Treatment of a *Salmonella*-induced rapidly expanding aortic pseudoaneurysm involving the visceral arteries using the Cardiatis multilayer stent

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Treatment of infection-induced aortic aneurysms is among the greatest challenges nowadays of vascular surgery because the use of prosthetic material is considered unsuitable. The Cardiatis multilayer stent (Cardiatis, Isnes, Belgium) is a flow-diverting bare stent with a proven efficacy in peripheral and visceral artery aneurysms. We present a unique case of a *Salmonella* serotype enteritidis-induced rapidly expanding aortic pseudoaneurysm with a penetrating ulcer that was treated with the Cardiatis multilayer stent. At 18 months of follow-up, the patient was in good clinical condition, with normalized C-reactive protein levels. Computed tomography angiography and 2-deoxy-2-[F18]-fluoro-D-glucose-positron-emission tomography/computed tomography showed a stable, mostly thrombosed aneurysm, with adequate perfusion of the side branches and no remaining signs of infection. (J Vasc Surg 2014;60:1056-8.)

The treatment of infection-induced aortic aneurysms is complicated by the fact that prosthetic material cannot be used. The femoral vein or a spiral vein constructed from the great saphenous vein may both be considered as a conduit. Despite advances in perioperative care, major surgery in these patients, who often have extensive comorbidities, results in a high morbidity and a mortality rate of up to 40%.[1]

Some small case series have described the feasibility of endovascular repair of infectious arterial disease, especially mycotic aneurysms.[2-5] Endovascular repair, using a stent graft, may provide time to optimize the patient's condition and act as a bridge to definitive surgery. Anatomic factors, however, may limit the application of endografts for the treatment of arterial aneurysms. The patient gave consent to publish the data.

Flow-diverting stents have recently been designed to reduce flow velocity in the aneurysm sac and promote thrombosis while maintaining flow in the main artery and branch vessels. In a recent review, Sfyroeras et al[6] concluded that the initial clinical experience in the treatment of visceral and peripheral aneurysms yields satisfactory results in technical success, aneurysm thrombosis and shrinkage, and in patency of branch vessels.

The Cardiatis multilayer stent (Cardiatis, Isnes, Belgium) is a bare cobalt alloy self-expanding stent with proven efficacy in peripheral and visceral aneurysms.[7] We present a unique case of a *Salmonella* serotype enteritidis-induced rapidly expanding aortic pseudoaneurysm with a penetrating ulcer that was treated with the Cardiatis stent.

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CASE REPORT

A 78-year-old male patient, with a medical history of insulin-dependent diabetes mellitus, dyslipidemia, and a laparotomy for a bowel perforation, was admitted to the hospital with fever, weakness, chills, headache, and abdominal pain. He had a fever of 39.5°C, blood pressure of 103/62 mm Hg, a pulse of 102 beats/min, and a blood oxygen saturation of 86%. The blood leukocyte count was 14.4 $\times 10^9$/L, C-reactive protein (CRP) was 140 mg/L, and the glomerular filtration rate was 45 mL/min.

Sepsis, with an unknown cause, was diagnosed, and the patient was treated with ceftriaxone (1000 mg, two times daily) and amoxicillin (2000 mg, six times daily). A computed tomography (CT) scan of the thorax and abdomen showed no focus of the sepsis. Blood cultures demonstrated a *Salmonella* serotype enteritidis (group D).

Owing to respiratory insufficiency, the patient was intubated and ventilated from days 5 to 7 after admission. At day 20 after admission, a 2-deoxy-2-[F18]-fluoro-D-glucose positron emission tomography (FDG-PET) fused with CT images was performed because the patient developed progressive back pain, but it showed no focal uptake. The blood leukocyte count and CRP levels had normalized but rose again at day 27 to, respectively, 18.4 $\times$ 10^9/L and 234 mg/L.

A new CT scan now showed a saccular aneurysm of the aorta, located at the level of the superior mesenteric artery, with a maximal diameter of 39 mm. Both renal arteries were located within the aneurysm. A surgical reconstruction was considered, but the patient was considered to be unfit for this major surgical procedure because of his age and general condition. A CT scan 1 week later showed the aneurysm diameter had increased to 56 mm, with signs of an impending rupture, including the rapid growth and the presence of a penetrating ulcer (Fig 1). We decided to treat the patient with a flow-diverting stent to reduce pressure from the aneurysm and maintain blood flow through the visceral arteries.

The patient was operated on under local anesthesia. The right femoral artery was exposed, and a 20F introduction sheath was introduced in the aorta. Then a 28- $\times$ 100-mm Cardiatis multilayer stent was inserted in the aorta, positioned under fluoroscopy, and deployed. A control angiography showed a good position of

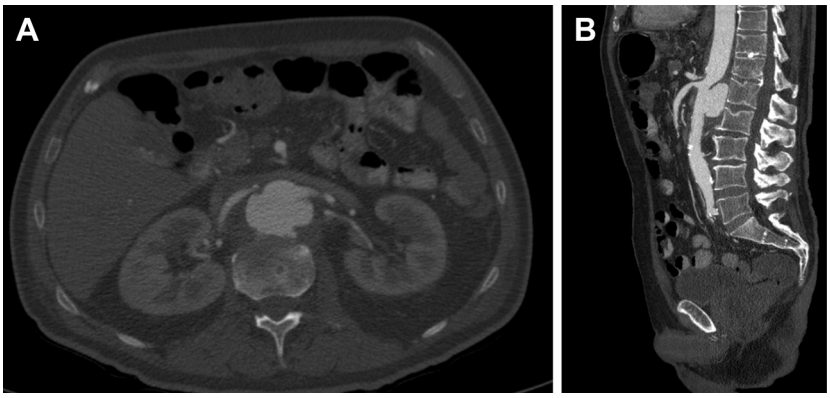

Fig 1. A and **B,** A computed tomography (CT) angiography shows an aneurysm with a contained rupture at the level of the visceral arteries.

the stent, with adequate flow through the celiac trunk, the superior mesenteric artery, and the renal arteries.

The patient was discharged from the hospital on postoperative day 8 with acetylsalicylic acid (80 mg, once daily), clopidogrel (75 mg, once daily), and ciprofloxacin (500 mg, twice daily) therapy.

At 2 months postoperatively, the blood leukocyte count and the CRP level had normalized. A control FDG-PET/CT scan, performed to assess any possible ongoing infection, however, showed a focal uptake in the aneurysmal wall with a standardized uptake value of 4.0 (Fig 2), supporting the infectious origin of this aneurysm. At 18 months postoperatively, patient was in good clinical condition, with a blood leukocyte count and CRP level within normal reference ranges and a stable glomerular filtration rate of 81 mL/min. The FDG-PET/CT scan demonstrated no signs of residual infection, and CT angiography showed a stable, mostly thrombosed, aneurysm with patent visceral arteries (Fig 3). The antibiotic therapy was stopped, without recurrence of disease.

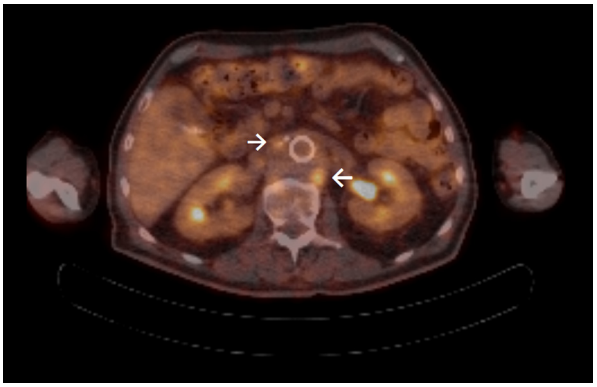

Fig 2. A 2-deoxy-2-[F18]-fluoro-D-glucose-positron-emission tomography/computed tomography (FDG-PET/CT) scan 2 months after surgery shows focal uptake (*arrows*) in the aneurysmal wall, with a standardized uptake value of 4.0.

DISCUSSION

The use of flow-diverting stents for aneurysms involving vital side branches will remain a matter of debate as long as their efficacy and safety have not been completely elucidated. In noninfected aneurysms, a fenestrated or branched endograft should be the first endovascular consideration. In our patient, with a rapidly enlarging aneurysm and a penetrating ulcer, the use of these endografts was not an option because they are custom made. This may change in the near future because off-the-shelf devices will be available soon. Moreover, their use would implicate the implantation of graft material in an infected environment, and because our patient was unfit for open repair, considering it as a bridge to definitive surgery was not an option.

The use of the Cardiatis stent in an infected aneurysm has not been described to date, neither has its use in a contained ruptured aortic aneurysm. The absence of graft material provided the opportunity for the stent to remain in situ for life, without any signs of ongoing infection at 18 months. After insertion of the stent, the aneurysm stabilized, without further expansion, indicating that the stent indeed reduced the pressure in the aneurysm immediately. The side branches remained patent during follow-up, and renal function was unaffected.

Flow-diverting stents were developed to reduce flow velocity within the aneurysm vortex while maintaining laminar flow within the main artery and side branches.[6] Because these stents modulate flow and do not seal, as do covered stents, the goal is to promote thrombosis. However, a thrombosed aneurysm does not preclude sac pressurization, and the risk of rupture may still be present. Therefore, sac shrinkage might be a more accurate marker of aneurysm depressurization and prevention from rupture, although further research is indicated to support this hypothesis.

CONCLUSIONS

Despite the successful and life-saving treatment of our patient, the use of flow-diverting stents for complex aneurysms should be limited only to those compassionate-use cases without treatment alternatives. Further studies on

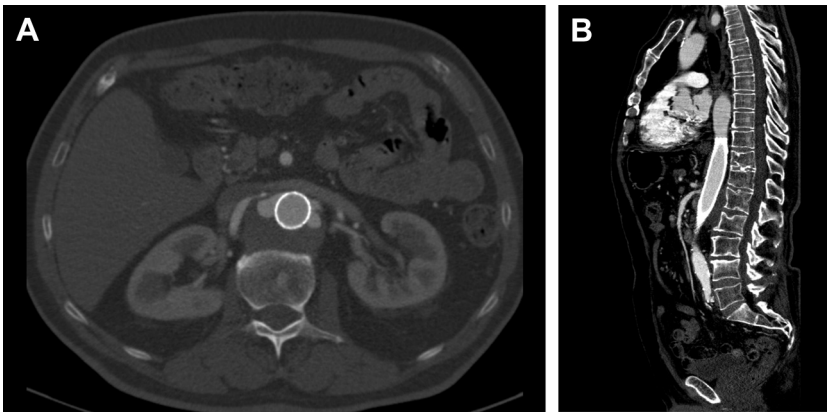

Fig 3. A and **B,** A computed tomography (CT) angiography 18 months after surgery shows a stable, mostly thrombosed, aneurysm with patent visceral arteries.

the efficacy of flow-diverting stents on various types of aneurysms are indicated to assess the position of these stents in the treatment algorithms of aneurysmal disease.

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