*What have been the most important advances in vascular surgery in the last century and why?*

With amputations having been recorded in the first century by Celsus(1), the history of vascular surgery is extensive. The development of vascular surgical techniques however, as with other surgical specialities, has been tied with the development of aseptic techniques, antibiotics and anaesthetics; and thus, limited to the last century. Consequently, vascular surgery has come a long way since Purmann’s ligations in 1680. This essay considers advances in vascular surgery over the last century (1917-2017) and considers the contributions made by them. In writing this essay, the author has found, as with history, clear periods, defined by vascular surgeons grappling with dreams and applying will and drive to turn them into reality. In the relatively short history of modern vascular surgery, this essay argues that two periods exist: one defined by the ability to turn the ligation and repair of an aneurysm into a successful operation; the other being the endovascular revolution. Although these two periods do overlap, the concepts grappled with are distinct. It should be noted that: while these techniques are now routinely employed, scope remains to improve them and; advancements in vascular surgery over the last century are by no means limited to these two areas.

With modern day’s routine screening for and repairs of abdominal aortic aneurysms (AAAs); lay individuals often perceive vascular surgery as focused around AAA rupture prevention and intervention. Modern approaches to this surgery however, are direct results from experiments in the last century. Matas was the first to ligate an AAA in 1923 with success and patient survival of 18 months, until death due to tuberculosis(2). Dubost in 1951 revolutionised AAA surgery by resecting an AAA and replacing the aorta with an allograft (aorta taken three weeks previously from a 20-year-old woman), a technique quickly latched onto by others(3). Later, Etheredge employed temporary shunts from the distal thoracic aorta to the distal abdominal aorta in his aneurysm operations, which led to DeBakey describing an analogous technique with a bypass shunt. Homograft techniques continued through the late 1950s to the early 1970s. Despite this, procurement and availability of aortas proved limiting. Collaborations by DeBakey in 1954 led to the development of artificial Dacron grafts, further refined and elasticated by Szilagyi(4). Crawford in 1974 began inserting Dacron grafts and reattaching aortic branches to side-arm tubes. Later cases involved inserting artificial grafts directly into aneurysm, which is the inclusion technique similar to modern AAA repair(5).

The combination of successful AAA intervention in 1923 and DeBakey’s collaborations resulting in the creation of Dacron grafts signify leaps forward in open approaches to the AAA and these techniques remain in modern practice for open repair. With approximately 8% of the UK’s men over 65 having one, these techniques have made AAA surgery safe and successful. The UK small aneurysm trial showed that at 5.5cm size, the risk of surgery equals that of an aneurysm rupture and led to widespread employment of this surgery(6). Studies since have led to national screening programmes and routine treatment, all of which would not have been possible without AAA surgery’s pioneers.

While open AAA surgery has saved many lives, it is endovascular approaches which have given rise to the modern-day case operation. Its ability to approach any vessel in the body with minimal risk to the patient and re-canalise, treat aneurysms and fix defects makes it a truly revolutionary means of surgery.

Dotter pioneered and fathered modern interventional radiology. His first contribution in 1950 was the X-ray roll machine, a means of being able to produce machines at a rate of two per second. Dotter’s work in 1958 on dogs to produce an effective means of coronary angiography led to methods employed today in direct injection of contrast media into the coronary vessels; both of these have combined to give us modern, live angiography. An accidental recanalization of the right iliac artery of a patient occurred in 1963. During an attempt to perform an abdominal aortogram, the retrograde introduction of a catheter to the vessel relieved the occlusion. This was followed in 1963 by the successful recanalization of the superficial femoral artery in a patient with a gangrenous left foot, which was for amputation. Gruntzig’s later development and use of the balloon catheter from 1974 to 1978 became key to peri-cutaneous interventions in vascular conditions, including limb ischaemia and myocardial infarctions(7). Combined with Dotter’s work on angiography, this gave rise to the gold standard for myocardial infarction management right up to the 1990s. However, it was work by LeMolle in 1984 and Balko in 1986 that demonstrated that devices could be loaded into a sheath, deployed into the aorta and could be used to exclude AAAs in vivo. In 1990, Parodi translated this into clinical practice in the first EVAR operation in a human patient(8). Sigwart et al. in 1986 deployed the first human coronary stent, which in itself has led to an explosion in coronary interventions(9). Thus, was the birth of the continuing endovascular revolution.

From the endovascular revolution, what was previously a significant operation warranting long stays in hospitals with occasionally poor outcomes, is now considered routine due to endovascular techniques. Today, patients no longer have to consider a risk to life in order to save a limb. EVAR accounted for 77% of intact AAA repairs in the United States of America in 2008. Meanwhile, in one study from 1995 to 2008, the total number of AAA ruptures decreased from 6,535 to 3,298(10). Although not solely attributable to EVAR, it has had a significant part to play in this reduction.

This essay has only scratched the surface regarding vascular surgery. Whilst looking at its history, it is clear that none of these discoveries stands alone as the most important. As science and clinical medicine has shown over years, the acquisition and dissemination of knowledge, with a few revolutionary eureka moments in between, has resulted in whole fields being created or changed. As with history, clear periods are defined where vascular surgeons have latched onto a concept and applied will and drive to turn it into a reality.

Vascular surgery’s progress has saved countless lives and limbs. Its safety has been improved to the point where screening and routine operations are considered safer rather than waiting for an event to respond to. This marks a significant turning point in approaches and concepts of surgery, as prophylactic, rather than reactive interventions dominate the landscape. Developments in one field have translated widely into many others and are not isolated to single vessels. As the population’s lifespan and co-morbidity continues to expand, the need for smart and safe vascular intervention will only increase. Vascular surgery’s history is not over, arguably, it has only overcome its first two major challenges. Its future now lies in developing a means of safely and effectively preventing and treating small vessel disease.

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