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HOW TO DO IT

"*Mantle-style*" modification of Cabrol shunt for hemostasis after extended aortic reconstruction in acute type A aortic dissection

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Abstract
Cabrol shunt and several of its modifications have been used as adjunctive procedures to control inaccessible bleeding occurring after aortic root surgeries. Nevertheless, the hemostatic effect of the shunt is suboptimal when the reconstructive procedure extends to the aortic arch and coronary arteries. We propose a "*Mantle-style*" modified Cabrol shunt to facilitate hemostasis of the exsanguination from the neo-root after aortic root replacement with concomitant arch and coronary reconstruction.

Keywords Acute type A aortic dissection · Modified Cabrol shunt · Hemostasis

Introduction

Despite improvements in both surgical and non-surgical hemostatic techniques, uncontrolled bleeding after aortic surgeries remains an undesired and frustrating complication. Since the classic "perigraft-to-right atrium" shunt proposed by Cabrol et al. [1] by wrapping the neo-aorta using the native aneurysmal aortic wall and shunting the aneurysm sac to the right atrium, several modifications have been published and applied not only to aortic aneurysmal diseases, but also to acute type A aortic dissection (aTAAD), using different coverage materials and drainage sitesHerein, we propose a novel modification of Cabrol shunt to facilitate hemostasis after extended root, arch, and coronary reconstruction for aTAAD [2–7]. Herein, we propose a novel modification of Cabrol shunt to facilitate hemostasis after extended root, arch, and coronary reconstruction for aTAAD.

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Case summary and surgical technique

A 43-years-old man presented to the emergency department with acute chest pain, shortness of breath, and low blood pressure. The diagnosis of aTAAD was confirmed using computed tomography angiography (CTA), which demonstrated the intimal flap extending from the aortic root to the juxtarenal abdominal aorta, with a suspicious intimal tear at the aortic arch. Additionally, transthoracic echocardiography revealed severe aortic insufficiency and a large amount of pericardial effusion. Coronary malperfusion was evident by diffuse ST segment depression on electrocardiogram and elevated cardiac enzymes. Acute liver and kidney injuries also presented. An emergency operation was performed. Due to presence of systemic malperfusion and preoperative hemodynamic instability, composite root replacement using a 26 mm Gelseal™ vascular graft (Vascutek/Terumo, Inchinnan, Scotland, UK) and a 23 mm STM Regent™ mechanical aortic valve (St. Jude Medical/Abbott, St. Paul, Minnesota, USA) was performed without attempting a valve-sparing procedure. The left main coronary was re-implanted with a "Button-Bentall's" technique. The presence of proximal right coronary artery dissection and the fragile aortic tissue surrounding the right coronary orifice precluded the "Button-Bentall" style reimplantation. A salvage coronary artery bypass graft (CABG) using a great saphenous venous graft to revascularize the middle part of right coronary artery was done and the right coronary artery orifice was ligated.

Distally, a semi-arch replacement with innominate and left common carotid artery reconstruction to completely exclude the arch tear site was performed using a 26-mm Gelseal™ 4-branch plexus vascular graft (Vascutek/Terumo, Inchinnan, Scotland, UK). The proximal and distal pieces of aortic grafts were anastomosed to each other to complete the reconstructive procedure and the patient was then weaned from cardiopulmonary bypass smoothly (Fig. 1a), but persistent bleeding from the neo-root developed. Several attempts of direct repair failed to achieve a satisfied hemostasis. To avoid additional cardiopulmonary bypass and re-clamping of the aorta, the replaced neo-root was not taken down and a modified Cabrol shunt was performed without re-establishing extracorporeal circulation.

The "*Mantle*" was designed by making an incision through one border of a 15 × 15-cm glutaraldehyde-treated bovine pericardial patch (Edwards Lifesciences, Irvine, California, USA) to the center and excising a circular shape at the central part. The diameter of the circle was equal to the size of the aortic graft (Fig. 1b). The aortic graft was retracted by assistant to expose the right pulmonary artery and the dome of the left atrium, and the transverse pericardial sinus was closed securely. The aortic graft was then encircled by the pericardial patch, and the inner circular border (the "*Collar*") of the patch was sutured to the graft, proximal to the graft-to-saphenous vein anastomosis site. The outer border (the "*Bottom*") of the pericardial patch was then sutured to the surrounding great vessels and cardiac structures, including the right pulmonary artery superoposteriorly, superior vena cava and right atrium right laterally, main pulmonary trunk and right ventricular infundibulum left laterally, and right ventricular free wall inferoanteriorly (Fig. 1c). The previously made incision (the "*Placket*") over the pericardial patch was closed, and the neo-root was completely covered with the pericardial "*Mantle*", which was under the saphenous venous graft (Fig. 1d). Finally, the shunt was completed by interposing an 8-mm graft between the pericardial patch and the brachiocephalic vein (Fig. 2a, b).

Exsanguination was controlled and the sternum was left unclosed after the initial operation. On the second operative day, the sternal wound was closed with again confirmed good hemostasis, although continuous blood flow within the pericardial patch was still detected by transesophageal echocardiography. The patient had an otherwise uncomplicated postoperative course and was discharged from hospital 2 weeks later. A CTA 3 months later revealed a spontaneously occluded shunt and a well-contained pseudoaneurysm, without compromising the coronary arteries and adjacent cardiac structures (Fig. 2c). The patient remained asymptomatic and intervention for defect closure would be discussed.

Discussion

An extended arch reconstruction in addition to aortic root replacement is occasionally necessary for patients with aTAAD, and a concomitant CABG is also not uncommon for those with associated coronary dissection. To facilitate arch reconstruction, the caudal part of the pericardial reflection is widely opened, and the mediastinal structure is extensively dissected to adequately explore the aortic arch and brachiocephalic vessels. The left pleural space might also be opened if the aortic reconstruction extended to proximal descending thoracic aorta. Once an inaccessible bleeding of the neo-root develops, the previously proposed modifications of Cabrol shunt, composed basically by "anterior coverage" using either an autologous pericardium or a bovine pericardial xenograft, could not achieve hemostasis and continuous bleeding into the loose upper mediastinal or pleural spaces would be a sorrowful end. Moreover, the presence of CABG could also make the "anterior coverage" difficult. Our "*Mantle-style*" modification of Cabrol shunt has a pericardial patch containing the bleeding within the pericardial space proximally and located under the saphenous venous graft. We believe it could be an ideal salvage procedure to control devastating neo-root bleeding in patients with aTAAD undergoing complex aortic reconstruction.

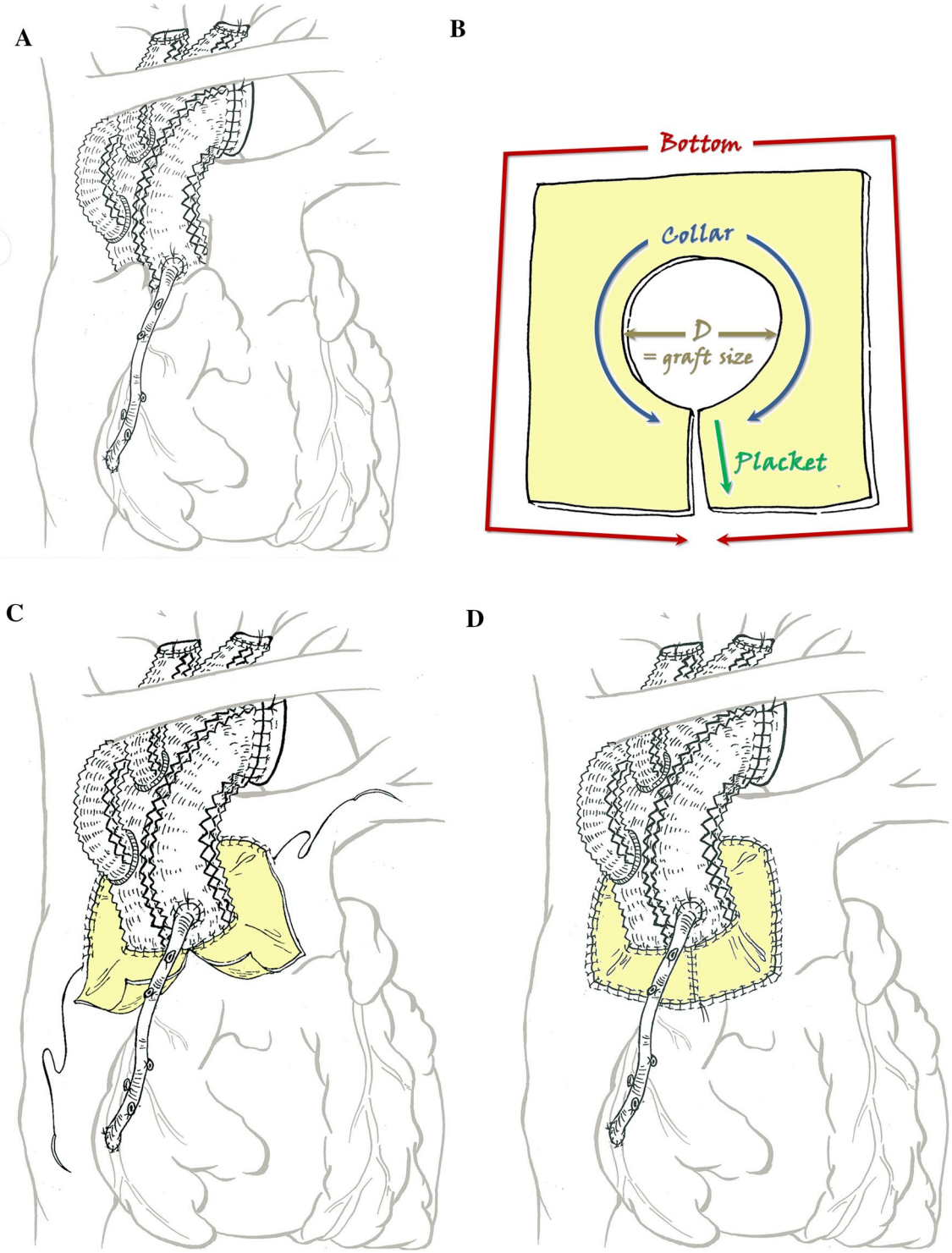

Fig. 1 **a** Aortic root replacement with a concomitant arch reconstruction and coronary artery bypass graft. **b** The design of the pericardial "*Mantle*". **c**, **d** The aortic graft is encircled with and sewn to the pericardial patch, which is under the saphenous venous graft, and the outer border of the patch is sewn to the surrounding great vessels and cardiac structures to cover the neo-root

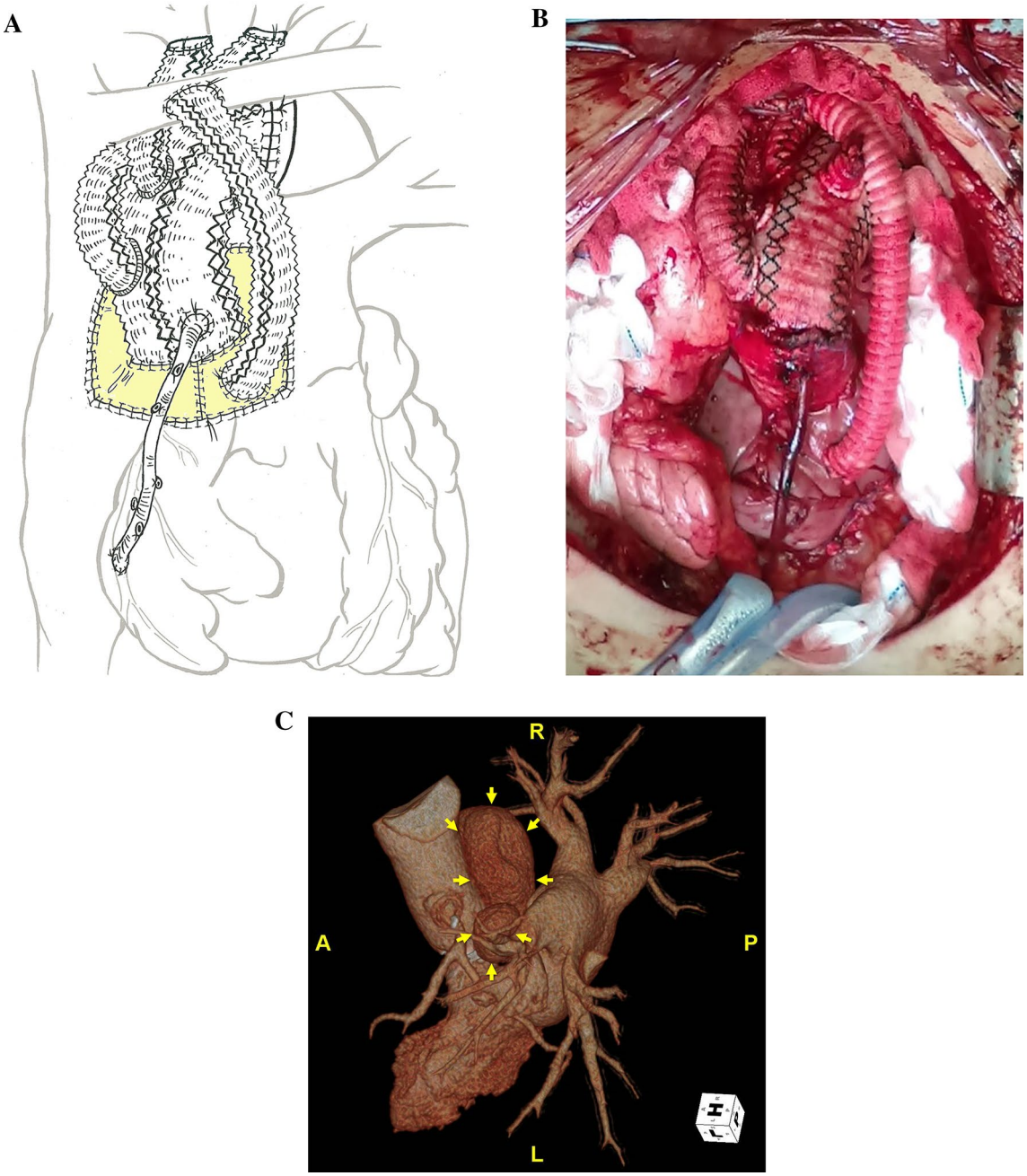

Fig. 2 **a** Completion of the "*Mantle-style*" modification of Cabrol shunt. **b** Intraoperative picture of the present case. **c** Left superolateral aspect of reconstructed CTA image postoperatively showed occluded shunt and residual pseudoaneurysm contained in the pericardial patch (arrows), without compromising the coronary arteries and adjacent cardiac structures

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Compliance with ethical standards

Conflict of interest All authors declare no conflict of interest.

References

1. Cabrol C, Pavie A, Gandjbakhch I, et al. Complete replacement of the ascending aorta with reimplantation of the coronary arteries: new surgical approach. J Thorac Cardiovasc Surg. 1981;81:209–15.
2. Hoover EL, Hsu HK, Arisan E, et al. Left-to-right shunts in control of bleeding following surgery for aneurysm of the ascending aorta. Chest. 1987;91:844–9.

3. Maisano F, Lorusso R, Alfieri O. The periprosthetic sac-innominate vein shunt: an effective way to control bleeding after aortic root operations. J Thorac Cardiovasc Surg. 1995;109:396.
4. Posacioglu H, Apaydin AZ, Calkavur T, Yagdi T, Islamoglu F. Perigraft to right atrial shunt by using autologous pericardium for control of bleeding in acute type A dissections. Ann Thorac Surg. 2002;74:1071–4.
5. Salerno TA, Carvalho EMF, Panos AL, Ricci M. Modified Cabrol shunt after complex aortic surgery. Ann Thorac Surg. 2008;86:669–70.
6. Kitamura T, Kinoshita O, Ono M. Radical surgical repair with stepwise Cabrol shunt for severe prosthetic valve endocarditis. Interact Cardiovasc Thorac Surg. 2012;14:689–91.
7. Zhang H, Wu X, Fang G, Qiu Z, Chen LW. Is it justified to apply a modified Cabrol fistula in surgical repair of acute type A aortic dissection? J Thorac Cardiovasc Surg. 2019. https://doi.org/10.1016/j.jtcvs.2018.12.082 **[Epub ahead of print]**.