

# Towards Endovascular Treatment of the Entire Aorta

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In this issue of *IMAJ*, Silverberg and colleagues describe their experience with fenestrated and branched stent grafts for complex abdominal aortic aneurysms [1]. This pathology, as well as the entire spectrum of aortic aneurysms, in both the abdomen and the thorax, constitutes an important and dynamic field in which significant progress has been made in the last decade and will surely continue in the next few years.

Endovascular treatment of infrarenal aortic aneurysms has become a routine procedure, replacing over 50% of open surgical abdominal aortic aneurysm repairs in some large databases and constituting a much larger proportion in some “endo-competent” centers [2]. Complex aneurysms, such as thoraco-abdominal aneurysms and thoracic aortic aneurysms involving the arch and the ascending aorta, on the other hand, are still treated primarily with open surgical repair. These open procedures are extremely complicated and are associated with a significant rate of mortality and major morbidity. The published mortality rates for open repair of thoraco-abdominal aneurysms are 6–22%, but one has to keep in mind that these figures come from the world’s leading centers specializing in these procedures and these results are not usually achieved elsewhere [3].

Against this background, it is the prevailing opinion among endovascular specialists that in the coming years

endovascular devices and techniques will evolve to expand applicability and provide therapy for most aortic diseases, including a growing number of diseases of the arch and the ascending aorta [4].

Complex aortic aneurysms that involve major aortic branch origins include those juxtaposed or involving the renal arteries (juxtarenal, perirenal), the visceral arteries (thoraco-abdominal) and the great vessels to the upper body in the aortic arch (arch aneurysms). These complex aortic aneurysms pose difficult challenges for endovascular therapy, and several solutions have been emerging.

One option to treat aneurysms involving branches without complicating the endovascular procedure has been to move the branches surgically to another location that is not covered by the aortic stent graft [Figure 1]. These so-called hybrid or de-branching procedures have largely fallen out of favor in the abdomen, mainly due to the high complication rate related to the open procedure, mitigating the benefit of the endovascular approach. These operations still play a role in the thorax in selected cases [5].

Currently, the most straightforward and available system for complete endovascular repair of thoraco-abdominal aneurysms consists of the custom-made fenestrated or branched Zenith stent grafts (Cook, Australia) as reported in this issue by Silverberg and co-authors [1]. Other options, besides custom-made stent grafts, do exist. However, the largest experience accumulated so far, involving several thousand cases worldwide, has been with these custom-made devices. Endovascular repair of thoraco-abdominal aneurysms with such endografts is associated with a published mortality rate of 0–27% (average 9%) and a mid-term branch patency

of over 90% [6]. These devices, however, are not without disadvantages, including a waiting period of at least 6 weeks, which makes them unsuitable for emergency cases, and very high cost.

An alternative to custom-made grafts are the parallel stent grafts, including so-called chimneys, snorkels or periscope stent grafts. Inserted by endovascular means, they are used to create a landing zone for the aortic stent graft while preserving the aortic branches [Figures 2 and 3] [7].



**Figure 1.** 3-D reconstruction of a computed tomography angiogram after an abdominal de-branching procedure for repair of a thoraco-abdominal aneurysm. A thoraco-abdominal aortic stent graft is seen (white arrow). Surgical bypass grafts feed the left renal artery (green arrow), superior mesenteric artery (red arrow) and right renal artery (blue arrow). The celiac artery was occluded at its origin and was not reconstructed



**Figure 2.** 3-D reconstruction of a CT angiogram after endovascular repair of a lower thoracic pseudoaneurysm by a lower thoracic aortic stent graft (white arrow) reaching down to the renal arteries. A periscope stent graft (green arrow) within the superior mesenteric artery and into the aorta below and beyond the aortic stent graft maintains mesenteric flow. The celiac artery was not reconstructed

In an effort to overcome the deficiencies of custom-made stent grafts, similar implants with prefabricated branches or fenestrations have been developed and examined for clinical use by several companies. For juxtarenal aneurysms such off-the-shelf fenestrated devices are suitable for over 70% of cases [8]. For thoraco-abdominal and aortic arch aneurysms, prefabricated multiple or single-branch grafts, respectively, are under clinical investigation.

For state-of-the-art endovascular treatment of complex aneurysms with



**Figure 3.** 3-D reconstruction of a CT angiogram after endovascular repair of the distal aortic arch and descending aorta of a thoracic aneurysm with an aortic stent graft (black arrow) reaching the common trunk of left and right common carotid arteries. A replaced right subclavian artery (light blue arrow) was covered and flow in the left subclavian artery is maintained by a chimney stent graft (red arrow)

any of the above mentioned devices and methods, the consensus today is that an adequate infrastructure and set-up is mandatory. This includes an endovascular hybrid suite with a fixed, high quality fluoroscopy machine in a modern spacious operating room supported by a well-trained and experienced endovascular team with adequate endovascular supplies [Figure 4] [9].

In summary, endovascular therapy of the aorta is evolving to cover the majority of aortic pathologies. To implement these new elaborate life-saving procedures, hospitals will require advanced hybrid facilities with appropriate support, and medical insurance will need to provide for adequate reimbursement.

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**Figure 4.** A modern hybrid endovascular suite, necessary for endovascular repair of complex aortic aneurysms

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**“Lower your voice and strengthen your argument”**

Lebanese proverb

**“In our every deliberation, we must consider the impact of our decisions on the next seven generations”**

Iroquois maxim. The Iroquois are a surviving Native American people that originally comprised the Mohawk, Oneida, Onondaga, Cayuga, and Seneca nations