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Extra-Anatomical Aortic Bypass for Infected Aortic Arch Stent Graft: A Case Series

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Statistical Analysis C
Data Interpretation D
Manuscript Preparation E
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Case series
Patients: Male, 37-year-old • Male, 34-year-old
Final Diagnosis: Aortic Arch Stent Graft Infection
Symptoms: Chest pain • Shock • Shortness of breath
Clinical Procedure: Extra-Anatomical Aortic Bypass
Specialty: Cardiac Surgery
Objective: Unusual clinical course

Background: Aorto-aortic extra-anatomical bypass is a specialized surgical intervention primarily used to manage complex vascular complications, including stent graft infections after endovascular aortic repair. Stent graft infection is a rare but severe complication associated with high morbidity and mortality, which requires prompt treatment to prevent life-threatening sequelae such as pseudoaneurysm formation, aortic rupture, or fistula formation.

Case Reports: We describe 2 young male patients who developed infected thoracic aortic stent grafts after aortic arch debranching and endovascular repair. The first patient, a 37-year-old man with a history of traumatic aortic isthmus transection managed via tube interposition grafting 10 years earlier, presented with a proximal anastomotic pseudoaneurysm; he subsequently underwent arch debranching and endovascular stent grafting. He was later readmitted with systemic infection and mediastinal hematomas indicative of graft infection. The second patient, a 34-year-old man with Behçet disease and an aortic arch aneurysm, presented with an infected mediastinal hematoma involving the aortic stent graft after arch debranching and stent grafting. Both patients underwent stent graft explantation and extra-anatomical ascending-to-descending aorto-aortic bypass under peripheral cardiopulmonary bypass with deep hypothermic circulatory arrest. Both patients survived the complex aortic procedure and remained clinically stable at 38 and 17 months of follow-up (after the most recent procedure), respectively. One patient required additional wound management for a surgical site infection; the other underwent delayed repair of an ascending aortic pseudoaneurysm.

Conclusions: This case series demonstrates the feasibility of aorto-aortic extra-anatomical bypass as a potentially life-saving intervention for aortic endograft infection when perioperative management is optimized.

Keywords: Extra-Anatomical Aorto-Aortic Bypass • Aortic Arch Stent Graft • Deep Hypothermic Circulatory Arrest • Ascending Aortic Pseudoaneurysm • Omental Flap

Full-text PDF: https://www.amjcaserep.com/abstract/index/idArt/952756

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Introduction

Aorto-aortic extra-anatomical bypass is a specialized surgical intervention primarily used to manage complex aortic pathology, including stent graft infections after endovascular aortic repair. Stent graft infection is a rare but severe complication associated with high morbidity and mortality, which requires prompt and definitive management to prevent life-threatening sequelae such as pseudoaneurysm formation, aortic rupture, or fistula formation.

In cases of stent graft infection, extra-anatomical bypass can serve as an alternative to in situ graft replacement by debriding and excluding the infected aortic segment while creating a new route for blood flow through uninfected tissue planes to restore distal perfusion.

The 2022 American College of Cardiology (ACC)/American Heart Association (AHA) Guideline for the Diagnosis and Management of Aortic Disease and the 2020 European Society for Vascular Surgery (ESVS) Clinical Practice Guidelines on Vascular Graft and Endograft Infections recognize extra-anatomic bypass as a potential surgical strategy for managing infected prosthetic aortic grafts. Both guidelines emphasize that this approach should be considered selectively (rather than routinely) and reserved for carefully screened patients. Although extra-anatomical aorto-aortic bypass for infected aortic arch stent grafts can be life-saving, the procedure is technically demanding and performed in a contaminated operative field, increasing the risk of postoperative complications. Accordingly, successful outcomes depend on careful patient selection, meticulous surgical technique, multidisciplinary perioperative management, and close postoperative surveillance.

This case series describes the clinical courses of 2 patients who underwent extra-anatomical aorto-aortic bypass for infected aortic arch stent grafts.

Case Reports

Case 1

A 37-year-old man with a history of traumatic aortic isthmus transection managed via tube interposition grafting by left posterolateral thoracotomy 10 years earlier presented with hemoptysis secondary to aortobronchial fistula (blood pressure, 105/51 mm Hg; heart rate, 78 beats/min; respiratory rate, 15 breaths/min; SpO_2, 99%). Computed tomography angiography (CTA) revealed a periaortic hematoma, contrast extravasation, and a pseudoaneurysm at the inferior aspect of the proximal anastomotic site (**Figure 1**). The patient underwent aortic arch debranching, followed by endovascular aortic

Figure 1. Computed tomography angiography (sagittal view) showing a periaortic hematoma, contrast extravasation, and a pseudoaneurysm at the inferior aspect of the proximal graft anastomotic site.

Figure 2. Computed tomography angiography (sagittal view) showing a superior mediastinal hematoma (arrow), fluid collection surrounding the graft, and a localized pericardial hematoma.

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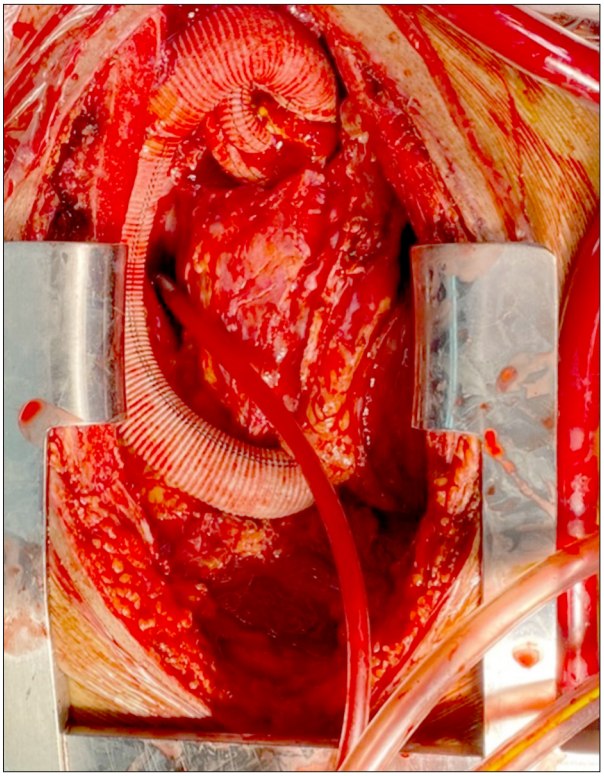

Figure 3. Intraoperative photograph of an extra-anatomical ascending-to-descending aorto-aortic bypass using a #20 Hemashield Platinum Woven Double Velour graft.

arch stent grafting. His postoperative course was uneventful, and he was discharged on postoperative day 6. During hospitalization, he received piperacillin-tazobactam 4.5 g every 6 hours and vancomycin, with dosing adjusted according to trough levels, until discharge. The patient was readmitted 2 months later with fever, hemoptysis, chest pain, and shortness of breath (blood pressure, 100/56 mm Hg; heart rate, 97 beats/min; respiratory rate, 20 breaths/min; SpO_2, 97%). CTA demonstrated a superior mediastinal hematoma, fluid collection surrounding the graft, and a localized pericardial hematoma, consistent with graft infection (**Figure 2**). He underwent stent graft explantation, extensive debridement, and extra-anatomical ascending-to-descending aorto-aortic bypass using a #20 Hemashield Platinum Woven Double Velour graft (**Figure 3**) under peripheral cardiopulmonary bypass with deep hypothermic circulatory arrest. The chest was left open for 3 days to allow daily mediastinal washout, after which the patient returned to the operating room for omental flap placement and sternal closure. During hospitalization, he received vancomycin, with dosing adjusted according to trough levels, for 44 days and meropenem 1 g every 8 hours for 11 days, followed by cefepime 2 g every 8 hours for 33 days. Blood cultures grew methicillin-sensitive *Staphylococcus aureus*. The patient was discharged on long-term intravenous vancomycin and cefepime for an additional 4 weeks with home healthcare support. He was subsequently readmitted with a surgical site infection. Wound cultures grew methicillin-sensitive *S. aureus*; he was treated with wound debridement, sternal wire removal, vacuum-assisted closure therapy, and intravenous cefazolin 2 g every 8 hours for 6 weeks, followed by home healthcare. At the 38-month follow-up (after the most recent procedure), he remained asymptomatic and clinically stable.

Case 2

A 34-year-old man with Behçet disease and an aortic arch aneurysm underwent aortic arch debranching and stent grafting. Two months later, he presented to the emergency department with hypotension and bleeding from the surgical site (blood pressure, 80/60 mm Hg; heart rate, 118 beats/min; respiratory rate, 18 breaths/min; SpO_2, 98%); he was resuscitated with 2 units of packed red blood cells and 1 L of intravenous normal saline. CTA revealed a mediastinal hematoma surrounding the ascending aorta and aortic arch, with contrast extravasation superior and anterior to the aortic arch. Additionally, a retrosternal hematoma extended from the neck to the diaphragm (**Figure 4**). Positron emission tomography/computed tomography (PET-CT) demonstrated an infected hematoma along the sternotomy site involving the aortic stent graft (**Figure 5**). Before surgery, the patient received cefepime 2 g

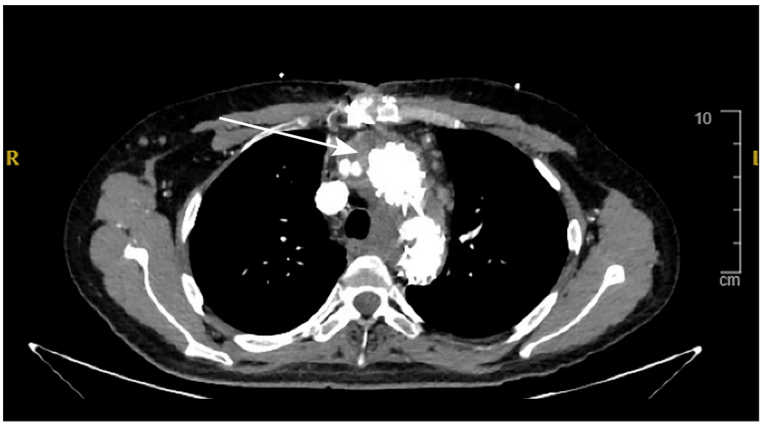

Figure 4. Computed tomography angiography (axial view) showing a mediastinal hematoma surrounding the ascending aorta and aortic arch (arrow) and a retrosternal hematoma extending from the neck to the diaphragm.

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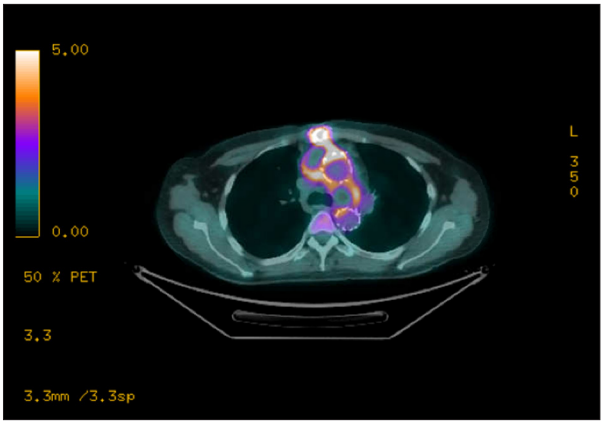

Figure 5. Positron emission tomography-computed tomography scan (axial view) showing an infected hematoma along the sternotomy site involving the aortic stent graft and extending into the upper anterior mediastinum.

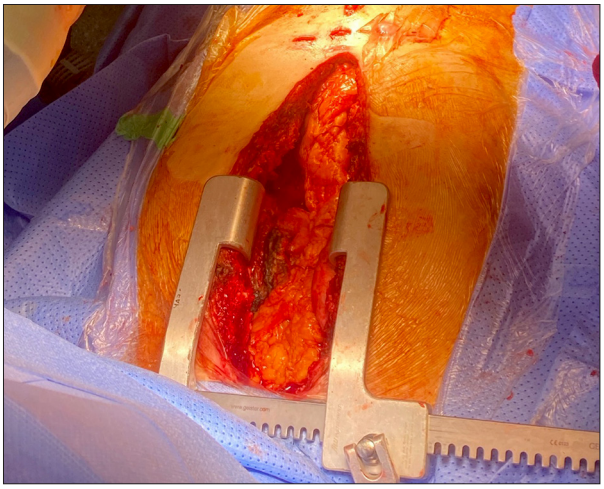

Figure 6. Intraoperative photograph demonstrating coverage of the extra-anatomical aorto-aortic bypass graft with an omental flap. The omentum was mobilized and positioned around the graft.

every 8 hours for 35 days and daptomycin 500 mg every 24 hours for 27 days. He underwent extensive debridement, aortic arch stent graft explantation, and extra-anatomical ascending-to-descending aorto-aortic bypass using a #20 Hemashield Platinum Woven Double Velour graft under peripheral cardiopulmonary bypass with deep hypothermic circulatory arrest. The chest was left open for 3 days, during which daily mediastinal washout was performed. The patient subsequently returned to the operating room for omental flap placement, pectoralis major muscle flap reconstruction, and sternal wound closure (**Figures 6, 7**). After bypass surgery, he continued daptomycin for a total of 45 days and received meropenem 1 g every 8 hours until discharge. Blood and tissue cultures remained negative throughout the hospital course. However, in contrast to Case 1, several findings strongly supported the

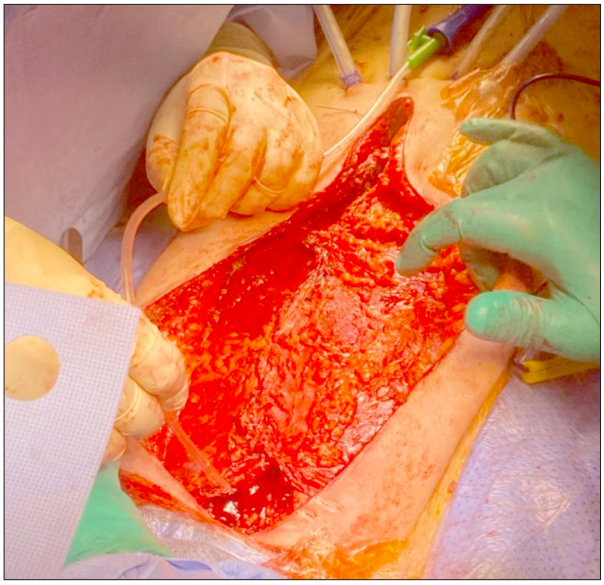

Figure 7. Intraoperative photograph showing advancement of a pectoralis major muscle flap to cover and reinforce the graft.

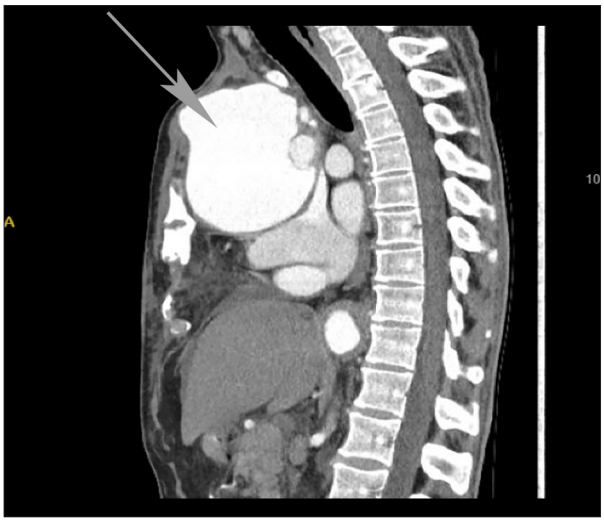

Figure 8. Computed tomography angiography (sagittal view) showing a large pseudoaneurysm arising between the ascending aorta and the sternum, with pronounced bulging through the sternal defect (arrow).

diagnosis of stent graft infection. First, PET-CT demonstrated a fluorodeoxyglucose (FDG)-avid infected hematoma involving the sternotomy site and aortic stent graft. Second, the patient's clinical and radiologic findings were highly suggestive of infectious disruption of the aortic stent graft. Third, he had received prolonged broad-spectrum antibiotic therapy before bypass surgery, which likely reduced the likelihood of obtaining positive culture results. Thus, despite negative cultures, the overall clinical presentation was considered highly consistent with stent graft infection. He had an uneventful postoperative

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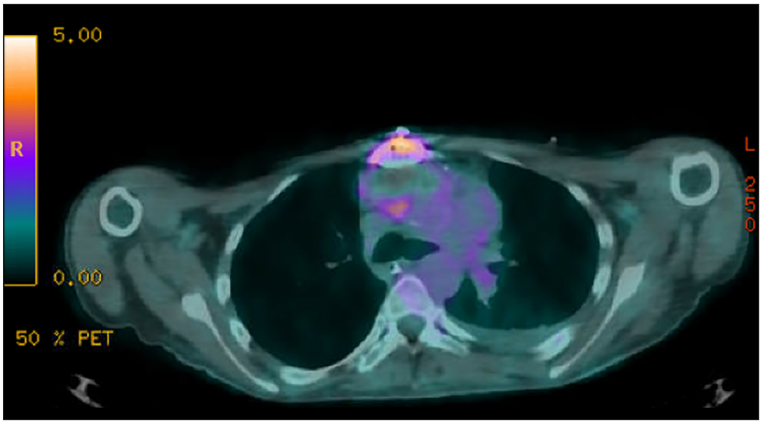

Figure 9. Positron emission tomography-computed tomography scan (axial view) showing fluorodeoxyglucose-avid uptake along the sternotomy wires and fluid collection in the anterior mediastinum corresponding to the pseudoaneurysm.

course and was discharged on postoperative day 27 with intravenous meropenem 1 g every 8 hours for 2 months, followed by lifelong trimethoprim-sulfamethoxazole (Bactrim DS), 1 tablet daily. Ongoing rheumatology follow-up was required due to his underlying Behçet disease. Eighteen months later, the patient presented to the emergency department with shortness of breath (blood pressure, 173/72 mm Hg; heart rate, 90 beats/min; respiratory rate, 27 breaths/min; SpO_2, 96%). CTA revealed a large ascending aortic pseudoaneurysm with pronounced bulging through the sternum (**Figure 8**). During hospitalization, he received vancomycin, with dosing adjusted according to trough levels, and meropenem 1 g every 8 hours for 17 days. PET demonstrated intense FDG uptake along the sternotomy wires and non-FDG-avid irregular fluid collection in the anterior mediastinum corresponding to the pseudoaneurysm (**Figure 9**). The patient subsequently underwent excision and repair of the ascending aortic pseudoaneurysm under cardiopulmonary bypass with deep hypothermic circulatory arrest and received piperacillin-tazobactam 4.5 g every 6 hours for 10 days. He was discharged on postoperative day 31. At the 17-month follow-up (after the most recent procedure), he remained asymptomatic and clinically stable.

Discussion

Compared with other similar case series, the Shanghai series (published by Tang et al [1]) focuses on the use of extra-anatomical bypass to manage aortic endograft infections after thoracic endovascular aortic repair. Similar to our series, patients in the Shanghai series [1] presented with clinical and radiologic evidence of infection. Imaging studies demonstrated periaortic hematomas, pseudoaneurysm formation, and mediastinal fluid collections. In both reports, treatment included removal of the infected grafts, extensive surgical debridement, and extra-anatomical aortic bypass. Similar to our series, omental or muscle flap coverage was commonly used in the Shanghai series to reduce reinfection risk and improve graft protection. Three major differences distinguish the Shanghai series from our experience. First, cardiopulmonary bypass was not required in any patient. Second, the bypass graft was constructed between the ascending and abdominal aorta. Third, aortic arch debranching was not performed before extra-anatomical bypass because the primary pathology involved the descending aorta. Patients in both reports required prolonged hospitalization; however, the mean durations of mechanical ventilation and intensive care unit stay were shorter in the Shanghai series. Both reports also involved prolonged intravenous antibiotic therapy for postoperative infection management. Long-term follow-up demonstrated that extra-anatomical bypass was generally effective; patients achieved stable outcomes in both series. However, Case 1 (in the present report) had a particularly complicated postoperative course, involving multiple emergency department visits and readmission for a surgical site infection. In Case 2, serial postoperative imaging demonstrated progressive enlargement of an ascending aortic pseudoaneurysm, which ultimately required surgical excision and repair.

Al Rstum et al [2] reported 2 cases of aortoesophageal fistula and aortobronchial fistula after thoracic endovascular aortic repair for traumatic aortic injury. Similarly, the patient in our Case 1 presented with hemoptysis secondary to an aortobronchial fistula. Although the patient in our Case 2 did not develop a fistula, vascular fragility associated with Behçet disease and the presence of clinically significant bleeding reflected a similarly high-risk clinical profile. Both patients described by Al Rstum et al underwent extra-anatomical bypass, similar to our patients. However, Al Rstum et al used a more extensive ascending-to-thoracoabdominal bypass method. Hypothermic circulatory arrest and omental or muscle flap coverage for infection control were also used in that report. Both reports demonstrate that aortic arch debranching is an important adjunct for management of aortic pathology involving or adjacent to the arch. Prolonged courses of intravenous antibiotics were standard, and some patients required repeated surgical debridement. Regular imaging and wound surveillance were essential for early detection and management of recurrent infection

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or graft-related complications. Long-term outcomes were generally favorable; however, 1 patient in the report by Al Rstum et al died of opioid overdose despite remaining infection-free.

The 2022 ACC/AHA Aortic Disease Guideline [3] states that, among patients with an infected prosthetic aortic graft who are hemodynamically stable and have suitable anatomy, open surgery with either in situ reconstruction or extra-anatomic bypass is reasonable. The guideline also recognizes a role for endovascular therapy as a bridge in hemodynamically unstable patients or as definitive treatment when open surgery is not feasible.

The 2020 ESVS Clinical Practice Guidelines [4] on Vascular Graft and Endograft Infections recommend extra-anatomic reconstruction as an alternative to in situ reconstruction in selected cases, particularly when extensive local infection, a contaminated operative field, or multiple prior operations make in situ reconstruction unsuitable. The guidelines also recommend covering the newly inserted graft and reinforcing the aortic stump with autologous, preferably vascularized, tissue after extra-anatomic reconstruction for thoracic or thoracoabdominal vascular graft or endograft infection. Both guidelines (ESVS and ACC/AHA) emphasize that extra-anatomic bypass should be reserved for carefully selected patients rather than used routinely. Its use is relatively contraindicated in patients who are hemodynamically unstable or unfit for major surgery.

Extra-anatomical aorto-aortic bypass for infected aortic arch stent grafts represents a complex but potentially life-saving strategy that allows exclusion of the infected aortic segment while maintaining distal perfusion. However, the procedure is technically demanding and performed in a contaminated operative field, increasing the risk of postoperative complications. These include recurrent graft infection, graft thrombosis, and anastomotic pseudoaneurysm formation. Such risks underscore the importance of early recognition of graft pathology, careful patient selection, meticulous surgical technique, multidisciplinary perioperative management, and close postoperative surveillance.

Considering the rarity of thoracic aortic graft infections, particularly those involving the aortic arch, and the limited number of reported cases of extra-anatomical thoracic aortic bypass, current recommendations are primarily based on small case series. Given the limited level of evidence and the small sample size in the present series, larger multicenter registries, collaborative observational studies, or pooled case series are needed to better define the indications, operative strategies, and long-term outcomes of this procedure and to strengthen future guideline recommendations.

Conclusions

This case series describes the use of extra-anatomical bypass in 2 patients with complex aortic pathology involving aortic endograft infection. Both patients underwent complex surgical interventions and experienced complicated postoperative courses, including infections, pseudoaneurysm formation, and the need for reoperation. Despite such challenges, both patients achieved favorable clinical outcomes during follow-up. These cases suggest that extra-anatomical bypass represents a feasible surgical option for selected high-risk patients when conventional approaches are unsuitable. Careful patient selection, meticulous surgical technique, multidisciplinary perioperative management, and close postoperative surveillance are essential to achieve stable long-term outcomes in this high-risk population. Larger multicenter registries, collaborative observational studies, or pooled case series are needed to better define the indications, operative strategies, and long-term outcomes of this procedure.

Department and Institution Where Work Was Done

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Patient Consent

Informed consent for publication was obtained from all patients in this case series.

Declaration of Figures' Authenticity

All figures submitted have been created by the authors who confirm that the images are original with no duplication and have not been previously published in whole or in part.

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