

# Achieving Accuracy in Challenging Arch Anatomies

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Patients with aortic arch disease represent a significant treatment challenge due to the anatomic constraints associated with arch angulation and associated relationship of the aortic disease with the origins of the great vessels.

As such, intense case planning is needed when considering an endovascular solution in these patients. Advanced multidetector computed tomography angiographic (CTA) imaging, along with three-dimensional reconstructions with centerline measurements, are needed to optimally evaluate the arch anatomy and choose an endovascular solution. Furthermore, a healthy respect and understanding of the unique hemodynamic forces in the aortic arch are essential to appreciate the impact these factors have on aortic stent-graft deployment accuracy and achieving adequate seal in a hostile proximal landing zone.

For example, cardiac output is increased in the aortic arch compared to the descending thoracic aorta, which translates into increased distal migration forces at the time of aortic stent-graft deployment during the period of time when the aortic stent-graft is partially deployed and all of the cardiac output forces are being directed to push the aortic stent-graft distally. In addition to the distal migration forces associated with increased cardiac output, there is also increased aortic motion in the aortic arch as a result of the fluid dynamics of the cardiac output being ejected from the left ventricle and traversing the curved aortic arch. Finally, the angulation of the aortic arch varies by individual and the degree of angulation, relative to the origin of the great vessels, and greatly affects the decision of where to land the proximal extent of the aortic stent-graft.

As a result of the combination of anatomic and hemodynamic challenges in the aortic arch, the selection of the optimal aortic stent-graft is critical for achieving optimal outcomes in thoracic endovascular aortic repair (TEVAR) procedures for the aortic arch.<sup>1</sup> The RESTORE study, published in 2010, was a prospective European

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**The Relay<sup>®</sup>Plus stent-graft is engineered with a nitinol wire associated with a polyester vascular graft with an associated spiral support bar that provides column support and torque response.**

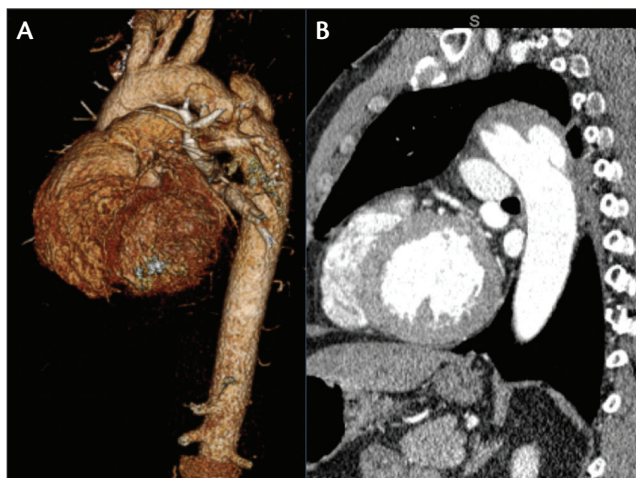
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registry involving 22 centers that studied the outcomes of patients treated with the Relay<sup>®</sup>Plus (Bolton Medical) aortic stent-graft.<sup>2</sup> The Relay stent-graft is engineered with a nitinol wire associated with a polyester vascular graft and an associated spiral support bar that provides column support and torque response. The study consisted of 304 consecutive patients, with an average age of 64 years. Thoracic aortic aneurysms constituted 52.9% of the aortic pathologies. Overall technical success was 97.7%, while 80% of the proximal landing zones in this study were in the aortic arch. There was a 95.4% freedom from endoleak and 30-day mortality was 7.2%. Freedom from procedure- and device-related mortality at 2 years was 95.9%. There were no retrograde dissections in the study, and the stroke rate was 1.6%.

## CASE DISCUSSIONS

### Case 1

A 65-year-old woman presented with new-onset back pain. A detailed workup demonstrated a 5-cm penetrating aortic ulcer (PAU) of the proximal descending thoracic aorta with associated intramural hematoma extending retrograde to the distal aortic arch and abutting the origin



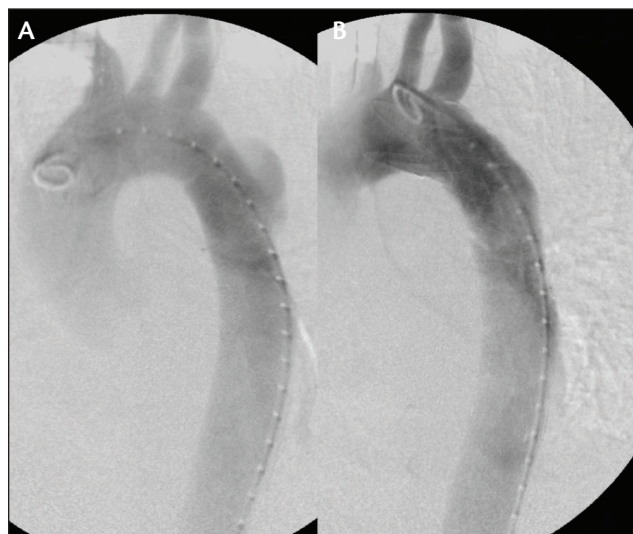
**Figure 1.** Three-dimensional reconstruction of a multidetector CTA of a patient with a 5-cm PAU of the proximal descending thoracic aorta extending retrograde into the distal aortic arch (A). Multidetector CTA of a 5-cm PAU of the distal aortic arch and proximal descending thoracic aorta (B).

of the left subclavian artery (LSCA) (Figure 1). The remainder of the aorta was normal. Due to the size of the PAU, a decision was made to treat the patient with an aortic stent-graft. A Relay aortic stent-graft was selected to align the maximal conformability of the aortic stent-graft in the distal aortic arch to the curvature of the arch in order to preserve the origin of the LSCA. The proximal sealing stent technology of the Relay device with the “Free-Flex Zone” is appealing in this patient’s anatomy because of the expected challenges associated with a proximal landing zone in the distal aortic arch. In addition, the precurved nitinol delivery catheter and inner delivery sheath of the Relay aortic stent-graft facilitates accuracy of deployment in this patient’s challenging anatomy.

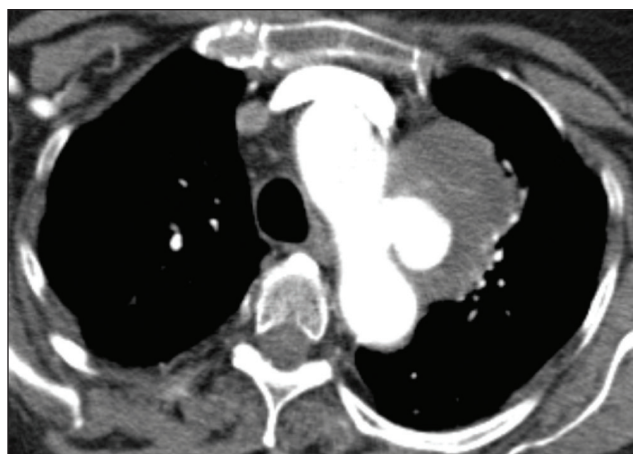
The patient was taken to the hybrid operating room, and right femoral access was obtained using general anesthesia. Aortography confirmed the landing zones (Figure 2A). The outer sheath of a 38-mm X 38-mm X 150-cm Bolton Relay aortic stent-graft was delivered into the lower descending thoracic aorta from a right common femoral artery access. The inner delivery sheath and aortic stent-graft were advanced out of the outer delivery sheath and maneuvered into the mid aortic arch. With transient hypotension, the aortic stent-graft was deployed, with the proximal aspect of the fabric landing just beyond the origin of the LSCA and the bare springs were subsequently released. A completion aortogram demonstrated a patent LSCA, no endoleak, and a successfully excluded PAU (Figure 2B).

## Case 2

A 69-year-old woman presented to the emergency room with new-onset back pain and shortness of breath.

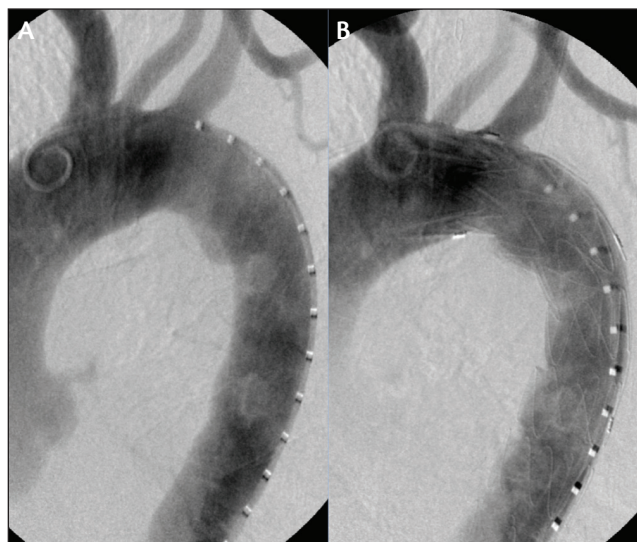


**Figure 2.** Intraoperative angiogram of a patient with a 5-cm PAU of the distal aortic arch with associated intramural hematoma (A). Completion angiogram after TEVAR for a 5-cm PAU of the distal aortic arch with a Bolton Relay aortic stent-graft distal to the LSCA (B).



**Figure 3.** Multidetector CTA of a 69-year-old patient with an 8-cm saccular aneurysm of the distal aortic arch.

A CTA revealed an 8-cm saccular aneurysm of the distal aortic arch (Figure 3). The distance between the origin of the LSCA and the aneurysm was 1.5 cm along the inner curve. With a short, angled proximal landing zone, we selected a Relay aortic stent-graft to take advantage of the minimum proximal seal zone of 15 mm (indicated in the indications for use). The patient underwent successful TEVAR with a Bolton Relay 42-mm X 42-mm X 150-mm aortic stent-graft. There were no endoleaks and even though the LSCA was partially covered with the fabric of the aortic stent-graft, there was adequate filling of the LSCA as determined by angiography, and there were no blood pressure differences between the left and right upper extremities (Figure 4).



**Figure 4.** Intraoperative angiogram of patient with an 8-cm saccular aneurysm of the distal aortic arch (A). Completion angiogram after TEVAR for an 8-cm saccular aneurysm of the distal aortic arch with a Bolton Relay aortic stent-graft with partial coverage of the LSCA (B).

## CONCLUSION

Endovascular repair of the distal aortic arch is a challenging process in any patient. The unique combination of aortic arch curvature, short proximal landing zone, rela-

tionship of the origins of the great vessels, and increased cardiac output forces all combine to challenge the accuracy of deployment and obtaining proximal seal of any aortic stent-graft. By understanding the different deployment mechanisms and aortic stent-graft designs, the astute clinician will optimize clinical outcomes of TEVAR procedures involving the aortic arch by aligning the notable design and functional attributes of a particular aortic stent-graft with the patient's anatomy.

1. Sweet MP. Anatomic features of the distal aortic arch that influence endovascular aneurysm repair. *J Vasc Surg.* 2016;50:741-55214;30006-30004.
2. Rimbaut V, Burkhardt Zipfel B, Gioacchino Coppi G, et al. Final operative and midterm results of the European experience in the RELAY Endovascular Registry for Thoracic Disease (RESTORE) study. *J Vasc Surg.* 2011;53:565-573.

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