

Ascending Aortic Aneurysm Wrapping: The Renaissance of an Old Technique



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In this issue of *Heart, Lung and Circulation*, Kocica revisits an old technique — wrapping of the ascending aorta aneurysm, with a good outcome [1].

Open graft replacement is the gold standard for ascending aortic aneurysm (AA) treatment, and from high-volume centres, the reported mortality can be as low as 0–8% [2]. However, higher mortality and morbidity rates are observed in the elderly and in patients with multiple comorbidities [3]. The Achilles tendons of the conventional ascending replacement are cardiopulmonary bypass (CPB), cross-clamping of the aorta and hypothermic circulatory arrest, which are characterised with a higher risk of permanent neurological injury.

Reducing aneurysm size with partial resection or plication the aneurysmal wall (aortoplasty) with and without supportive wrapping with some artificial graft material was considered to be a less invasive approach for treating AA, without having to replace the diseased aorta.

Since the first case in 1956 [4], quite a few wrapping techniques were introduced (Figure 1). As summarised by González-Santos and Arnáiz-García [5], Ake Senning was the first to wrap the aneurysm with a polypropylene mesh in the 1960s, although published much later [6]. Francis Robicsek championed the introduction and development of reduction aortoplasty at the end of the 1970s as a less invasive substitute for resection of ascending aortic aneurysm (RAA) [7]. Over two decades, reduction aortoplasty established itself as a credible alternative to aneurysm resection with a lower incidence of stroke, myocardial infarction and reoperation compared to the gold standard of open graft replacement [8]. The endeavour to reduce the size, to 35 mm or less, involved excision of an oval segment of the anterior aortic wall. The same result can be accomplished by the plication of the anterior aortic wall with Teflon strips support. However, despite the simplicity and safety of the technique, patients were left with a pathological aorta, carrying a risk of re-dilatation of the aorta or other acute aortic complication [9].

On this basis, cardiac surgeons nearly discarded unwrapped aortoplasty and only sporadically utilised it and complemented it with some synthetic material wrapping. Its advantages over open graft replacement are shorter clamp time, and lower morbidity and mortality. Despite the lack of prospective studies to compare its results with those of other techniques, reported long-term follow-up showed a low incidence of aortic re-dilatation [9,10] and Robicsek reported low incidence (1.1%) of rupture [11]. In 2014, Kiesling et al. confirmed the low incidence of rupture involving the remaining aortic wall [10].

The reoperation rate for re-dilatation of the wrapped aorta is low [6,12,13]. Lee et al. reported that just 1.7% had significant dilatation of any aortic segment during follow-up, with a reoperation rate of only 1.8% to repair residual or recurrent aortic pathology [14].

Aortic re-dilatation has been seen in areas which were not reinforced, or which were insufficiently reinforced, particularly in the non-coronary sinus of Valsalva, and it has also been associated with wrong placement or migration of the prosthesis [2,15]. Diameter reduction is the main objective of wrapping, achieving near-normal dimensions, and in most cases to less than 35 mm in diameter. This goal may be accomplished with diverse materials. The operator can use a straight low-porosity polyester vascular graft of 32 or 34 mm; however, a low-porosity graft is not mandatory since there is no contact with the bloodstream. The low porosity prosthesis may, in theory, be problematic, because it encourages fluid collection between the wrap and the aortic wall, which would inhibit good adherence between both structures [16]. As González-Santos and Arnáiz-García remind us, according to Laplace's law, this effect reduces the stress of the aortic wall. Also, external reinforcement increases the thickness of the aortic wall [5]. Both measures contribute to preventing dilatation and the appearance of dissection or rupture of the AA [17,18]. To avoid migration of the prosthesis, Carrel et al. proposed fixing the prosthesis at the level of

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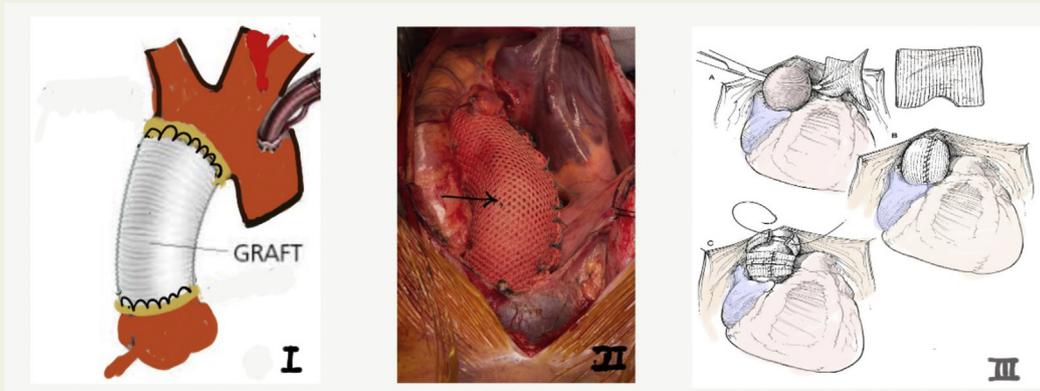


Figure 1 Surgical Repair Techniques for Ascending Aortic Aneurysm (AA). I: Open Graft Replacement with aneurysm resection on bypass. II: Personalised External Aortic Root Support (PEARS) 3D printed Mesh Wrap off-pump. III: a. Graft Wrap b. Wrap using synthetic sheet c. Wrap using Strips of multiple grafts.

sino-tubular junction with the three commissural sutures and one on the non-coronary sinus, where it tends to retract more, to stop its migration [15].

In a recent meta-analysis by Plonek et al., most surgeons managed to reduce the maximum diameter of the aneurysm by 39%, from an average size of 50.5 mm down to 30.7 mm [19]. The compliance of wrapping materials externally is less than that of a normal aorta; this mismatch leads to haemodynamic changes that increase wall stress in the aortic segments closest to the wrapped segment, with further aneurysmal changes [19].

Logically, it is imperative to use an elastic graft that may mimic the regular compliance of the aorta. Moreover, meshes of various synthetic materials can be used, including polyester, polypropylene or polytetrafluoroethylene. To achieve accurate diameter, sizing before implantation is necessary [17,18].

Elasticity allows for a better fit to the aortic contour as well as dynamic expansion [20]. Three-dimensional (3D) printing can be used to custom fit the prosthesis to the aortic wall, to improve the wrap's fit and to prevent any potential displacement, which has been recently used for wrapping dilated aortic roots in patients with Marfan's Syndrome [12].

While in most cases wrapping of the AA is a concomitant procedure with the correction of other cardiac pathologies, surgeons have done it as an isolated procedure, sometimes without the need of CPB [21].

In a biomechanical analysis, Plonek et al. recorded lower aortic wall stress on the inner surface of the wrapped aorta compared to the non-dilated one [22]. The highest stress was found distally in the wrapping model, at the junction between the AA and the aortic arch.

These changes seem to be less potent when the AA is reinforced with a Dacron mesh instead of with a vascular conduit [22], probably due to its increased elasticity, and healing into one layer.

Because of the reduction of the forces affecting the supported aortic wall it is possible to explain good follow-up

results and low incidence of acute aortic syndrome reported by Lee and Plonek [14,22].

However, there is no evidence that the changes described in the wrapped aortic wall increase the risk of an acute aortic syndrome [14].

In a systematic review and meta-analysis, Plonek et al. reported the short term and long term results of wrapping, with and without reduction aortoplasty, in 722 patients; early mortality was 1.5%, was independent of surgical technique [19]. No deaths were associated with isolated wrapping. The combination of aortic valve replacement and AA wrapping has not increased either early morbidity or mortality of the procedure [14,21,23–25], compared to a slight increase (2%) in patients who underwent concomitant aortic reduction with resection of the aortic wall [7].

Blood and products usage and postoperative hospital stay were also reduced in patients who underwent wrapping than in those who underwent AA replacement [13].

Surgeons follow the most recent clinical practice guidelines' recommendation to replace the dilated AA in symptomatic patients and asymptomatic patients with an aortic diameter of 55 mm [26–29]. Nevertheless, it is still debatable what to do when one operates on a patient with different pathology, and the aorta is mildly aneurysmal, between 40 and 50 mm.

Because of the risk of further dilation and unpredicted complications, most surgeons have a low threshold to progress to repair the AA in some way. It is also known from the International Registry of Acute Aortic Dissection (IRAD) that aortic dissections happen at an aortic diameter lesser than indicated for its replacement [30], which would justify prophylactic approaches to the AA while repairing another cardiac pathology.

Wrapping of the AA may be considered in patients with essential comorbidities in whom the risk of conventional aortic replacement is too high.

There is some evidence that reverse remodelling can happen following wrapping of the aorta during the early stages of the disease before irreversible damage has occurred [31];

this may stabilise its size and reduces the aortic wall stress. In patients who need aortic valve surgery or other cardiac procedures alongside AA, this technique may be desirable because of the anticipated reduction of surgical risk. For the safest outcomes, elastic and easily manageable prostheses should be made available specifically for wrapping the AA, without the inherent disadvantages of other currently available vascular prostheses.

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