood loss, maintaining hemoglobin levels above 10 g/dL. The possibility of switching to partial cardiopulmonary bypass was always an option by adding femoral venous cannulation in case of excessive blood loss.

AORTIC REPLACEMENT. The aorta was cross-clamped above the diaphragm and at the level of the bifurcation. Upon performing a longitudinal aortotomy, no backflow from the intercostals was observed. The infected grafts were removed, and the aorta was replaced with a presutured 22-mm pericardium tubular graft (Video 5). During the distal anastomosis, above the aortic bifurcation, we preserved a patent hypertrophic sacral artery. Visceral arteries were sequentially reattached on the main graft in an end-to-side fashion (Video 6). Thromboelastography was used to guide transfusion therapy, offering targeted therapy for coagulopathy during and at the end of the procedure.

PERIOPERATIVE OUTCOME AND FOLLOW-UP

Postoperatively, the patient was monitored in the intensive care unit for 3 days and was discharged on postoperative day 13, under 2 oral hypertensive medications. Postoperative physical examination revealed palpable femoral and peripheral pulses, and triphasic Doppler waveforms were bilaterally present. Cultures from the explanted grafts were positive for methicillin-resistant *S. aureus*, therefore oral antibiotics were continued for 1 year. At the 6-months follow-up, computed tomography angiography showed conserved patency of all visceral vessels apart from the celiac trunk, which occluded (**Figure 6**, Video 7). Yearly follow-ups were planned thereafter. No sign of increased metabolism was

FIGURE 5 **Splanchnic Vessel Elongation With 6-mm Pericardium Tubules and Selective Blood Perfusion as Part of the "Debranch-First" Technique and Cold Perfusion With Custodiol Solution in the Left Renal Artery**



Abbreviations as in Figure 1.

seen on follow-up FDG-PET. The patient was discharged with a creatinine value of 1.8 mg/dL, which became normal after 6 months. At present, his hypertension is controlled with 1 oral medication.

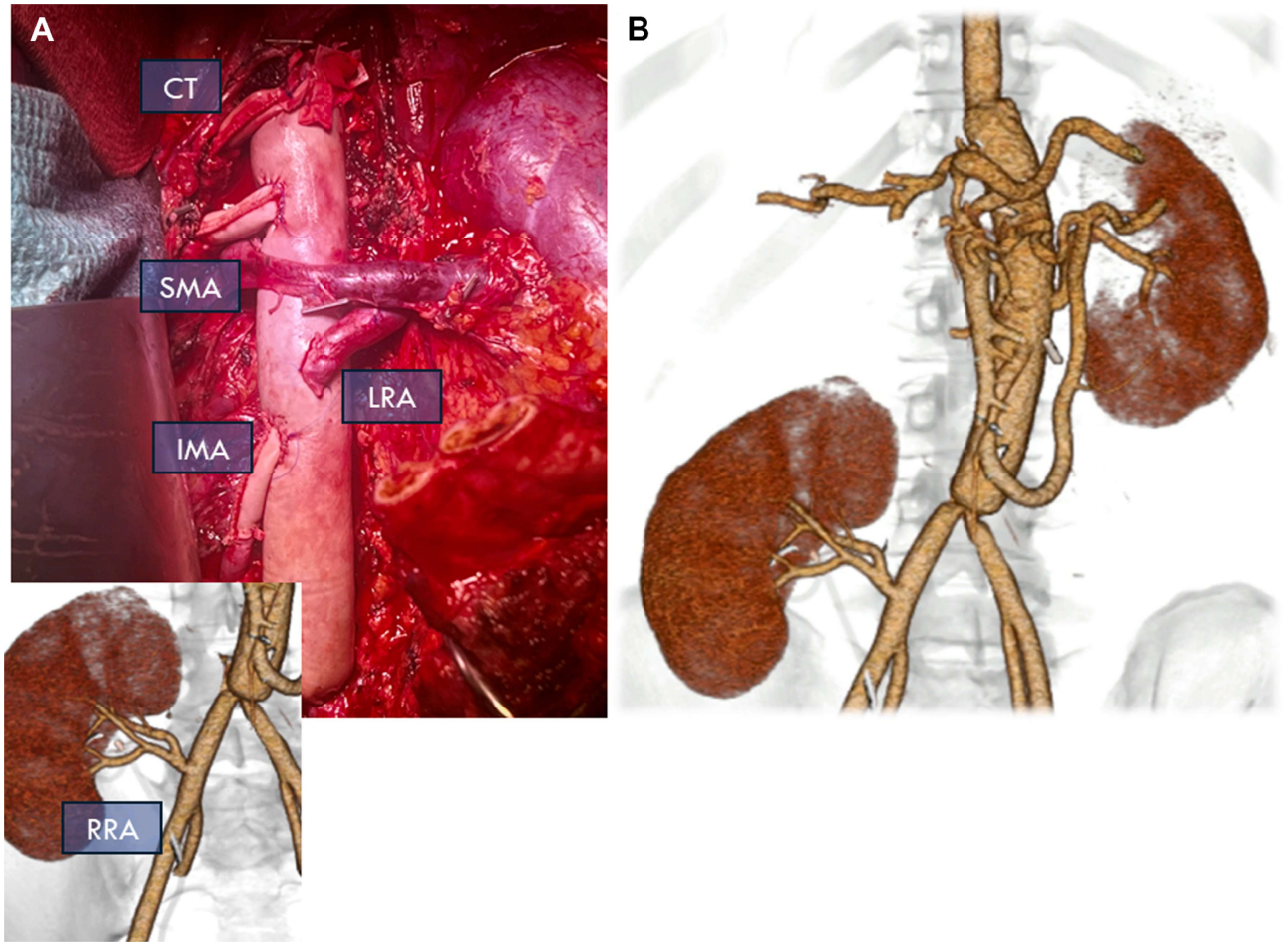
DISCUSSION

Contemporary management of MAS includes medical therapy, endovascular surgery, and open surgery. Hypertensive medications are considered the first line of treatment for symptomatic MAS, leaving endovascular and open surgery as second options.[3] Endovascular solutions include percutaneous balloon angioplasty and stenting of the aorta and visceral arteries. Most published studies suggest that endovascular therapy provides a temporary solution to hypertension and kidney function deterioration, as patients undergo multiple reinterventions (median: 1.6-2.0).[7] In some patients, blood pressure control is not achieved despite medical and endovascular therapy, making open surgery necessary, although it should not be performed until completion of puberty according to most authors.[7] Procedures include aortic replacement and bypass to the renal or splanchnic arteries. Single renal autotransplantation or nephrectomy are also possible solutions when medical therapy and endovascular solutions fail. Open surgery is thought to provide a definitive solution to MAS, although complications and reintervention rates are not reported.

Although aortic reconstructions with different materials, such as rifampin-soaked Dacron grafts,[8] cryopreserved allografts, and autologous femoral veins,[9] are comparable to pericardium in terms of reinfections and mortality, xenopericardial graft degeneration is a possible complication in this patient, under-reported in the literature. The limited availability of cryopreserved allografts and limited experience with rifampin-soaked Dacron led us to the use of pericardium in this case. Furthermore, we believed that bilateral femoral vein harvesting could have resulted in increased blood loss and prolonged procedural time, possibly increasing the risk of spinal cord ischemia. Additionally, we were concerned about damaging the transplanted kidney by harvesting the right femoral veins.

In the event of inadequate blood pressure in the femoral artery preoperatively, we would have performed the right nephrectomy followed by cold automated perfusion in a sterile machine, awaiting

FIGURE 6 Complete Visceral Aorta Reconstruction With Pericardium Graft



(A) Splanchnic vessels, including the inferior mesenteric artery and the left renal artery, are attached to the tubular graft in an end-to-side fashion. (B) Three-dimensional reconstruction of postoperative CTA images showing the right kidney in the right iliac fossa. Abbreviations as in Figure 1.

aortic replacement. Once the autotransplantation was completed, we assessed organ perfusion by invasive pressure monitoring of the right femoral artery. In case of overnight kidney malperfusion, our bailout strategy would have been to anticipate aortic replacement. Long-term results of autotransplantation has shown that 90% of patients retain normal kidney function at a median follow-up of 73.5 months.[10]

CONCLUSIONS

Vascular reconstructions of the thoracoabdominal aorta are technically demanding, especially in the presence of vascular graft infection (Video 8). In order to avoid devastating pitfalls, extensive knowledge of different surgical techniques is required; therefore, they should only be performed in experienced centers.

FUNDING SUPPORT AND AUTHOR DISCLOSURES

The authors have reported that they have no relationships relevant to the contents of this paper to disclose.

ADDRESS FOR CORRESPONDENCE: Dr Pietro Dioni, Division of Vascular Surgery, Department of Experimental and Clinical Sciences, University of Brescia, Piazza Spedali Civili 1, Brescia 25123, Italy. E-mail: p.dioni001@studenti.unibs.it OR pietrodioni97@gmail.com.

REFERENCES

1. Swerdlow RH, Burns JM. Midaortic syndrome: 30 year experience with medical, endovascular and surgical management. *Biochim Biophys Acta*. 2014;8:1219-1231.

2. Sethna CB, Kaplan BS, Cahill AM, Velazquez OC, Meyers KEC. Idiopathic mid-aortic syndrome in children. *Pediatr Nephrol*. 2008;23:1135-1142.

3. Brunet-Garcia L, Prada Martínez FH, Lopez Sainz A, Sanchez-de-Toledo J, Carretero Bellon JM. Mid-aortic syndrome in a pediatric cohort. *Pediatr Cardiol*. 2023;44:168-178.

4. Zhao L, Zhu L, Zhao Q-M, et al. Mid-aortic syndrome: a rare cause of heart failure in infants. *ESC Hear Fail*. 2022;9:3619-3624.

5. Juan PC, Durán V, Burek C, et al. Renal autotransplantation for the treatment of renovascular hypertension in the pediatric population. *J Pediatr Urol*. 2011;7:378-382.

6. Hiremath N, Bhatnagar G, Mapara K, Younes H, Park WM. Hybrid repair of type II thoracoabdominal aortic aneurysm using modified branch-first technique. *J Vasc Surg Cases Innov Tech*. 2023;9:101105.

7. Tummolo A, Marks SD, Stadermann M, et al. Mid-aortic syndrome: long-term outcome of 36 children. *Pediatr Nephrol*. 2009;24:2225-2232.

8. Tabiei A, Cifuentes S, Glasgow AE, et al. Cryopreserved arterial allografts vs rifampin-soaked Dacron for the treatment of infected aortic and iliac grafts. *J Vasc Surg*. 2023;78:1064-1073.e1.

9. Voit A, Commander SJ, Anjorin AC, Williams Z. Outcomes following in situ reconstruction for aortic infection with the neo-aortoiliac system and aortic homograft. *Ann Vasc Surg*. 2023;90:93-99.

10. Tran G, Ramaswamy K, Chi T, Meng M, Freise C, Stoller ML. Laparoscopic nephrectomy with autotransplantation: safety, efficacy and long-term durability. *J Urol*. 2015;194:738-743.

KEY WORDS aorta, claudication, hypertension, infection, kidney transplantation, thoracotomy

APPENDIX For supplemental videos, please see the online version of this paper.