Coronéo extra-aortic annuloplasty ring could stabilize even the pulmonary autograft annulus in a Ross operation

Jan Vojacek,*, Jaroslav Spatenka, Tomas Holubec and Pavel Zacek

a Charles University in Prague, Faculty of Medicine and University Hospital, Hradec Kralove, Czech Republic
b Department of Transplant Centrum, University Hospital Motol, Prague, Czech Republic
* Corresponding author: Department of Cardiac Surgery, University Hospital Hradec Kralove, Sokolska 581, 50005 Hradec Kralove, Czech Republic.
Tel: +420-49583-2242; fax: +420-49583-3026; e-mail: vojacek.jan@fnhk.cz (J. Vojacek).

Abstract
The Ross procedure is an alternative technique to mechanical prosthesis and recent evidence suggests that it is associated with improved long-term survival and quality of life. However, late pulmonary autograft failure can occur more frequently in patients with significant dilation of the aortic annulus. Here, we present a technical modification of the Ross procedure—a case report of a patient who underwent a Ross procedure in which the gross dilation of the aortic annulus was reduced by implantation of an extra-aortic Coronéo annuloplasty ring. Before discharge, we performed a multidetector computed tomography (MDCT) to verify the effect of extra-aortic annuloplasty on the geometry of the neoaortic root and particularly on the dimension of the aortic annulus. The result of the MDCT demonstrated that the ring sits in the optimal position at the level of aortoventricular base and that aortic annulus is significantly reduced.

Keywords: Ross procedure · Pulmonary autograft · Aortic annuloplasty · Aortic valve replacement

INTRODUCTION
Replacement of the diseased aortic valve with a pulmonary autograft (PA) (Ross procedure) [1] is an alternative technique to mechanical prosthesis in a carefully selected group of active young or mid-age patients who do not wish to be on anticoagulant treatment. The advantages of the PA are excellent haemodynamics, the reduction of thromboembolic and bleeding complications, resistance to infection when compared with the prosthetic valve substitutes, and a potential for autograft growth in children. After a renewal of interest in this procedure in the early 1990s, long-term results of the Ross procedure are beginning to emerge. It now appears that autograft dilation may occur over time eventually mandating reoperation. The pattern of PA failure has been repeatedly described; with dilation of the aortic annulus being one of the most prevalent presentations [2, 3].

Here, we present a technical modification of the Ross procedure aimed at mitigating potential long-term autograft annular dilation by implantation of an extra-aortic Coronéo annuloplasty ring (Coronéo Inc., Montreal, QC, Canada). This ring has been designed by E. Lansac with the aim to reduce and stabilize the aortic annulus during aortic valve sparing procedures [4].

CASE PRESENTATION
A 54-year-old male patient was scheduled for the Ross procedure because of severe aortic regurgitation of his bicuspid aortic valve. According to transoesophageal echocardiography (TEE), he had a gross dilation of the aortic annulus (up to 32 mm) and moderate dilation of the aortic root and ascending aorta. The diameter of the pulmonary artery annulus was 27 mm.

Surgical technique
The operation was accomplished through median sternotomy, on conventional cardiopulmonary bypass, with aortic and bivacal cannulation. After cross-clamping of the aorta and administration of cardioplegia, an aortotomy was performed and the diseased aortic valve excised. The diameter of the aortic annulus was 32 mm. The PA was harvested and the size of its annulus was 27–28 mm.

The technique of Coronéo ring implantation has been described elsewhere [4]. Briefly, the coronary buttons were excised and the aortic root dissected as far as the level of the aortic annulus. Five pledgeted mattress sutures were placed circumferentially, from inside out in the subvalvular plane. Three sutures were placed 2 mm below the nadir of insertion of each cusp, and two sutures were placed below two of the three commissures at the base of the interleaflet triangles. No suture was placed at the base of the interleaflet triangle between the right and non-coronary cusps to avoid potential injury to the bundle of His (Fig. 1A). The proximal anastomosis of the PA was then performed with multiple interrupted sutures. The five anchoring mattress stitches were passed through a 31-mm Coronéo ring and tied down externally at the level of aortic annulus (Fig. 1B). The coronary buttons were reimplanted into the PA and the...
continuity of the right ventricular outflow tract was restored with cryopreserved pulmonary allograft. The dilated ascending aorta was replaced with a 26-mm Dacron vascular graft (Vascutek, Scotland, UK).

On the perioperative TEE, the aortic annulus diameter was measured at 22 mm, and there was only trace aortic regurgitation with good leaflet coaptation above the level of the aortic annulus. The patient’s postoperative course was uneventful. Before discharge, we performed a multidetector computed tomography (MDCT) to verify the effect of extra-aortic annuloplasty on the geometry of the neoaortic root and, especially on the dimension of the aortic annulus (Fig. 2).

**DISCUSSION**

The adverse impact of the dilated aortic annulus on the long-term function of PA is well known [2, 3]. There is also scientific evidence that surgical reduction of a dilated aortic annulus may improve the durability of the PA. The investigators from the German–Dutch Ross Registry demonstrated that routine reinforcement of the aortic annulus resulted in a lower reoperation rate [5]. Different surgical techniques of reducing and stabilizing the dilated aortic annulus have been described [2, 3, 5]. The use of the extra-aortic Coronéo ring for this purpose may have the following

![Image of aortic root with annulus and leaflets]
advantages: The Coronéo ring is both flexible and expansible and thus preserves the systolic expansion of the aortic root at the level of the interleaflet triangles. This technique is easy and reproducible, and could be used to stabilize the PA annulus as well. It represents an analogy to the classical use of the ring in aortic annulus dilation, so we may hypothesize improvement of the PA durability. Some questions can be raised regarding this technique. In an ideal situation, the ring should be placed in a single horizontal plane at the level of the aortoventricular base. Based upon our experience from Coronéo ring implantation in aortic root remodeling, this may be difficult because of external anatomical limitation. The right coronary sinus and subcommissural triangles of left coronary/right coronary and right coronary/non-coronary commissure face the right ventricular outflow tract and membranous septum. In this region, the ring may actually be implanted in a supra-annular fashion. The postoperative MDCT was performed to clarify whether the ring was implanted in a proper position. The result of the MDCT demonstrated that the ring sits in the optimal position at the level of aortoventricular base (Fig. 2B). The other important issue is the sizing of the ring. The aim of extra-aortic annuloplasty is to reduce the dilated aortic annulus to match the diameter of the PA. The Coronéo ring is positioned from the outside of the native aortic annulus and with the walls of the aorta and the PA located between the ring and the lumen of the PA. Knowing this, we decided to use a relatively bigger size of the ring (31 mm). According to the MDCT measurement, the maximum and minimum PA annulus inner diameters were proved to be 25 and 22 mm, which we believed to be optimal (Fig. 2A).

In conclusion, we believe that this technique may be used when performing the Ross procedure in patients with a dilated aortic annulus. It might improve the durability and long-term results of the PA, and thus reduce the rate of reoperations in this particular group of patients.

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**REFERENCES**


