Historical Vignette

The Beginning of Endovascular Aortic Aneurysm Repair

Sairam Subramanian
Department of Vascular Surgery, Sundaram Medical Foundation, Chennai, Tamil Nadu, India

Endovascular aortic aneurysm repair (EVAR) has drastically altered the treatment landscape and replaced open surgical repair as the primary treatment modality for majority of abdominal aortic aneurysms (AAAs) in large parts of the world. Since its inception in the early 1990s as an experimental alternative to patients unfit for open surgical repair, it has today caused a paradigm shift in the management of most uncomplicated AAAs with rapidly widening indications in the treatment of anatomically complicated pararenal and suprarenal AAAs.[1]

EVAR was introduced to most of the world by the work of Parodi et al. published in 1991 in the Annals of Vascular Surgery.[2] This introduced a radical change at a time when open surgical repair was well established as a robust procedure to treat most AAAs, and most vascular surgeons had not acquired the skill sets for endovascular intervention. The lack of complete understanding of the anatomic complexities, disease progression, and sophisticated imaging added to the initial doubts and dismissive resistance to its widespread use in the early phase.

Behind the Iron Curtain

Unknown to most in the English-speaking world, the earliest attempts at design and successful aortic endografting occurred in Ukraine in the erstwhile USSR. Tragically, the extent and path-breaking quality of their work remained hidden in the English language publications due to the existing sociopolitical circumstances.

Prof. Nicolai Leontievich Volodos (May 15, 1934–April 3, 2016) was the master innovator heading the team at Kharkov Research Institute of General and Emergency Surgery (USSR). Although he was well known to the international surgical community, the details of his pioneering insights and the meticulous detail of his research work in aortic endografting remained underexposed to most of the world till recent years.

Prof. Volodos [Figure 1] graduated from Odessa Medical School in Ukraine. He trained in cardiovascular surgery and then defended his PhD thesis at Kharkov Medical Postgraduate Institute in 1971. He developed an early interest in self-expanding vascular grafts with the ability for self-fixation within the vessel lumen. Inspired by the work of Charles Dotter and with the help from scientists who were familiar with use of materials in space and defense industry, he developed the first model of a self-expanding stent in the form of a radial cylindrical tube of stainless steel wires with a Z-shaped lateral frame. This frame, when inserted into a vascular graft, was able to fix the graft in the vessel lumen from within, and thus, the first self-expanding covered stent was produced. Further refinements in stent design and creation of new delivery systems that could be used to deploy the device from the femoral arteries were developed, and the first USSR patent was obtained in May 1984. Extensive animal experiments then prepared the device for human use.[3,4]

Figure 1: Prof. Nikolai Volodos

Address for correspondence: Dr. Sairam Subramanian, E-mail: sairam_subramanian@hotmail.com

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

For reprints contact: reprints@medknow.com

How to cite this article: Subramanian S. The beginning of endovascular aortic aneurysm repair. Indian J Vasc Endovasc Surg 2018;5:283-5.

Received: October, 2018. Accepted: November, 2018.

© 2018 Indian Journal of Vascular and Endovascular Surgery | Published by Wolters Kluwer - Medknow
Prof. Volodos et al. developed extensive experience and are credited with many first in arterial endografting. These include as follows:

- Iliac artery stent grafting for multi-level arterial occlusive disease in 1985
- First aortic stent graft for a posttraumatic descending thoracic aortic aneurysm (1987). The patient survived 18 years without any device malfunction
- Intraoperative stent grafting of AAA using a self-fixing synthetic endograft (1987)
- Attempts on stent grafting of AAA with whole self-fixing bifurcated endograft using two femoral approaches (1989)
- Combined endovascular and open surgical repair of aortic arch using debranching technique accomplished via two surgical approaches – ascending aorta and common femoral artery (1991)
- Stent grafting of descending thoracic aorta for aneurismal disease complicated by aortobronchial fistula and massive pulmonary hemorrhage (1993).[5]

Prof. Volodos et al.’s groundbreaking work in the field of arterial endografting deserves to be given proper recognition and accorded its rightful place in medical history.

**Endovascular Aortic Aneurysm Repair in the Western World**

EVAR for AAA was introduced to most of the world by Dr. Juan C Parodi et al. in Argentina. After the first few cases in his institute, and publication of the same in the Annals of Vascular Surgery in 1991, Dr. Parodi introduced the procedure in the US and Europe in 1992. With years of collaboration and determination, Dr. Parodi succeeded in popularizing EVAR all over the world.

Dr. Juan C Parodi [Figure 2] was born in Argentina. He started his journey of innovation in aortic endografting, while he was a vascular fellow at the Cleveland Clinic. Successive complications in a couple of patients who underwent open repair of AAA spurred the interest to develop a catheter-based solution. Preliminary work on device design was done at the Cleveland Clinic after which he returned to Argentina. In collaboration with Dr. Palmaz, and bioengineer Hector Barone, Dr. Parodi used the extra-large Palmaz stent to design devices up to 30 mm in diameter. This was followed by extensive experiments in dogs in the late 1980s, most of it without any external funding.

The first successful EVAR case on a human was done in September 1990. The patient had a large AAA causing back pain and had severe chronic obstructive pulmonary disease, making him unfit for an open repair. The first device was an aortic stent graft and had a graft designed with expandable ends, the extra-large Palmaz stent, a Teflon sheath with a valve, a wire, and a valvuloplasty balloon. The first case was done along with Dr. Palmaz and Hector Barone. The procedure was successful initially, but the initial patients started developing distal aortic endoleaks after a few months. This was tackled with an aorto-uni-iliac device extension with occlusion of the contralateral common iliac artery and a femoro–femoral bypass.[6,7]

Dr. Parodi’s results were received with great skepticism, and the first cases were published only in November 1991. Over the next couple of years, Dr. Parodi worked with teams around different countries and introduced EVAR to the rest of the world. The first EVAR in Europe was performed as a live case at a meeting in Nancy, France, by Dr. Parodi, Claude Mialhe, Claude Amicabile, and Claudio Schonholz in October 1992. This was followed by the first EVAR in the US with Frank Veith, Michael Marin, Jacob Cynamon, and Claudio Schonholz in New York in November 1992 and at the Royal Perth Endovascular Unit in Australia led by Michael Lawrence-Brown.[8]

EVAR then went on to spread rapidly among different continents and across different specialties with selfless and extensive collaboration, resulting in advancements in device design and delivery systems. Bifurcated devices were developed and eventually became standard practice. Pioneering work by Timothy Chuter and Roy Greenberg made it possible to extend EVAR into the suprarenal and thoracic abdominal aortic segment.

The EVAR procedure that is done today is vastly different from how it all started and it is difficult to even imagine how the initial devices coupled with the primitive imaging adjuncts worked successfully. That EVAR is today established as the primary treatment modality for most uncomplicated AAAs is in itself a tribute to the sheer determination, vision, and ingenuity of the pioneers of aortic endografting.

**Financial support and sponsorship**
Nil.

**Conflicts of interest**
There are no conflicts of interest.
REFERENCES

1. Vandy F, Upchurch GR Jr. Endovascular aneurysm repair: Current status. Circ Cardiovasc Interv 2012;5:871-82.
2. Parodi JC, Palmaz JC, Barone HD. Transfemoral intraluminal graft implantation for abdominal aortic aneurysms. Ann Vasc Surg 1991;5:491-9.
3. Svetlikov AV. Unknown pages in the history of vascular stent grafting. J Vasc Surg 2014;59:865-8.
4. Björek M. The fall of a giant professor Nicolai Leontyevich Volodos. Eur J Vasc Endovasc Surg 2016;52:3-4.
5. Criado FJ. Nikolay Volodos and the origins of endovascular grafting. Vasc Dis Manage 2012;9:107-8.
6. Parodi JC, Lawrence P. Endovascular revolution in the aorta: 25 years of a landmark case. Vasc News 2016.
7. 15-year EVAR update. Suppl Endovasc Today 2013.
8. Pioneering insights: Why EVAR’s history must guide its future. Endovasc Today 2017;16.