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Case Report

Treatment of Ruptured Coronary Aneurysm with a Novel Covered Stent

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Coronary artery aneurysms are relatively rare but have been diagnosed with increasing frequency since the advent of coronary arteriography. Their reported incidence varies from 1.5% to 5% with male dominance and a predilection for the right coronary artery (RCA), accounting for over 40% of all cases. The most common etiology amongst adults remains atherosclerosis accounting for 50% of coronary aneurysms. We describe the first use of a novel flexible pericardium covered stent for successful treatment of a ruptured coronary aneurysm in 76 year old lady. © 2009 Wiley-Liss, Inc.

Key words: percutaneous coronary intervention; coronary aneurysm; coronary angiography

INTRODUCTION

Coronary artery aneurysms are relatively rare but have been diagnosed with increasing frequency since the advent of coronary arteriography. Their reported incidence varies from 1.5% [1] to 5% [2] with male dominance and a predilection for the right coronary artery (RCA), accounting for over 40% of all cases [3]. There are a number of reported etiologies, which include Kawasaki's disease, syphilitic arteritis, as a complication of percutaneous intervention and connective tissue disorders such as Ehlers-Danlos or Marfan's. However, the most common etiology amongst adults remains atherosclerosis accounting for 50% of coronary aneurysms [4]. The precise incidence of ruptured aneurysms is unclear but appears to be extremely rare. In the largest reported cohort of coronary aneurysms (Coronary Artery Surgery Study), Swaye et al. [2] did not find any cases of rupture in 978 patients. There are a handful of reported cases in the literature, most of which were treated surgically. Percutaneous delivery of polytetrafluoroethylene covered coronary stents for treatment of "stable" aneurysms and concomitant stenosis have also been reported [5,6]. To the best of our knowledge, this is the first reported use of a flexible pericardium covered stent for treatment of a ruptured coronary aneurysm.

CASE

A 76-year-old lady presented to her local district general hospital with a 4 week history of chest pains and mild dyspnoea. The features of her chest pains were largely anginal; however, in the 24 hr prior to presentation she experienced a severe sharp chest pain, which was worse on movement, inspiration, and coughing. A history of low-grade temperature without chills or rigors was also noted. Her only significant past medical history was of treated hypertension, and there were no other additional risk factors for coronary artery disease (CAD). Physical examination was unremarkable other than pallor and slight pyrexia. Initial investigations revealed elevated inflammatory markers with an ESR of 136 and CRP of 261, and a normochromic anemia with a hemoglobin of 7.2 g/dl. Soon after admission, she experienced an episode of chest pain which resembled angina. A 12 lead ECG demonstrated ischemic changes in the infero-lateral leads but subsequent assays for cardiac enzymes were negative. She had a further episode of severe chest pain with

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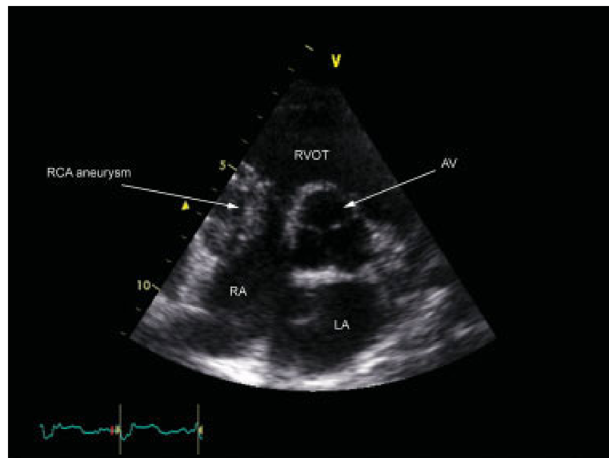

Fig. 1. Short axis view at the aortic valve level demonstrating the RCA aneurysm impinging on the right atrium (RA) and disrupting the tricuspid valve annulus. LA, Left atrium; AV, Aortic valve; RVOT, right ventricular outflow tract. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com.]

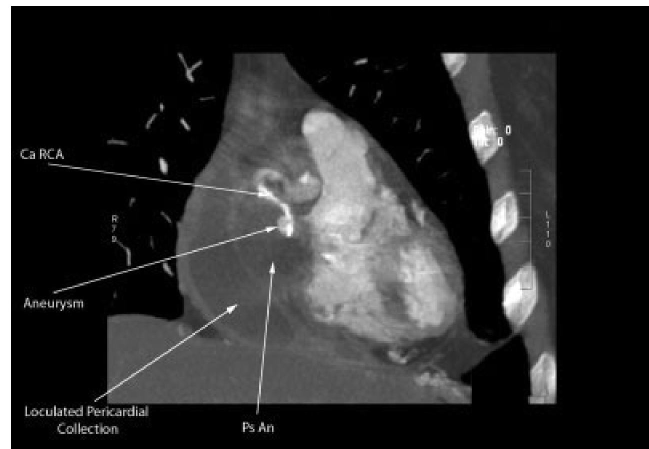

Fig. 2. Computed tomography demonstrating a calcified right coronary artery (Ca RCA) associated with a saccular aneurysm surrounded by a large pseudoaneurysm (Ps An) and a loculated pericardial collection.

evidence of ST elevation in lead II, III, and aVF and ST depressions in leads V2 to V5. The pain subsided quickly with prompt resolution of the ST segment changes.

In light of her raised inflammatory markers, anemia and chest pain she underwent a CT scan of the thorax, abdomen, and pelvis. This demonstrated a small localized pericardial effusion with a soft tissue mass within the pericardium impinging on the right atrium. In addition, a pelvic mass was also identified with characteristic features of a teratoma. Transthoracic echocardiography (TTE) demonstrated what appeared to be a right atrial mass with a localized pericardial effusion overlying the right atrial and ventricular free walls (Fig. 1). Transoesophageal echocardiography confirmed such findings but failed to provide any further diagnostic clue. An urgent referral was made by the admitting unit to our centre for further investigation and treatment of this unusual pathology for which the differential diagnoses included endocarditis and infiltrative tumor possibly related to her pelvic teratoma.

Repeat TTE upon transfer demonstrated biphasic blood flow within this "cavitating" mass located mainly in the atrioventricular groove of the right heart. Consequently a cardiac CT scan (Fig. 2) was requested and confirmed a saccular aneurysm involving the middle segment of the RCA measuring approximately 3.1 cm × 3.8 cm. The RCA was aneurysmal and surrounded by thrombus located within a false aneurysm. This composite mass (6.5 cm × 4.5 cm) was impinging on the right atrium and ventricle. The appearances suggested a contained rupture into the pericardium. Coronary arteriography revealed a very angulated proximal RCA with an 80% proximal and 70% mid stenoses. A complex aneurysm arising from the mid RCA was confirmed which communicated with the contained ruptured through a fistula (Fig. 3). There were 50% stenoses in the mid and distal segments of the left anterior descending artery (LAD).

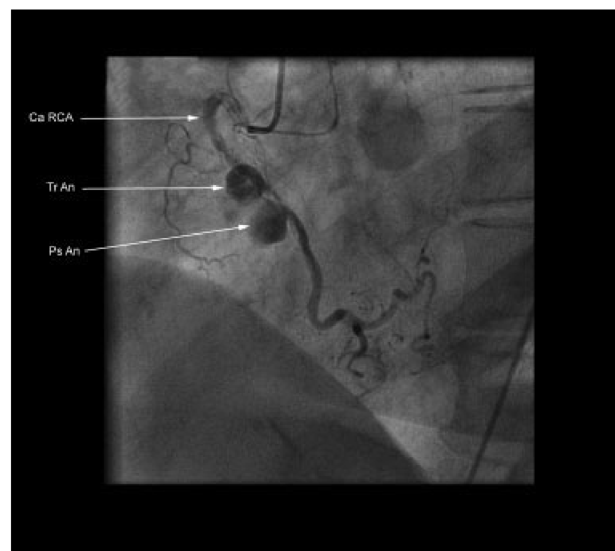

Fig. 3. Aneurysmal right coronary artery with contrast opacification of both true aneurysm (Tr An) and psuedoaneurysm (Ps An).

Although hospitalized, the patient developed persistent cough associated with hemoptysis. Chest roentogram revealed a small right pleural effusion. Following respiratory assessment a CT pulmonary angiogram was performed, which excluded the diagnosis of pulmonary

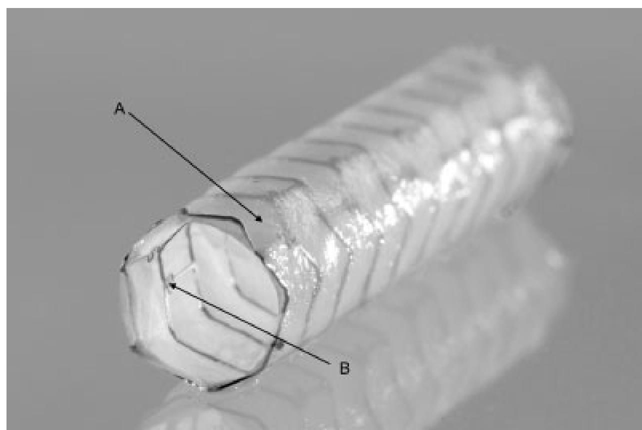

Fig. 4. (A) Fixed heterologous pericardium (equine) providing 100% coverage, creating barrier between vessel wall and lumen. (B) Stainless steel structure designed to host a pericardium cylinder and create a flexible expandable graft allowing navigation in tortuous vessels.

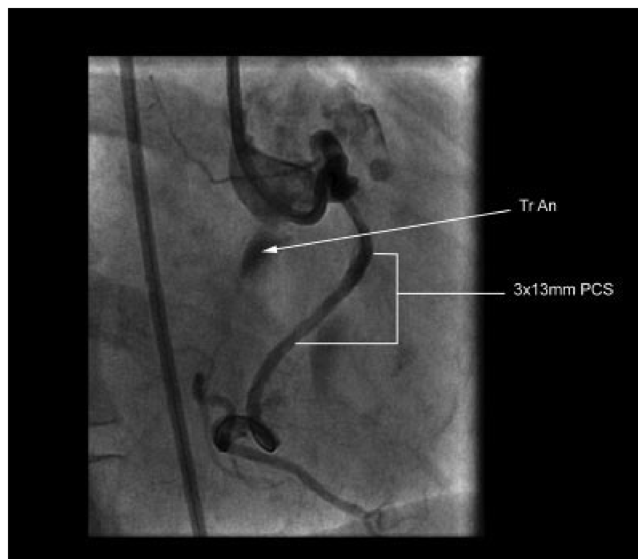

Fig. 5. Right coronary artery following pericardium covered stent (PCS) deployment, demonstrating improved flow in the distal RCA and minimal flow into the true aneurysm.

embolism. However, this demonstrated de novo moderate right pleural effusion and localized lung consolidation and collapse adjacent to the ruptured RCA aneurysm.

Following cardiac surgical assessment, although it was technically feasible to isolate the aneurysm within the contained rupture and revascularize the distal RCA territory, it was felt that an operative approach would likely sacrifice important blood supply to the conduction tissue and part of the right ventricular myocardium potentially resulting in the need for permanent pacing and a localized infarct, respectively. It was felt that such complications could be avoided or minimized with percutaneous coronary stenting, which isolates a much shorter segment of artery. Conventional polytetrafluoroethylene covered coronary stents are stiff and thus can be difficult to manoeuvre particularly in tortuous vessels. Given the angulated nature of the RCA just proximal to the aneurysm an "over and under" equine pericardium covered stent (PCS) (ITGI Medical Ltd. Or Akiva, Israel) was used (Fig. 4). This covered stent, which has only recently become available, consists of one flexible laser cut stent (made of implantable high grade surgical stainless steel 316L) combined with one piece of pericardial tissue. The tissue is treated with a glutaraldehyde process, which cross links the collagen fibers and minimizes antigenicity and is attached to the stent with polypropylene suture. The stent assembly is mounted on a specially designed balloon catheter to host the "over and under" stent design. The avoidance of a "sandwich" design makes this a relatively flexible stent to use in angulated and tortuous vessels as in our patient's case. Stent preparation involves two wash cycles of 2 minutes with normal saline to remove the glutaraldehyde in which the covered stent is packaged.

An 80% stenosis just proximal to the aneurysm was predilated and then intravascular ultrasound (IVUS) was performed to help size the stent required. A 3 mm $\times$ 13 mm PCS was successfully deployed via a 7F guide catheter with an inflation pressure of 10 atmospheres (Fig. 5). The lesion was reduced to residual 0% stenosis and post procedure TIMI flow grade III was achieved. There was very mild residual leak into the true aneurysm but no filling of the false aneurysm (Fig. 5). A subsequent contrast TTE showed no filling into the previous aneurysm.

She made an uneventful and good clinical recovery and was discharged home 4 days later after a repeat chest roentogram demonstrated improvement in the right pleural effusion.

DISCUSSION

Coronary artery aneurysm is defined as an irreversible dilatation that exceeds the diameter of normal adjacent coronary artery segments or the patient's largest coronary vessel by 1.5 times [3]. The pathogenesis of coronary artery aneurysms is not completely understood but is likely to involve destruction of the arterial media, thinning of the arterial wall, increased wall stress, and progressive dilatation of the coronary artery segment [7]. The commonest cause is coronary atherosclerosis disease accounting for 50% of cases [4]. Spontaneous rupture of a coronary artery aneurysm is usually a terminal event. Blood can dissect through

myocardium and rupture internally into a cardiac chamber or externally into the pericardial cavity. Either mechanism usually causes rapid deterioration of contractile function and death by tamponade [8] or ventricular failure. Consequently the majority of diagnosis is made at postmortem. In the setting of a contained rupture, the resulting thrombus is localized but is usually complicated by myocardial infarction [9] secondary to thrombotic luminal occlusion [10] or external compression of the affected artery from resultant pericardial effusion.

There is no clear consensus on the management of this rare clinical entity although surgery has traditionally been the preferred modality. Nonsurgical options include covered stent deployment and conservative medical management. Although surgery has been recommended to prevent complications, there is no available data comparing this to medical management which principally consists of antiplatelet therapy. The range of surgical procedures used encompasses coronary artery bypass grafting, total aneurysm resection, proximal and distal ligation, and thrombectomy [3,11,12]. The exact procedure of choice depends on aneurysm anatomy and any complicating pathology. Coronary bypass grafting should be performed only in the presence of concomitant severe stenosis, progressive angina despite optimal medical therapy or complications including fistula formation and cardiac compression.

Percutaneous stenting of coronary artery aneurysms has already been well reported [6,7]. We have observed excellent early clinical outcome following the pioneering use of a flexible "over and under" equine PCS for the treatment of a contained ruptured RCA aneurysm, which may have result in a more complicated recovery if treated surgically.

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