coronary extensively. The sinus of Valsalva was recreated with another photo fixed bovine pericardial patch. The mobilized coronary button was implanted into the patch by use of the trapdoor technique, and the aorta was reclosed (Fig 1B). The LAD distribution then appeared to have normal perfusion. Left ventricular activity was diminished, but this was thought to be due to repeated cross-clamp periods and a relatively prolonged period of ischemia in the LAD distribution. The patient was then given extracorporeal membrane oxygenation (ECMO) to provide hemodynamic support. The patient was weaned from ECMO 48 hours later, the remainder of the hospital course was uneventful, and she was discharged home on the eighth postoperative day. Echocardiography at the time of discharge revealed normal left ventricular function. The patient remains well 3 years after operation, with normal biventricular function and trivial (<10 mm Hg) gradients across the left and right ventricular outflow tracts.

Comment

Supravalvular aortic stenosis (SVAS) remains a challenging surgical problem. Some variation of the three-sinus reconstruction technique has been widely adopted, despite the scarcity of data demonstrating improved clinical outcomes in comparison with single- and dual-sinus techniques [1–5]. Nevertheless, SVAS is a disease of the entire aortic root, and a symmetric repair offers the potential for greater relief of pressure gradients and may improve coaptation of the aortic valve [4, 5].

The incision onto the left sinus must be rightward of the left coronary orifice to prevent injury to the left coronary artery. Overenlargement of the aortic sinuses has been described as a potential cause of aortic valvar insufficiency [2], but impact on coronary perfusion has not been previously noted. The diameters of the annulus and sinotubular junction are similar, and in this case were assessed by echocardiography. However, echocardiography may not provide an accurate estimation of diameter if the measurement is not made at the greatest diameter. This may have led to oversizing of the patches, leading to kinking of the LAD. Direct measurement of the sinotubular junction and annulus may have provided a more accurate measurement. Another possible explanation is that the sinuses may have also been asymmetrically affected, with the left sinus requiring less patch augmentation in comparison with the other sinuses. Finally, the angle of the left coronary takeoff may have been a contributing factor, inasmuch as even a mildly acute takeoff angle may predispose to kinking if the sinus is surgically enlarged.

This report demonstrates that patch enlargement of the left sinus may effectively lengthen the left main coronary artery and cause kinking of the coronary arteries.

References


Successful Treatment of a Patient With Purulent Pericarditis by Daily Intrapericardial Washouts

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Purulent pericarditis in adults is rare, but once it develops, it carries a high mortality rate. Adequate pericardial drainage and proper antibiotic treatment are essential in the successful management of purulent effusions, for which percutaneous catheter drainage is the most commonly performed technique. We herein report the case of a 75-year-old woman with purulent pericarditis attributable to methicillin-resistant Staphylococcus aureus. Although percutaneous pericardial drainage by catheter was used, the drainage was insufficient because of hyperviscous effusion. We performed surgical subxiphoid pericardial drainage, and a piece of a purulent stone was found in the pericardial cavity with purulent effusion. Additionally, daily intrapericardial washouts with physiologic saline alone were used as adjunct therapy. Five weeks later, the patient had a decreasing inflammatory reaction and symptom relief. She was discharged with no complications such as constrictive pericarditis.


Purulent pericarditis is the most serious clinical manifestation of bacterial pericarditis, characterized by gross pus in the pericardial sac or microscopically purulent pericardial effusion, which often develops as a complication of a thoracic surgical procedure or chemotherapy. Despite advance in diagnostic and treatment modalities, purulent pericarditis remains a life-threatening illness.

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A 75-year-old woman who had undergone a lung resection and chemotherapy for lung cancer 3 months earlier was referred to our hospital with chest discomfort. She had a history of postoperative pyothorax and had achieved partial remission by intravenous antibacterial therapy 1 month earlier. Physical examination showed blood pressure of 122/82 mm Hg, body temperature of 36.6°C, and heart rate of 90 beats per minute. Laboratory analysis revealed high inflammatory reactions, including increased white blood cell count of 9400/μL and increased C-reactive protein level of 6.28 mg/dL. Electrocardiography showed a sinus rhythm with low voltage in the limb and chest leads. She had an enlarged cardiac silhouette without pulmonary congestion on chest roentgenogram. Transthoracic echocardiography showed a preserved ejection fraction of the left ventricle and a large amount of pericardial effusion and thick solid exudate with collapse of the right atrium and right ventricle (Fig 1). Computed tomography (CT) of the chest showed a large amount of circumferential pericardial effusion (Fig 2) and an expanded inferior vena cava. The density of the pericardial effusion was 40.0 HU, suggesting purulent material.

An urgent pericardial drainage by catheter was performed percutaneously, and 200 mL of hyperviscous red purulent fluid was drained off. Histopathologic examination of the effluent revealed the aggregation of leukocytes and leukocytes phagocytosing gram-positive cocci (Fig 3). Blood and the pericardial fluid cultures grew methicillin-resistant *Staphylococcus aureus*. The patient received a diagnosis of purulent pericarditis secondary to pyothorax. Although appropriate antibiotic therapy (vancomycin plus sulbactam) was given, the pericardial effusion remained because of deposition of fibrinous material and formation of loculations. Therefore, surgical subxiphoid pericardial drainage was performed. Two drainage tubes were inserted through the chest wall and into the pericardial space (Fig 4). Surprisingly, a piece of stone measuring 25 × 20 × 10 mm was removed from the pericardial cavity with the purulent effusion (Fig 5). The stone was an irregular contoured mass. Gross examination of the stone’s cut surface showed it to be reddish yellow, with an internal spotty liquefaction or softening but peripheral elastic hardness. Because the purulent effusion could not be drained completely even by a subxiphoid pericardial drainage technique, daily intra-pericardial washouts with physiologic saline alone were used for 5 weeks as adjunctive therapy. A closed instillation-drainage technique was achieved by pouring warmed (approximately 36°C) physiologic saline into the pericardial cavity at 50 mL/h with continuous drainage for 9 hours a day. Closed, continuous, steady-flow

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**Fig 1.** Transthoracic echocardiogram (subxiphoid view) showing a large amount of pericardial effusion and thick solid exudate with collapse of the right atrium and right ventricle.

**Fig 2.** Axial image from multislice computed tomography (CT) of the chest, showing a large amount of circumferential pericardial effusion. The density of the pericardial effusion was 40.0 HU.

**Fig 3.** Pathologic findings. Histologic image of the effusion stained with hematoxylin at a magnification of ×400, showing aggregations of leukocytes and leukocytes phagocytosing gram-positive cocci.
instillation drainage was thus established. The therapeutic procedure successfully prevented cardiac tamponade, and the C-reactive protein level decreased to 0.45 mg/dL after 5 weeks. Thus, the catheter could be removed from the pericardial space. Both echocardiography and CT demonstrated the disappearance of the effusion and showed no complications such as constrictive pericarditis. The patient has had no problems for the past year.

Comment

Purulent pericarditis in adults is rare, but once it develops, it carries a high mortality rate. The mortality rate in patients even when it is treated is 40% because of cardiac tamponade, toxicity, and constriction [1-3]. We present a case of purulent pericarditis in which highly viscous pericardial effusion induced collapse of the right atrium and right ventricle. Two aspects of this case are of special interest.

First, subxiphoid pericardial drainage with repeated intrapericardial washouts with saline alone led to the successful outcome in this patient. In purulent pericarditis, failure to control the pericardial fluid may lead to persistent sepsis, which is a potentially lethal condition. Proper antibiotic treatment and adequate pericardial drainage is essential for successful management of purulent pericarditis [1]. Although percutaneous catheter drainage is the most commonly performed technique, successful drainage of thick purulent effusion remains a challenge in clinical practice. Incomplete drainage of the pericardial fluid is related to several factors, the most critical of which is believed to be highly viscous pericardial fluid with fibrinous debris. In complicated effusions, the increased production of fibrin results in formation of loculations and septations within the pericardial cavity, leading to ineffective chest tube drainage. Consequently, incomplete drainage causes large adhesions, where extensive pericardiectomy is needed to prevent constriction [1, 3]. Early surgical drainage may be necessary for resistant effusions. In our case, the fact that complete percutaneous catheter drainage could not be achieved prompted us to perform surgical subxiphoid pericardial drainage. Another therapeutic option includes fibrinolytic therapy. Intrapericardial fibrinolytic therapy agents offer a promising alternative and have been reported as an effective adjunct to accelerate drainage of loculated effusions and thus avoid extensive pericardiectomy in such complicated pericardial effusions [4-6]. Fibrinolytic agents such as urokinase or streptokinase are believed to work by decreasing fibrinous strands and reopening pores liquefied by fibrinous material, permitting pericardial resorption. However, our patient had undergone an operation 3 months earlier, and postoperative pyothorax was a complication. Given the risk of hemorrhage, we did not use urokinase or streptokinase [7]. Instead, we used daily intrapericardial washouts with physiologic saline alone, which led to the successful outcome. So far, few reports have described treatment by repeated intrapericardial washouts with physiologic saline alone. It seems likely that intrapericardial washouts with physiologic saline should be started early so that patients could benefit from their potential advantages before severe pericardial adhesions develop as a result of the inability to liquefy fibrinous material.

The second interesting finding of this case was the stone formation in the pericardial purulent exudate. Fibrinopurulent effusion is characterized by fibrinous septations forming loculations. Prolonged and enhanced fibroblastic activity leads to spiderweb-like formations in the intrapericardial space. It seems likely that these
intrapericardial processes contributed to the stone formation. This hypothesis is supported by CT findings in which the density of the pericardial effusion was homogeneous even though the pericardial cavity had included the stone. To our knowledge, this is the first report of stone formation within the pericardial cavity in a patient with purulent pericarditis.

Daily intrapericardial instillation of physiologic saline is an effective and safe adjunct in preventing constriction and avoiding an open surgical approach. Instillation of physiologic saline is not associated with complications such as hemorrhage or allergic reaction. We emphasize its usefulness in patients with purulent pericarditis, especially those at risk of hemorrhagic complications. However, a tendency for a decreased rate of drainage with persistent fever and symptoms of right-sided heart failure may indicate the need for early surgical chest opening.

Off-Pump Revascularization in a 2-Year-Old Girl After Neonatal Arterial Switch

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One drawback of the arterial switch operation for treating transposition of the great arteries is the occurrence of coronary lesions, found during follow-up in about 5% of asymptomatic children. The established corrective procedures include coronary artery proximal patch arterioplasty or coronary artery bypass grafting (CABG). To avoid aortic manipulations and extracorporeal circulation, off-pump coronary artery bypass (OPCAB) has become increasingly used in the adult population. We report a case of OPCAB revascularization in a symptomatic 2-year-old child.

The indications for myocardial revascularization remain relatively rare in children. The establishment of the arterial switch operation (ASO) as the treatment of choice for transposition of the great arteries (TGA) has increased the incidence of ostial and proximal coronary lesions [1]. In most published series, significant coronary abnormalities can be found during follow-up in about 5% of children whether or not they are symptomatic.

The surgical alternative procedures include coronary artery proximal patch arterioplasty [2] or coronary artery bypass grafting (CABG) [3].

For patch arterioplasty, the coronary lesion should be very proximal and short, and it should not involve the left main coronary artery bifurcation. On the other hand, internal thoracic artery (ITA) grafting should be reserved for more distal lesions with long and near complete occlusion of the native vessel.

For both approaches, the use of cardiopulmonary bypass remains mandatory, with its deleterious systemic effects secondary to the activation of leukocytes and the release of free oxygen radicals and cytokines that lead to decreased myocardial contractility and participate in a systemic inflammatory response [4]. In adults, to avoid both aortic cross-clamping and cardiopulmonary bypass, the off-pump coronary artery bypass (OPCAB) procedure is now frequently used for myocardial revascularization. We report here the first case of OPCAB with ITA grafting in a child 2 years after successful ASO.

The patient was a 2-year-old girl who underwent an ASO and closure of a ventricular septal defect at 5 days of age. According to Leiden’s classification, the coronary pattern was 1LCx-2R, and coronary transfer on the neoorta was performed by the trapdoor method. Prolene 8-0 running sutures were used for all anastomoses. The procedure was uneventful. No myocardial ischemia was suspected during the perioperative period and no electrocardiographic changes were recorded. On postoperative day 5, a supraventricular tachycardia was treated with adenosine and amiodarone. The patient’s intensive care unit and hospital stays were 2 and 13 days, respectively.

At month 2, echocardiography revealed moderate mitral regurgitation and good left ventricular function, which responded well to treatment with angiotensin