Surgical repair of anomalous connection of the left coronary artery

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Abstract
An asymptomatic 10-year-old girl with anomalous connection of the left coronary artery to the pulmonary artery (ALCAPA) underwent successful surgical repair to create a two-artery coronary system with a coronary elongation technique using an autologous pulmonary arterial wall flap. This technique facilitates direct and tension-free coronary artery re-implantation.

Keywords
Coronary elongation, pulmonary arterial wall flap, two-artery system

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Introduction
Two-artery coronary system repair is considered the optimal procedure for treating anomalous connection of the left coronary artery to the pulmonary artery (ALCAPA), but this method is not suitable for all cases due to the distance between the empty left aortic sinus and the site of origin of the anomalous coronary artery. A longer distance most likely precludes direct implantation and makes the tunnel (Takeuchi) repair necessary.1 In the present report, surgical repair of the anomalous coronary artery to the aortic root was successfully performed with a coronary elongation technique,2–6 which uses a sizable autologous pulmonary arterial wall flap for coronary extension.

Case report
Use of the patient’s data was approved by the Ashikaga Red Cross Hospital institutional review board and the parental informed consent has been obtained for this report. A 10-year-old girl was referred to our hospital for evaluation of an asymptomatic heart murmur. Echocardiography showed normal left ventricular function without segmental wall motion abnormalities, and extraordinarily dilated bilateral coronary arteries. Color flow Doppler imaging showed that the blood flow pattern of the entire left coronary system was retrograde. Myocardial scintigraphy showed an abnormal ischemic response at the anteroseptal segment. Cardiac catheterization demonstrated a single, extraordinarily dilated right coronary artery arising from the aorta and retrograde filling of the similarly dilated left coronary system that produced opacification of the pulmonary trunk (Figure 1). Given the objective findings of ongoing myocardial ischemia, surgical reconstruction was indicated. After median sternotomy, cardiopulmonary bypass was instituted with standard aortic and bicaudal venous cannulation. The heart was arrested with antegrade blood cardioplegia infused into the ascending aorta. A transection was made in the pulmonary trunk just below the bifurcation. The ostium of the left coronary artery was located at the posterior aspect of the pulmonary trunk. After identification of the origin of the left coronary artery, additional infusion of cardioplegia was administered to the ostium of the left coronary artery. The left coronary artery was excised as a button together with a sizable amount of tissue from the pulmonary arterial wall. The proximal portion of the left coronary artery was mobilized with care. Both side edges of the excised flap were sutured to each other with 7-0 monofilament suture to form an extension tube to lengthen the left coronary artery (Figure 2). In the present case, this procedure extended the left coronary ostium to a length of about 10 mm. An opening was made in the left lateral side of the ascending aorta. The anastomosis was performed using 7-0 monofilament continuous suture. After

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reconstruction of the resultant defect in the posterior aspect of the pulmonary trunk with an expanded-polytetrafluoroethylene (e-PTFE) patch, the aortic cross-clamp was released. Then, the transected pulmonary trunk was anastomosed in an end-to-end anastomotic fashion on an empty beating heart. The patient’s postoperative course was uneventful. Postoperative multidetector computed tomography angiography showed that the newly implanted left coronary artery was patent and anastomosed to the ascending aorta without stenosis (Figure 3).

**Discussion**

ALCAPA is a rare congenital heart disease with a high mortality rate. Survival beyond the first year of life may be related to the presence of rich interarterial collaterals from the right coronary artery, or possibly associated with a slightly restricted opening between the left coronary artery and the pulmonary trunk. However, such patients still remain at risk of death from myocardial ischemia. Therefore, upon diagnosis, patients with ALCAPA who survive beyond childhood need surgical coronary reconstruction even if they are asymptomatic. Direct transfer of the anomalous connection of the left coronary artery into the aortic root

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**Figure 1.** Preoperative coronary angiography shows that collaterals from the significantly dilated right coronary artery (RCA) feed the left coronary artery (LCA), in which flow is reversed, and the left coronary artery drains into the main pulmonary artery (PA).
Ao: aorta.

**Figure 2.** (a) The pulmonary trunk is transected, and the origin of the left coronary artery is detached from the pulmonary artery along with a sizable tissue flap from its posterior wall (*). (b) The excised pulmonary arterial wall flap is folded over with a single 7-0 polypropylene suture line laterally to produce a tube. (c) The extended coronary arterial conduit is anastomosed to the left lateral aspect of the ascending aorta (arrow). The resultant defect of the posterior aspect of the pulmonary artery is reconstructed using an e-PTFE patch (**). Ao: aorta, PA: pulmonary artery, e-PTFE: expanded-polytetrafluoroethylene.
appears to be an ideal procedure, but it is not always possible. It depends on the distance between the empty left aortic sinus and the site of origin of the anomalously connected left coronary artery. Various operative procedures have been reported to achieve coronary transfer in ALCAPA treatment. Katsumata and Westaby reported the composite conduits made from both native pulmonary artery and aortic wall flaps, which were harvested in the longitudinal direction from both the great arteries. Amanullah et al. described the same autogenous conduits that were harvested in the transverse direction from both the great arteries. These methods are more complicated procedures than ours, but it can be an effective alternative in some situations, such as when the distance between the ALCAPA and the aorta is much greater than anticipated. Erdinc et al. proposed rolled-conduit implantation, which is a similar technique to ours with only one suture line for creating a sizable pulmonary arterial wall flap. However, there is a contrasting difference in the direction of harvesting the pulmonary arterial wall flaps. Erdinc described the technique harvesting the pulmonary arterial wall flap in the longitudinal direction from the pulmonary artery. On the other hand, in our method, the pulmonary arterial wall flap was harvested from the transverse direction. The advantage of our method is that the harvested flap keeps in an anatomically correct axis easily. The selection of which procedure to apply and which way to harvest the aortic wall flap or pulmonary arterial wall flaps should be decided based on the patient’s age, figure, relation between the location of the ostium of ALCAPA and pulmonary valvular structures, and the distance between the ostium of ALCAPA and the ascending aorta. This method is feasible in most patients. It is simple and less time consuming, and ensures a wide and lengthy extension. Moreover, it may decrease the risk of bleeding.

This method is not only very useful to allow tension-free coronary transfer, but it also has the potential of allowing conduit growth with the patient’s growth. It can provide complete arterialization of the two-artery coronary system, while avoiding the inherent problems associated with coronary artery bypass grafting or tunnel procedures. In the present case, an e-PTFE patch was used for the repair of the pulmonary artery deficit. However, the e-PTFE patch does not grow and in smaller children might possibly lead to supravalvular stenosis later in life. Therefore, long-term follow-up is necessary.

**Conclusion**

A coronary elongation technique using an autologous pulmonary arterial wall flap is a suitable method to perform for repair of ALCAPA. This technique facilitates direct and tension-free coronary artery re-implantation.

**Conflict of interest**

Present author of this manuscript has no any financial or personal relation with other people or organizations that could inappropriately influence this work.

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