Aortic valve/root procedures in patients with an anomalous left circumflex coronary artery and a bicuspid aortic valve: anatomical and technical implications

Markus Liebricha,b,*, Ioannis Tzanavarosac, Michael Scheida,b, Wladimir Votha, Kai-Nicolas Dolla and Wolfgang B. Hemmera

a Department of Cardiac Surgery, Sana Cardiac Surgery Stuttgart, Stuttgart, Germany
b Department of Congenital Cardiac Surgery, Sana Cardiac Surgery Stuttgart, Stuttgart, Germany
* Corresponding author. Sana Cardiac Surgery Stuttgart GmbH, Herdweg 2, 70174 Stuttgart, Germany. Tel: +49-711-27836001; fax: +49-711-27836009; e-mail: markus.liebrich@sana.de; markus.liebrich@gmx.net (M. Liebrich).

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Abstract

An anomalous origin of the left circumflex coronary artery that arises as a side branch of the right coronary artery from the right coronary sinus of Valsalva encircling the aortic annulus is usually an incidental finding. However, in patients undergoing aortic valve procedures, its existence can significantly complicate the surgical treatment. We report our operative strategy in patients with an anomalous left circumflex coronary artery, a bicuspid aortic valve morphology and different aortic valve pathologies.

Keywords: Aortic root remodelling • Aortic valve replacement • Anomalous circumflex coronary artery • Bicuspid aortic valve

INTRODUCTION

A left circumflex coronary artery (LCX) with a separate ectopic ostium originating from the right sinus of Valsalva is among the most common anatomic variations, but usually has no clinical significance. (Fig. 1A) [1]. A rare specific anatomical malformation represents the anomalous LCX arising from the proximal right coronary artery. However, the incidence of coexisting coronary anomalies is more frequent in patients with a bicuspid aortic valve (BAV) morphology. Coronary artery anomalies and BAV have been described as risk factors for coronary complications after aortic valve/root procedures [2]. Since many of these patients are potential candidates for surgical aortic valve/root interventions throughout their lifetime, appropriate imaging before surgery is crucial to understanding the spatial relationship between the anomalous coronary arteries and the aortic valve/root. A review of the current literature shows that there are only a few reports regarding this entity, and recommendations on how to deal with this special anatomical aberration do not exist. Therefore, we report our series of 6 cases in order to present different surgical strategies if aortic valve replacement or aortic valve/root repair is required in patients with either a stenotic or an insufficient BAV and a concomitant aberrant LCX.

MATERIALS AND METHODS

Between January 2012 and April 2013, 6 consecutive patients with a diagnosis of aortic valve stenosis/regurgitation, BAV and an anomalous LCX were referred to our department for surgical treatment. The detailed patient characteristics are given in Table 1.

Surgical technique

In all patients, the chest was opened by median sternotomy and mild hypothermic cardiopulmonary bypass (32–34°C) was initiated with distal aortic and right atrial cannulation. After aortic cross-clamping and infusion of antegrade crystalloid cardioplegia, a transverse aortotomy at the sinotubular junction was performed. A 1.0- or 1.5-mm coronary probe was placed into the assumed anomalous LCX originating from the right coronary sinus in close proximity to the commissure between the right- and non-coronary sinus to verify the retro-aortic course between the aortic root and the left atrial roof. The anomalous, non-calcified LCX was sharply dissected free from the aortic wall along its entire dorsal run, lateral and then posterior to the aorta at the level of the annulus until its course was identified in the atrio-ventricular groove. In the 4 cases of a heavily calcified BAV, the diseased aortic valve cusps were excised and different types of stented bioprostheses were implanted to the debrided aortic annulus while paying meticulous attention to the mobilized anomalous LCX when placing annular sutures (Fig. 1B). The remaining 2 patients had aortic regurgitation of two different aetiologies. One patient presenting with aortic regurgitation due to an ascending aneurysm and a dilated, non-coronary sinus with thin, non-calcified BAV cusps (Sievers type 1/L-R) was treated by selective one-sinus...
repair and central plication of the fused left-right coronary cusps (W.L. Gore & associates, Flagstaff, AZ, USA) [3]. After resecting the aneurysm, identification and surgical separation of the anomalous LCX from the aortic root followed, and the morphology of the aortic sinuses and valve cusps was assessed. When tube graft sizing was made, a vascular graft (Hemashield, Natick, MA, USA) was trimmed for selective one-sinus repair. The dilated non-coronary sinus was excised leaving a minimal rim of aortic wall attached to the aortic valve. The tongue of the Dacron prosthesis was sewn to the rim of the aortic wall with 4-0 polypropylene (Ethicon, Norderstedt, Germany) running suture passing through the aortic annulus, preserving the integrity of the mobilized LCX (Fig. 1C).

The mechanism for aortic regurgitation in the other patient was a prolapse of the fused left-/right coronary cusps. After adequate detachment of the anomalous LCX from the aortic annulus, subcommissural plication could be performed underneath the non-/left-coronary commissure, thereby avoiding possible injury to the vessel when placing the sutures. The patients were weaned from cardiopulmonary bypass in sinus rhythm.

RESULTS

Intraoperative transoesophageal echocardiography revealed no regional wall motion abnormality and a normally functioning bioprosthesis in 4 patients. In all 6 patients, creatine kinase MB fraction (CK-MB) showed insignificant values at all times after the operations. In the 2 patients with aortic regurgitation, trans-oesophageal echocardiography demonstrated reconstructed BAV without significant aortic valve regurgitation. The perioperative electrocardiograms were unchanged compared with preoperative tracings.

All patients survived the procedure without complications. Echocardiography performed during the hospital stay showed no clinically relevant aortic regurgitation or mean gradient (10 ± 2 mmHg) across the implanted bioprosthesis/reconstructed aortic valve. All patients were alive and in New York Heart Association functional class I. Transthoracic echocardiography and graded exercise testing was performed in all 6 patients (mean, 7 months; range, from 4 to 17 months). All patients were symptom-free, exercise stress echocardiography was negative in all 6 patients. Postoperative data are given in Tables 1.

DISCUSSION

The incidence of coronary artery anomalies from the aorta is ~1% [4]. The most common anomaly is origin of the anomalous LCX from the right sinus of Valsalva by a separate ostium. This anomaly appears to be more frequent in patients with BAV. McAlpine previously published a rightward displacement of the anomalous LCX/right coronary ostia in patients with a tricuspid aortic valve, which resulted in a short spatial relationship of the anomalous coronary artery and the aortic annulus. In contrast, we observed in all 6 patients substantial differences before and at operation with respect to landmark coronary morphological features associated with BAV compared with that noted in a tricuspid aortic valve [5]. We found the anomalous LCX adherent to the complete dorsal run of the non-/left-coronary sinus of Valsalva.

Figure 1: (A) Preoperative coronary angiogram. The anomalous left circumflex coronary artery (LCX) originated from a common ostium from the right coronary artery (RCA) and coursed behind the aortic annulus. (B) Intraoperative photography demonstrating mobilization of the LCX (arrows; vessel loops) and implantation of a bioprosthetic valve (Ethicon, Norderstedt, Germany) in an end-to-side manner. (C) Dissection of the anomalous LCX (arrows) away from the aortic annulus to enable safe aortic root remodelling using a selective one-sinus repair. (D) Volume rendering image of the top of the heart showing the retroaortic course of the LCX (arrows) and its close proximity to the aortic annulus, especially alongside the non-/left-coronary sinus of Valsalva.
Valsalva in all 6 patients (Fig. 1D). However, in this series, the anomalous LCX arises exclusively as a side branch of the proximal right coronary artery. Therefore, patho-anatomy and concomitant surgical strategy are different due to the fact that the common ostium cannot be transferred without compromising one of the vessels [6]. Unroofing is also not a surgical option in these patients because of a missing intramurally coursing segment of the LCX [7]. The presence of an anomalous LCX in this patient cohort undergoing aortic valve/root procedures can lead to serious complications. These include coronary vessel injury by suture ligation or compression by prosthetic ring, inducing prosthesis-patient-mismatch by implanting a smaller-sized prosthesis to avoid coronary artery distortion, LCX injury during resection of the non-coronary sinus of Valsalva or during suturing for selective one-sinus repair [2–4]. These sequelae were a major driver for development of the proposed surgical strategy by precise mobilization of the anomalous LCX away from the aortic annulus to perform safe aortic valve/root surgery. In evolving technologies like sutureless aortic valve replacement, the described operative manoeuvre could also be relevant to achieve maximal of procedural safety and accuracy. A word of caution should be added to patients with this coronary anomaly who are referred for transcatheter aortic valve replacement due to possible coronary obstruction in self-expanding and especially in balloon-expandable valves. In our opinion, a combination of thorough diagnostic work-up and consequent mobilization of the anomalous LCX in the setting of BAV morphology are essential cornerstones to minimize the potential operative risk during aortic valve/root procedures in this patient subset.

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REFERENCES