A minimally invasive approach to the infected aorta with novel endovascular use of biocomposite antibiotic material

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ABSTRACT

We have presented the case of a symptomatic, primarily infected aortic pseudoaneurysm treated with endovascular stent graft exclusion and adjunctive use of a long-acting biocomposite antibiotic material injected directly into the pseudoaneurysm sac. We have described preparation of the biocomposite antibiotic material and the catheter-directed delivery technique in detail. Although the use of long-acting antibiotic materials such as antibiotic beads has been well described when performing open surgery in an infected field, the application of these materials in endovascular procedures has been less certain. The techniques we have described have the potential to promote field sterilization in a minimally invasive manner for patients with aortic infections who could be poor candidates for open surgery. (J Vasc Surg Cases Innov Tech 2022;8:674-7.)

Keywords: Infected aortic aneurysm; Mycotic aneurysm; Antibiotic beads; Endovascular infected aneurysm

Treatment of aortic infection has traditionally required complex and highly morbid surgical intervention. Whether treating a primarily infected aneurysm of the native aorta or infection involving vascular grafts, the therapy has typically involved debridement of all infected tissue, explantation of the prosthetic material, vascular reconstruction, and antibiotic therapy.[1,2] As endovascular technology has evolved, minimally invasive approaches have become more common when treating these patients. Adjunctive techniques for additional local infection control during open surgery such as implanting long-acting antibiotic material within the operative field have been described.[3-5] However, to the best of our knowledge, similar techniques for local infection control that can be used endovascularly have not been previously reported. We have described a novel approach to the treatment of an infected aortic aneurysm using endovascular delivery of long-acting antibiotic material into the pseudoaneurysm sac. The patient's family provided written informed consent for the report of the patient's case details and imaging studies.

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CASE REPORT

A frail 83-year-old woman with significant medical comorbidities, including aortic stenosis, congestive heart failure, and prior myocardial infarction, who was receiving anticoagulation therapy for venous thromboembolism had presented with a several-day history of generalized abdominal pain. She reported malaise and low-grade fever and had had moderate abdominal tenderness. She had leukocytosis of 24,000/μL and bacteremia due to methicillin-sensitive *Staphylococcus aureus*. Computed tomography angiography of the abdomen revealed a saccular pseudoaneurysm of the infrarenal aorta with surrounding inflammatory changes, including localized lymphadenopathy in the area of the pseudoaneurysm (Fig 1). Additional evaluations and consultation with our infectious disease colleagues was pursued to rule out other causes of infection. These included chest radiography, which was negative for infiltrates, urinalysis with negative urine cultures, and echocardiography, which showed no signs of vegetations.

Thus, a symptomatic infected aortic pseudoaneurysm was diagnosed. Because of her frailty and cardiopulmonary comorbidities, she was not a candidate for open repair, and we pursued a minimally invasive approach.

OPERATIVE DETAILS

Our patient was treated with endovascular pseudoaneurysm exclusion using an Excluder bifurcated stent graft (W.L. Gore & Associates, Flagstaff, AZ) with concomitant catheter-directed delivery of an absorbable calcium sulfate antibiotic carrier–vancomycin slurry (STIMULAN; Biocomposites Ltd, Keele, UK) directly into the sac. Anatomically, the area in question could have been treated with an aortic cuff or aortoiliac bifurcated device. We chose to use a bifurcated device to allow for staged and partial deployment of the main body to prevent embolization of the antibiotic material during delivery,

Fig 1. Computed tomography image showing a saccular infrarenal aortic pseudoaneurysm with surrounding inflammation.

which the use of a cuff alone would not have allowed. Through bilateral percutaneous common femoral artery access, the infected pseudoaneurysm sac was cannulated, and a 7F sheath was positioned in the sac before positioning the endograft. The main body of the Excluder stent graft (W.L. Gore & Associates) was then advanced into position and partially deployed (Fig 2).

Delivery of small STIMULAN—vancomycin beads (Biocomposites Ltd) into the aneurysm sac via the 7F sheath was attempted. However, even the smallest size bead available (3 mm) could not be flushed through the sheath. Therefore, a 1:1 mixture of intravenous (IV) contrast and saline was combined with the STIMULAN—vancomycin bead matrix material to create a liquid slurry that could be readily injected through the sheath. The 1:1 contrast and saline mixture was added to the slurry until an oil-like consistency had been achieved. This slurry material was carefully delivered directly into the pseudoaneurysm sac via the 7F sheath using direct fluoroscopic visualization. This allowed for complete filling of the sac (Fig 3). Although a 7F sheath was used in the present case in an attempt to use the solidified beads, we believe that a 5F sheath could be used to deliver the slurry in future cases.

The 7F sheath was removed from the aneurysm sac, and deployment of the aortic stent graft was completed in standard fashion. Completion imaging demonstrated antibiotic slurry contained within the aneurysm sac, with no evidence of an endoleak or slurry embolization (Fig 4). Our patient was a candidate for on-label use of a bifurcated aortic stent graft. If the aortic anatomy had been such that this were not possible (eg, if the pseudoaneurysm had been located close to the aortic bifurcation), the options to prevent slurry embolization during delivery include inflating a balloon in the common iliac artery contralateral to the side used for delivery of the aortic device. Additional measures to prevent embolization of antibiotic material include taking care to avoid overfilling the pseudoaneurysm sac and only injecting the material using direct fluoroscopic visualization.

The groin access sites were closed percutaneously without complication. The patient recovered without any major complications in the immediate postoperative period. She was discharged on postoperative day 11 to a skilled nursing facility with long-term IV antibiotic therapy. The blood cultures obtained postoperatively showed no growth, and her white blood cell count had decreased from 24,000/μL at admission to 12,200/μL before discharge. However, the patient could not undergo her scheduled postoperative imaging study because of her frailty. Although she did not develop overt signs of ongoing or recurrent intra-abdominal infection, she experienced a generalized failure to thrive after discharge and died 6 weeks postoperatively.

DISCUSSION

Although the use of antibiotic beads has been well described as an adjunct for infection control during open surgery in orthopedics and for infected vascular grafts, to the best of our knowledge, the use of such materials in endovascular procedures has not been described. We have described endovascular, catheter-directed delivery of antibiotic-infused biocomposite material directly into an infected aortic aneurysm as a novel technique. This approach might allow for improved local infection control using a method previously only feasible during open procedures. Although the reference standard for treating aortic infections remains open surgery, the use of endovascular approaches to infected aneurysms has been becoming more common as primary or palliative therapy for patients who cannot tolerate open surgery and as a temporizing bridge to open repair for unstable patients.[6-8]

Although some success has been achieved with endovascular repair for primary mycotic aneurysm without local adjuncts, experience and reported studies have been limited. Di et al[6] reported a series of 19 patients with infected aortic aneurysms treated with emergent open repair (3 patients), emergent endovascular aneurysm repair (EVAR; 6 patients), or elective EVAR after antibiotic therapy (10 patients). In their small series, the 30-day mortality was 0%, 17%, and 0% and the 1-year survival rate of 100%, 17%, and 89% after emergent open repair, emergent EVAR, and elective EVAR, respectively. Although these results likely reflected the increased disease severity in patients requiring emergent repair, their results also suggest that antibiotic therapy/field sterilization can play an important role in patient outcomes.[6] Luo et al[7] reported a slightly larger series of 40 patients who had undergone EVAR for primarily infected aortic aneurysms, with 1- and 5-year survival rates of 71% and 53%, respectively. In addition, 20% of the

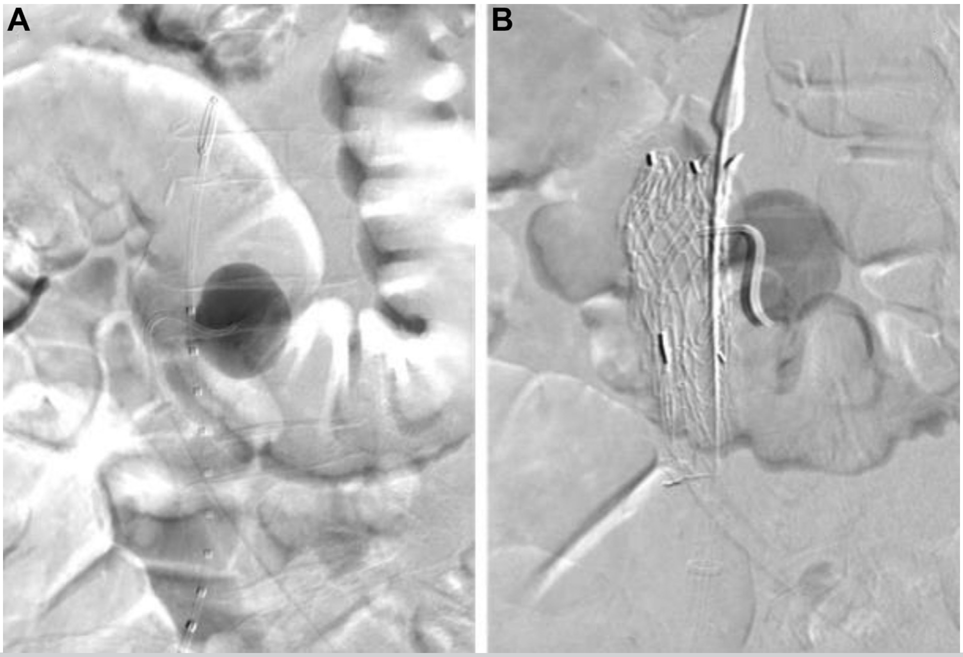

Fig 2. Selection of pseudoaneurysm sac with the catheter **(A)** and subsequent positioning and partial deployment of the aortic endograft **(B)**.

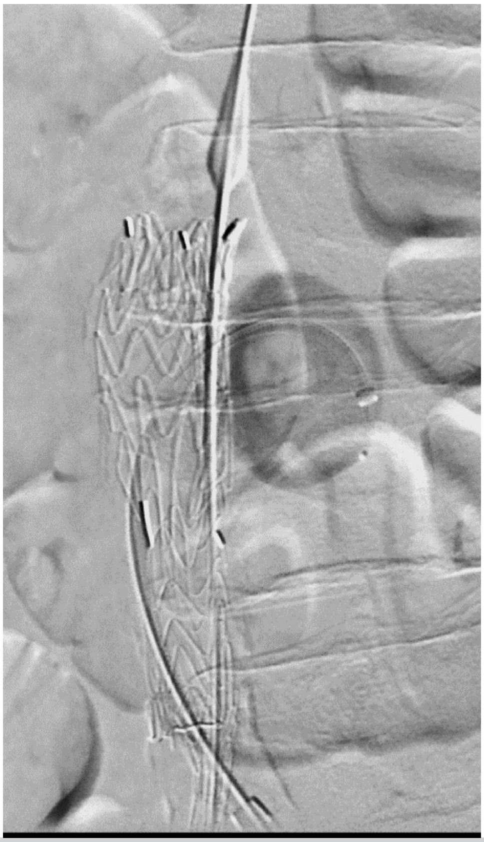

Fig 3. Intraoperative image showing 7F sheath positioned within the pseudoaneurysm during injection of contrast–antibiotic biocomposite slurry directly into the sac.

patients in their series had had evidence of persistent or recurrent infection after EVAR (treated with long-term antibiotics), and all these patients had ultimately died of the infection.[7] These findings further highlight the potential importance of field sterilization when treating these patients with endovascular techniques.[7] Given the excellent reported results with STIMULAN adjuncts in managing implant infections with open surgery, the use of such adjuncts seemed a useful addition to systemic antibiotic therapy in achieving adequate local infection control during endovascular therapy and is likely important to preventing prosthetic reinfection. Our technique allows for the delivery of long-acting antibiotic materials using a minimally invasive method. Although we had originally attempted to use antibiotic beads in their solidified form, we ultimately used a liquid slurry to facilitate sheath-guided delivery. After reflection, we believe a slurry might actually be better for endovascular use, because the slurry is able to fully fill the sac instead of leaving space between the beads, In addition, larger diameter beads could confer a higher risk of complications if embolized to distal vessels. Additionally, using this type of material will potentially be more beneficial than simply injecting an IV antibiotic solution or ethanol locally because the slurry material allows for a longer acting antimicrobial effect. We acknowledge that our single case report is somewhat limited because our patient was unable to undergo the follow-up postoperative imaging study and had died 6 weeks after the procedure. Owing to our patient's age, frailty, and high-risk presentation, her chance of mortality was certainly high, regardless of which intervention had been performed. Given that the

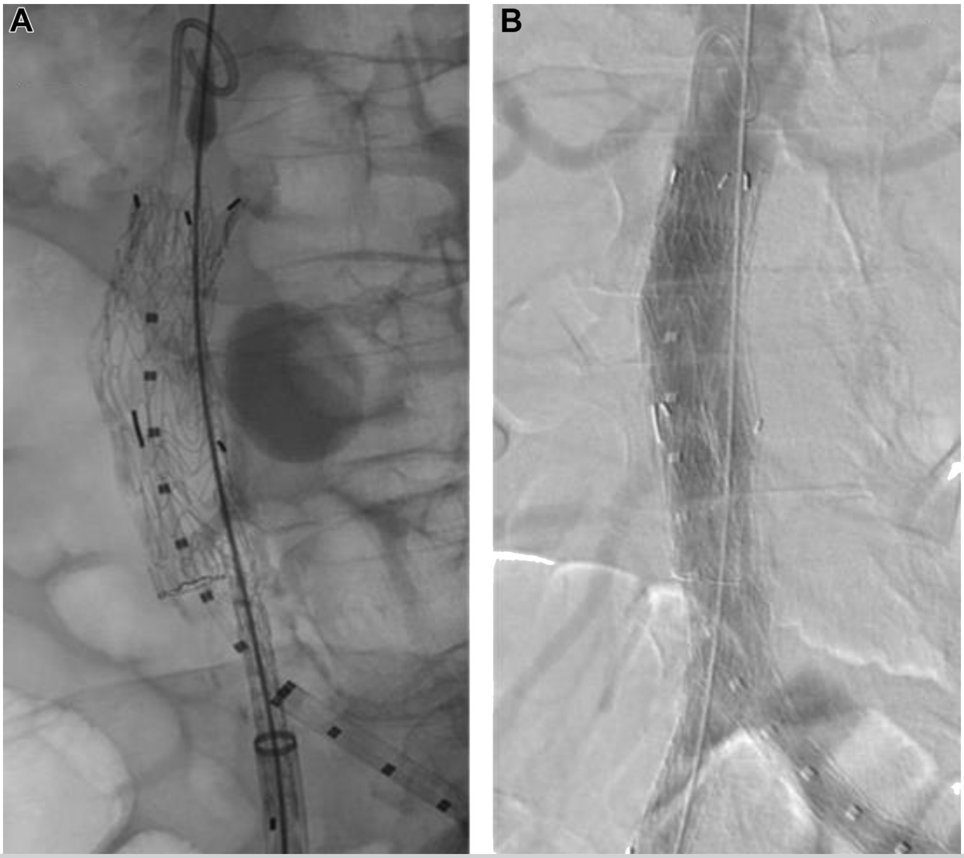

Fig 4. A, Nonsubtraction imaging study showing retention of antibiotic–contrast slurry within pseudoaneurysm sac after 7F sheath removal. **B,** Completion arteriogram showing exclusion of pseudoaneurysm without evidence of an endoleak.

procedure was technically successful and the laboratory evidence showed improvement in her infection, we propose that the technique we have presented has potential benefits as a palliative or temporizing measure for patients who are not candidates for open surgery. Although the present case might serve as "proof of concept" of a previously undescribed technique, more investigation is required before its ultimate effectiveness can be determined. Ultimately, achieving high antimicrobial levels adjacent to infected tissue that might not be well perfused is a logical goal, and our technique offers some promise in this regard.

CONCLUSIONS

Endovascular, catheter-directed delivery of a long-acting antibiotic slurry directly into the sac of a primarily infected aortic aneurysm is a previously undescribed approach to the treatment of infected aortic aneurysms. The novel technique we have presented could have the potential to improve the success of minimally invasive therapy in this highly morbid patient population.

We gratefully acknowledge our patient's family, who consented to the publication of our case report.

REFERENCES

1. Oderich G, Panneton J, Bower T, Cherry K, Rowland C, Noel A, et al. Infected aortic aneurysms: aggressive presentation, complicated early outcome, but durable results. J Vasc Surg 2001;34:900-8.
2. Swain T, Calligaro K, Dougherty M. Management of infected aortic prosthetic grafts. Vasc Endovasc Surg 2004;38:75-82.
3. McGuinness B, Ali K, Phillips S, Stacey M. A scoping review on the use of antibiotic-impregnated beads and applications to vascular surgery. Vasc Endovasc Surg 2020;54:147-61.
4. Doub J, Bork J, Heil E, Stafford K, Banoub M, Karwowski J, et al. Effectiveness and safety of biodegradable calcium sulfate antibiotic beads as adjuvant therapy in vascular graft infections. Open Forum Infect Dis 2021;8:ofaa650.
5. Zamani N, Sharath S, Barshes N, Braun J, Kougias P. Long-term outcomes of lower extremity graft preservation using antibiotic beads in patients with early deep wound infections after major arterial reconstructions. J Vasc Surg 2020;71:1315-21.
6. Di X, Liu C, Zeng R, Ni L. Endovascular aortic repair is a viable strategy for treatment of primary infected abdominal aortic aneurysm. Ann Vasc Surg 2020;63:117-28.
7. Luo CM, Chan CY, Chen YS, Wang SS, Chi NH, Wu IH. Long-term outcome of endovascular treatment for mycotic aortic aneurysm. Eur J Vasc Endovasc Surg 2017;54:464-71.
8. Yu S-Y, Lee C-H, Hsieh H-C, Chou A-H, Ko P-J. Treatment of primary infected aortic aneurysm without aortic resection. J Vasc Surg 2012;56:943-50.

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