



Case Report

Open repair of a type IV thoracoabdominal aortic aneurysm using a modified branch-first technique with axillary perfusion: first reported case in Colombia

Reparación abierta de aneurisma de aorta abdominotorácica de tipo IV con prótesis utilizando una nueva técnica modificada: branch-first con rama de perfusión axilar; primer caso en Colombia

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Abstract

Introduction: thoracoabdominal aortic aneurysms (TAAAs) involve both the descending thoracic and abdominal aorta. Although uncommon—accounting for approximately 5%–10% of all aortic aneurysms—they are associated with substantial morbidity and mortality. Multiple surgical strategies, including endovascular and open approaches, have been described for their management. We report a case of a Crawford type IV TAAA treated with a modified branch-first open repair technique.

Case report: a 63-year-old man with no significant medical history presented with a 3-day history of lumbar pain radiating to the right iliac region. Computed tomography angiography demonstrated a Crawford type IV TAAA with features suggestive of impending rupture. Given the patient's anatomy (type IV aneurysm with early visceral vessel bifurcation) and preserved functional status, open surgical repair was selected. A modified branch-first technique was performed using a custom-made branched graft with an axillary perfusion limb, following multidisciplinary evaluation by Cardiology, Pulmonology, and Nephrology teams. In the absence of commercially available branched grafts in Colombia, a graft with 5 dedicated visceral branches was manually constructed. The sequence of anastomoses was adapted to minimize total ischemia time. The postoperative course was uneventful.

Keywords:

Thoracoabdominal aortic aneurysm. TAAA repair. Modified branch-first technique. Open aortic surgery.

Discussion: despite the widespread adoption of endovascular techniques, open repair remains an important option in younger patients requiring durable repair or in those with complex anatomy unsuitable for endovascular treatment. The branch-first technique offers several advantages, particularly in reducing spinal cord and visceral ischemia. The use of a custom-made branched graft with an axillary perfusion limb allows continuous visceral perfusion and hemodynamic stability without the need for extracorporeal circulation.

Received: 08/20/2025 • Accepted: 09/04/2025

Conflicts of interest: The authors declare no conflicts of interest.

Artificial intelligence: The authors declare that they did not use artificial intelligence (AI) or any AI-based tools in the writing of this article.

Montoya M, Hernández Ó, Pulido F, Tabares R, Turizo JL, Fajardo E. Open repair of a type IV thoracoabdominal aortic aneurysm using a modified branch-first technique with axillary perfusion: first reported case in Colombia. *Angiología* 2026;78(2):89-94

DOI: 10.20960/angiologia.00817

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Resumen

Introducción: los aneurismas de aorta abdominotorácica (AATA) tienen compromiso de la aorta torácica descendente y de la aorta abdominal, aunque son poco frecuentes (5-10 % de todos los aneurismas), y tienen una alta morbilidad. Se han descrito diferentes técnicas quirúrgicas tanto endovasculares como abiertas para su corrección. Se presenta un caso de un AATA Crawford IV que, por las características del paciente, se interviene quirúrgicamente con técnica de *branch-first*.

Caso clínico: paciente masculino de 63 años sin antecedentes que ingresa por un cuadro de tres días de dolor lumbar irradiado hacia fosa ilíaca derecha. La angiotomografía de abdomen evidenció un aneurisma de aorta abdominotorácica de tipo IV de Crawford con ampolla prerruptura. Debido a la anatomía del paciente, se decide manejo quirúrgico con técnica de *branch-first* y prótesis hecha a mano ramificada con rama de perfusión axilar. Debido a la falta de prótesis en Colombia, se creó de manera manual con cinco ramas exclusivas para perfusión visceral y se modificó el orden de las anastomosis, lo que redujo aún más el tiempo de isquemia global. El paciente no presentó complicaciones.

Discusión: a pesar de que en las últimas décadas se ha preferido el manejo endovascular en pacientes jóvenes que requieren una corrección definitiva o en pacientes con anatomía difícil, la técnica abierta para la corrección del AATA es una opción válida. Encontramos que la técnica *branch-first* tiene múltiples ventajas, sobre todo el tiempo mínimo de isquemia visceral. La técnica *branch-first*, utilizando una prótesis hecha a mano con rama de perfusión axilar, es una técnica segura y con buenos resultados, ya que garantiza la perfusión visceral y mantiene la estabilidad del paciente sin necesidad de circulación extracorpórea.

Palabras clave:

Aneurisma de aorta abdominotorácica. Reparación de AATA. Técnica modificada de *branch-first*. Cirugía aórtica abierta.

INTRODUCTION

Thoracoabdominal aortic aneurysms (TAAAs) are defined by the continuous involvement of the descending thoracic aorta and the abdominal aorta. They account for 5% to 10% of all thoracic aortic aneurysms (TAAs). Most are fusiform and are classified according to Crawford into 5 types. Type IV involves the abdominal aorta from the level of the diaphragm to the aortic bifurcation (1). Perioperative mortality after open repair ranges from 4% to 16%. In addition, postoperative complications are often severe and include acute kidney failure, paraplegia, myocardial infarction, and prolonged ventilation (2).

Open repair of TAAA remains one of the greatest surgical challenges due to the involvement of vital structures, such as visceral/renal branches and segmental arteries. In this article, we describe a modified branch-first open repair technique using a custom-made branched graft with an axillary perfusion branch designed by Dr E. Fajardo, which avoids the use of cardiopulmonary bypass (CPB) and reduces visceral ischemia time, bleeding, and other complications.

CASE REPORT

A 63-year-old man with no relevant medical history presented with a 3-day history of lumbar pain

radiating to the right iliac fossa. Abdominal computed tomography angiography revealed a Crawford type IV thoracoabdominal aortic aneurysm with loss of the calcified ring at the right infrarenal level, suggestive of impending rupture (Fig. 1).

After multidisciplinary team discussion, the patient was considered suitable for open surgery. A branch-first surgical approach using a custom-made branched graft with an axillary perfusion branch was planned.



Figure 1. Computed tomography angiography of the abdomen showing TAAA.

Graft planning was performed using reconstruction with medical software (OsiriX MD). Diameters of visceral vessels, arch length, clock position, and distances between vessels were measured. The graft was constructed according to the position of the visceral vessels, with 5 dedicated branches for visceral perfusion (Fig. 2).

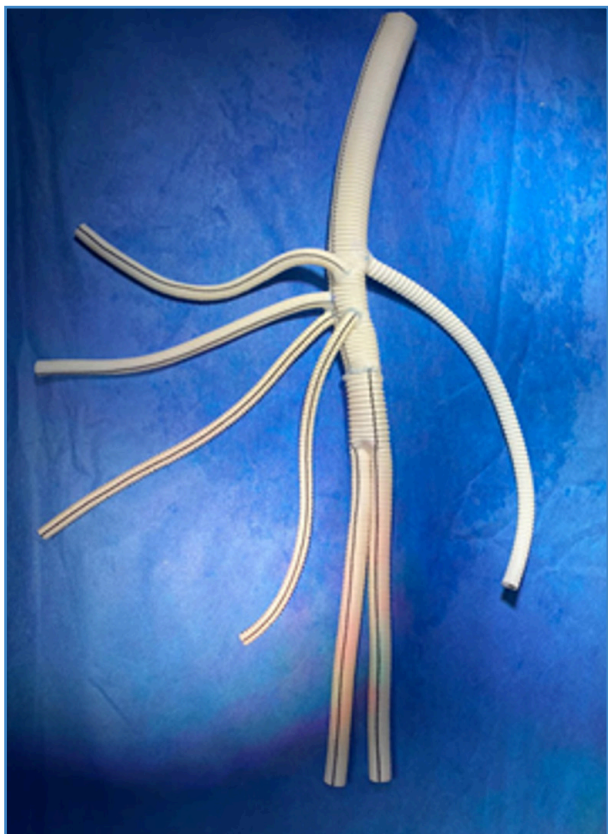


Figure 2. Graft construction. Author's own work.

A left infraclavicular incision was performed to expose the axillary artery, followed by end-to-side anastomosis using an anchoring technique with an 8 × 600 mm ringed Dacron graft (VUP Medical) and 6-0 Prolene. Sequential anastomosis with the perfusion branch of the custom graft was then performed and covered with loban.

A thoracoabdominal incision was performed from the 8th intercostal space to the umbilicus. The diaphragm was divided with a radial incision, and medial visceral rotation was performed to expose the thoracoabdominal aorta. Proximal and distal dissection was carried out to identify and control

the iliac arteries; the healthy descending thoracic aorta was dissected and encircled. Dissection and repair of visceral arteries were performed with selective and sequential clamping of the branches while maintaining visceral perfusion through the axillary perfusion branch: first the celiac trunk (23 minutes of ischemia), then the superior mesenteric artery (23 minutes), and the left renal artery (22 minutes) (Figs. 3 and 4).

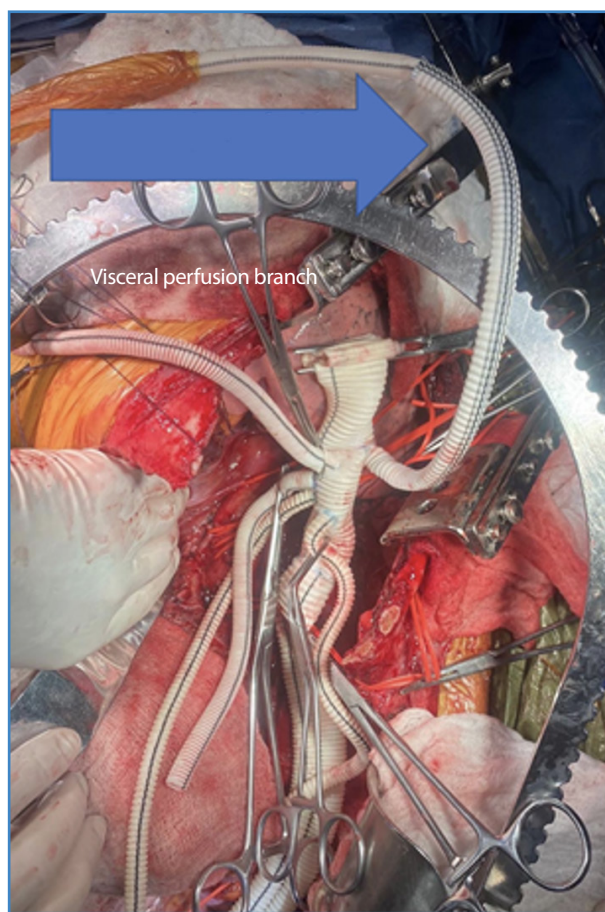


Figure 3. Intraoperative image: visceral perfusion branch. Author's own work.

The right and left common iliac arteries and the previously dissected healthy thoracic aorta were clamped. The aneurysm sac was opened, thrombus was removed, and lumbar arteries were controlled with 4-0 silk. The right renal artery was anastomosed from its ostium to the graft branch using 6-0 Prolene, with an ischemia time of 28 minutes. Renal protection with mannitol and 4 °C solution was used during the procedure.

Signs of lower limb ischemia were observed; therefore, end-to-end anastomosis of the bifurcated graft to the right and left iliac arteries was performed using 5-0 Prolene, restoring limb perfusion and showing resolution of waveform abnormalities on intraoperative neuromonitoring, with 42 minutes of ischemia (Fig. 5).

Finally, proximal end-to-end anastomosis of the thoracoabdominal aorta was performed using 4-0 Prolene, without ischemia time (Fig. 6).

The patient was transferred to the intensive care unit, where he remained for 3 days. Mechanical ventilation was discontinued on postoperative day 1, and oral intake was initiated on day 2. The patient was discharged on postoperative day 6 without complications. Imaging follow-up demonstrated satisfactory aortic repair with adequate perfusion of visceral branches. The patient resumed an active lifestyle 4 weeks after surgery.

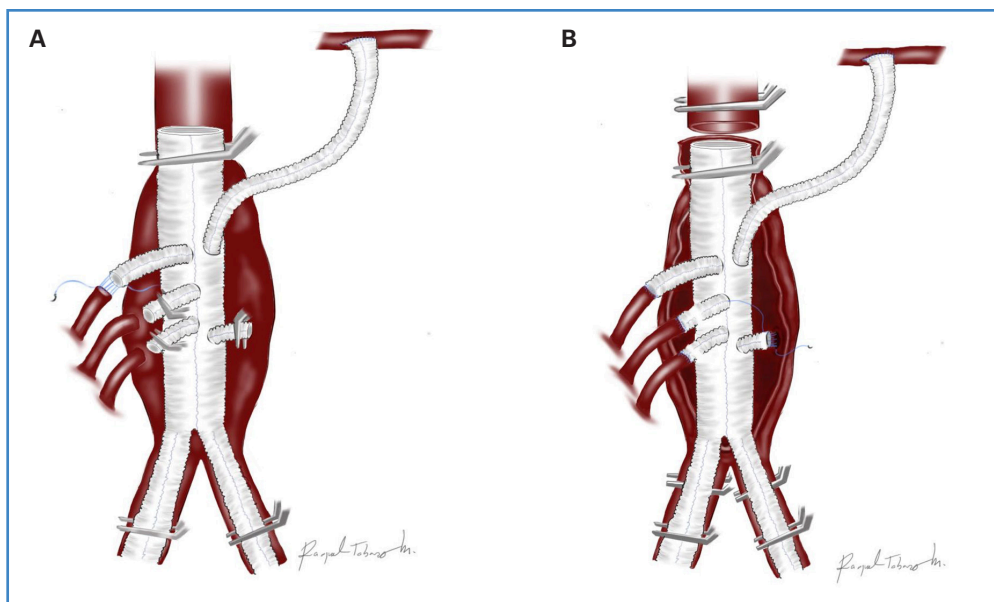


Figure 4. A. Celiac trunk anastomosis and opening of the aneurysm sac. B. Right renal artery anastomosis. Author's own work.

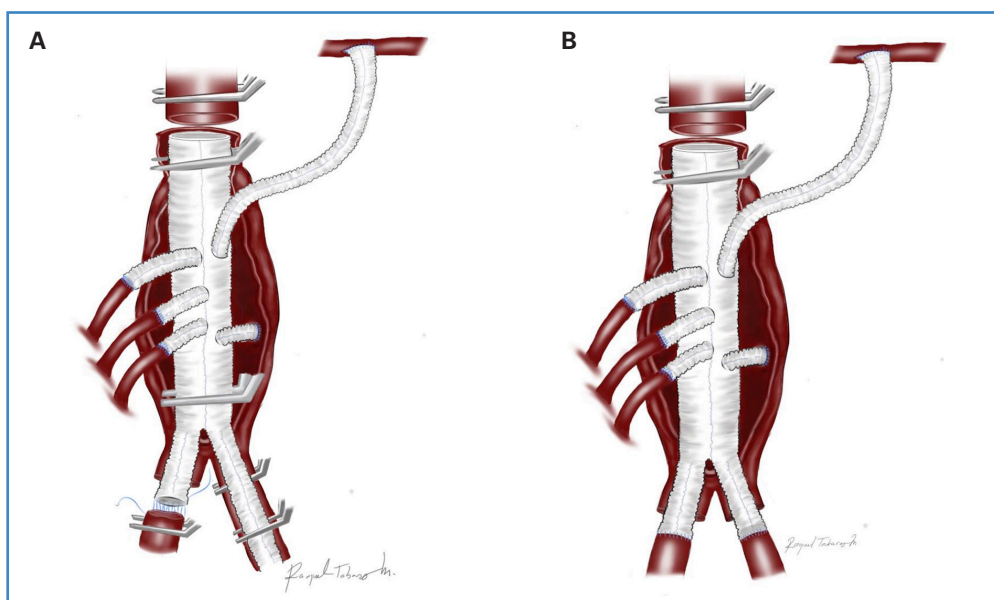


Figure 5. A. Right common iliac artery anastomosis. B. Proximal aortic anastomosis. Author's own work.

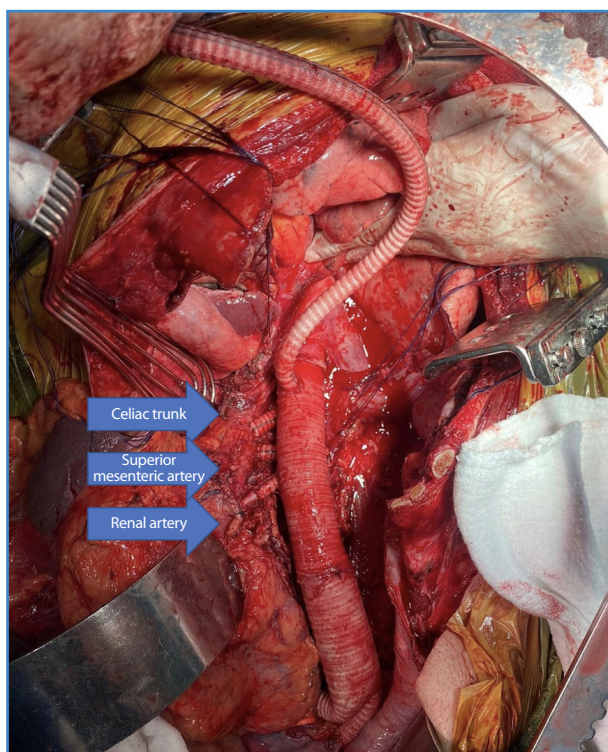


Figure 6. Intraoperative image. Author's own work.

DISCUSSION

Until the early 1950s, techniques used for aneurysm repair (such as ligation or intraluminal wiring) were inadequate for large fusiform atherosclerotic thoracoabdominal aortic aneurysms. The first successful repairs were performed using donor homografts. However, these were associated with complications, including inability to incorporate visceral branches and a high risk of potentially fatal distal ischemia during the procedure (3). Although some centers developed aortic banks to prepare and store homografts, these were ultimately found to be suboptimal for aortic replacement (3). Subsequently, the inclusion graft technique was adopted, improving patient outcomes.

Currently, with the growing use of endovascular surgery and techniques such as fenestrated grafts and chimney/snorkel approaches, the benefits of these strategies are evident. However, open repair of thoracoabdominal aneurysms remains a valid option, not only for patients with unfavorable anatomy for endovascular treatment but also for those with a good life expectancy who require durable repair (4).

In a retrospective study of 255 patients in Germany, despite the high morbidity and mortality associated with this condition, reintervention and aortic-related mortality rates during follow-up were low (2.8% and 5.6%, respectively) (4). In another Canadian study of 664 patients, long-term mortality was not significantly different (HR, 1.09; 95%CI, 0.78-1.50) (5). Secondary procedures were more frequent in the endovascular group (HR, 2.64; 95% CI, 1.54-4.55) (5). At 8 years, overall survival was 41.3% after endovascular repair and 44.6% after open repair ($p = .62$) (5).

The original branch-first technique was described by Matalanis and Ch'ng in 2019 (6). Subsequently, in 2021, Niranjana Hiremath described a modification (7) (Table I).

We present a new modification using axillary bypass, creating 5 dedicated branches for visceral perfusion and modifying the order of anastomoses, further reducing ischemia time. In Colombia, branched grafts such as the Coselli graft are not available for open repair of these aneurysms; therefore, custom-made grafts must be constructed, as in this case.

This technique has a major advantage over previously reported approaches, as it reduces ischemia time for right renal and lower limb anastomoses. With this modified branch-first technique incorporating an axillary perfusion branch, cardiopulmonary bypass is not required, and ischemia times of visceral trunks and lower limbs are reduced, resulting in satisfactory postoperative recovery.

CONCLUSIONS

We describe a new modified branch-first technique using a custom-made graft with an axillary perfusion branch, which is a safe approach with good outcomes. This technique reduces ischemia time and does not necessarily require cardiopulmonary bypass or aortic cannulation.

It is the first technique using a 5-branch graft exclusively for visceral perfusion, reducing overall ischemia time.

Table I. Advantages and disadvantages of the branch-first technique (6)

Advantages	Disadvantages
– Hemodynamic stability – Unhurried anastomosis in good-quality tissue – Minimal spinal and renovisceral ischemia time – Unobstructed operative field – Easy access to anastomoses to assess hemostasis – Oxygenator support during single-lung ventilation – Preservation of important intercostal arteries supplying the descending thoracic aorta (DTA), with preparation for staged endovascular repair	– Short renal/visceral arteries with early branching – Dense periaortic adhesions; e.g., inflammatory aortitis or prior surgical procedures – Severely atherosclerotic aorta at clamping sites with risk of thromboembolism – Pathology preventing preservation of the distal descending thoracic aorta (DTA) for staged endovascular completion; e.g., large aneurysm in this segment – Full heparinization – Single inflow graft for all four renovisceral arteries – Potential for graft kinking or angulation at the ends

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