Indian Journal of Thoracic and Cardiovascular Surgery (March–April 2023) 39(2):182–185
https://doi.org/10.1007/s12055-022-01457-5

CASE REPORT

Surgical management of drug-eluting stent associated coronary artery aneurysms: a case series

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Received: 5 October 2022 / Revised: 1 December 2022 / Accepted: 7 December 2022 / Published online: 3 January 2023

Abstract

Drug-eluting stents (DES) have been introduced to counter the in-stent restenosis associated with bare metal stents. However, the mechanism of action of DES results in a counter-productive effect of coronary artery aneurysm (CAA) formation. Although CAA after the implantation of drug-eluting stents (DES) is a rare occurrence with an incidence rate of up to 0.5%, they are increasingly being detected due to the progressive rise in the usage of DES for the management of coronary artery disease (CAD). Due to the rarity of this condition, evidence and guidelines regarding the management strategies for this condition are still lacking. We present a series of 5 cases of CAA, post-DES implantation, who were all successfully managed with surgical intervention.

Keywords Drug-eluting stent · DES · Coronary artery aneurysm · Percutaneous coronary intervention

Introduction

Drug-eluting stents (DES) have been a major advancement in stent technology for the management of coronary artery disease (CAD). Although bare metal stents (BMS) drove the initial shift in the management of CAD to percutaneous interventions, the high in-stent restenosis (ISR) rate of BMS due to neo-intimal hyperplasia remained a major drawback. The introduction of drug-eluting stents (DES) resulted in a marked reduction of ISR due to the anti-inflammatory and anti-proliferative effects of the eluted drug [1, 2]. Although very infrequent, these effects may also be counterproductive in the long term, leading to progressive vessel wall weakening and the development of a coronary artery aneurysm (CAA). CAA is defined as dilatation of the coronary artery more than 50% of the reference vessel segmental diameter. The stent may also become infected due to various reasons, leading to an infected aneurysm or a pseudoaneurysm. We present a case series of 5 patients (Table 1) who developed CAA after DES implantation and were all managed with a surgical intervention in the last 6 years.

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Case series of aneurysms after DES implantation

Case 1

A 64-year-old hypertensive and diabetic male presented with an acute inferior wall myocardial infarction (MI). He underwent a percutaneous transluminal coronary angioplasty (PTCA) and stenting of the right coronary artery (RCA). The patient was discharged on dual antiplatelet therapy. Three years later, he underwent a stent-in-stent procedure due to re-stenosis of the implanted stent. Four years after the second intervention, he presented with an ulcer over the epigastrium. On evaluation, computed tomography (CT) of the chest revealed migration of the stent to the epicardial soft tissue with an abscess and a sinus tract discharging through the chest wall at the epigastrium. Coronary angiogram (CAG) revealed a double-vessel disease (DVD) and an RCA aneurysm with total occlusion of the RCA. He underwent an explantation of the infected RCA stent and a coronary artery bypass grafting (CABG) using the saphenous vein graft (SVG) to the distal RCA. He also underwent

Table 1 Baseline characteristics and treatment profile of all patients who developed coronary artery aneurysms after DES implantation

Patient characteristics	Case 1	Case 2	Case 3	Case 4	Case 5
Age (years)	64	42	59	55	38
Sex	Male	Male	Male	Male	Male
Diabetes Mellitus	Yes	No	Yes	Yes	No
DES	RCA	LAD	LAD and RCA	LAD	LAD
Anti-platelet drugs	Clopidogrel + aspirin	Clopidogrel + aspirin	Clopidogrel + aspirin	Ticagrelor + aspirin	Ticagrelor + aspirin
Re-admission presentation	Ulcer over epigastrium	Unstable angina	Angina	Intermittent fever	Angina on exertion
Fever	Febrile	Afebrile	Afebrile	Febrile	Afebrile
Weeks after PCI	6 years	3 weeks	4 months	6 weeks	2 years
TLC during re-admission	7000/μL	6200/μL	8000/μL	9900/μL	5800/μL
Aneurysm details	Type III	Type I	Type II	Type III	Type II
Arterial segment involved	RCA	LAD	Proximal LAD and RCA	LAD	Proximal LAD and LCX
Thrombus	Yes	Yes	Yes	Yes	Yes
Treatment	Operative repair and grafting	Operative repair and grafting	Operative repair and grafting	Operative repair and grafting	Operative repair and grafting
Stent culture	Pseudomonas aeruginosa	Nil	Nil	Pseudomonas aeruginosa	Nil
Recent follow-up	Lost to follow-up	Alive and asymptomatic	Alive and asymptomatic	Alive and asymptomatic	Alive and asymptomatic

DES, drug-eluting stent; *RCA*, right coronary artery; *LAD*, left anterior descending artery; *PCI*, percutaneous coronary intervention; *TLC*, total leukocyte count; *LCX*, left circumflex artery

an excision of the infected sinus tract. He had an uneventful postoperative period.

Case 2

A 42-year-old normotensive, non-diabetic male presented with angina and was diagnosed with an anterior wall MI. CAG revealed a DVD for which he underwent PTCA and stenting to the left anterior descending (LAD) artery. Three weeks later, he presented with complaints of unstable angina of 1-week duration. CAG showed a LAD aneurysm with a thrombosed stent. He underwent explantation of the stent and CABG and received a left internal thoracic artery (LITA) graft to the LAD and a SVG to the diagonal artery. He had an uneventful postoperative period (Fig. 1A).

Case 3

A 59-year-old hypertensive and diabetic male presented with an acute anterior wall MI. He underwent a PTCA and stenting of the LAD and the RCA. Four months later, he presented with complaints of angina of 2-week duration. CAG revealed a complete LAD stent occlusion with an aneurysm of the proximal LAD and the proximal RCA. He underwent a stent endarterectomy with the repair of the proximal LAD and the proximal RCA aneurysm. CABG was performed using the LITA graft to the LAD and the SVG to the distal RCA. He had an uneventful postoperative period (Fig. 1B).

Case 4

A 55-year-old diabetic male presented with an acute anterior wall MI. CAG showed critical stenosis of the proximal LAD and PTCA and stenting of the LAD was done. Six weeks later, the patient presented with an intermittent fever of 3-week duration. CT-CAG revealed triple vessel disease and LAD stent thrombosis with an aneurysm of LAD. LAD stent endarterectomy was performed along with CABG and received LITA graft to LAD and SVG to the obtuse marginal artery. The stent culture grew *Pseudomonas aeruginosa* and the patient was treated with appropriate postoperative antibiotics (Fig. 1C).

Case 5

A 38-year-old non-diabetic male presented with angina and was diagnosed to have acute anterior wall MI. CAG revealed a DVD for which he underwent PTCA and stenting to LAD. Two years later, he presented with stable angina. CAG revealed an aneurysm of the LAD and left circumflex artery (LCx). He underwent resection of the aneurysm involving proximal LAD and proximal LCx, and revascularization was

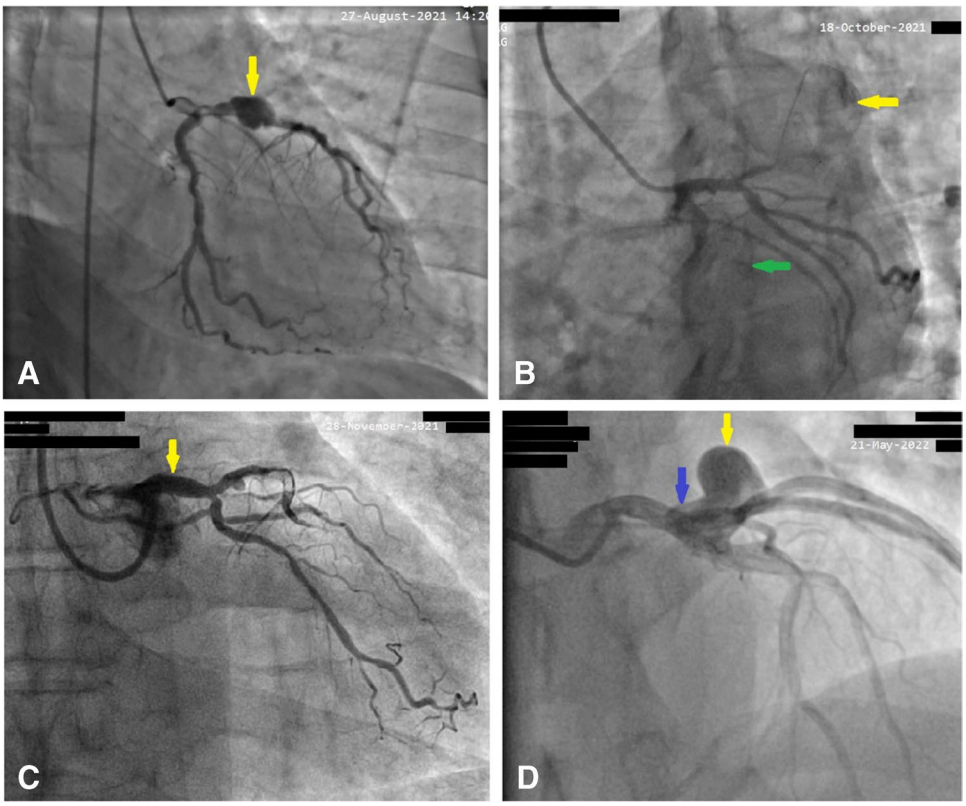

Fig. 1 Coronary angiography images confirming the diagnosis of coronary artery aneurysms (CAA). **A** Case 2: Coronary angiography reveals a coronary artery aneurysm of 2 × 1.3 cm in the proximal left anterior descending (LAD) artery. **B** Case 3: Coronary angiography reveals two coronary artery aneurysms of 3.5 × 2.5 cm in the proximal left anterior descending (LAD) artery (yellow arrow) and 2.3 × 2.3 cm in the proximal right coronary artery (RCA) (green arrow). **C** Case 4: Coronary angiography reveals a coronary artery aneurysm of 2.5 × 0.9 cm in the proximal left anterior descending (LAD) artery. **D** Case 5: Coronary angiography reveals two coronary artery aneurysms of 2.5 × 2 cm in the proximal left anterior descending (LAD) artery (yellow arrow) and 2 × 1.5 cm in the proximal left circumflex artery (LCX) (blue arrow)

achieved using SVG to proximal LAD and proximal LCx under cardiopulmonary bypass (CPB). He had an uneventful postoperative period (Fig. 1D).

Discussion

CAA may be defined as dilatation of the coronary artery by more than 50% of the corresponding vessel diameter and incidence ranges from 0.3 to 5.3% [3, 4]. The most common cause is atherosclerosis in adults and Kawasaki disease in children. The causes of CAA after DES implantation include an acute dissection due to high pressure of the dilating balloon (type I), damage to the artery by toxic/allergic/hypersensitivity effects of drugs and polymers (type II), or infection of the implanted stent (type III) [2]. The current series had 2 (40%) patients with type III, 2 (40%) patients with type II, and one (20%) patient with type I DES-CAA. The radiological differentiation into type I and type II can be difficult. And the time of presentation from implantation can only be suggestive, with the early (< 4 weeks) non-infective aneurysms generally being of type I and the late (> 4 weeks) non-infective aneurysms being of type II.

In the current series, the age of the patients ranged from 38 to 64 years (51.6 ± 9.97 years), with all of them being male. The onset of presentation ranged from 3 weeks to 6 years. The most common presentation in the current series was unstable angina due to stent thrombosis. The disruption in the laminar flow of the blood near the aneurysm may precipitate acute or sub-acute thrombosis and occlusive symptoms of angina. However, one patient (case 4) presented with a history of intermittent fever within 6 weeks of stent implantation, and another patient (case 1) presented with a fever and a discharging fistula at the epigastrium. The major risk factors for developing infective stent complications post-percutaneous coronary intervention (PCI) include diabetes mellitus (DM), renal dysfunction, age > 60 years, and procedure-related risk factors such as repeated use of catheter, lengthy procedure, and prolonged duration of sheath retention [5]. One of the major risk factors for infection of implanted stents in the current setting may have been poor sterilization practices employed in the handling of reused hardware. Both the patients who developed infective aneurysms had DM, whereas one patient was over 60 years.

Coronary angiography is the diagnostic modality of choice for confirming the diagnosis of CAA and is also crucial to determine the flow to the myocardial segment supplied by the particular coronary artery.

The various management strategies of DES-CAA involve close follow-up, percutaneous, and surgical intervention depending on the size, symptoms, and associated complications. Although conclusive evidence regarding the optimal strategy of management for this condition is still not available, the factors that warrant management by a surgical

approach include a large size of CAA with an impending rupture, aneurysm with a branch involvement, thrombosis of the stent and/or coronary artery with anginal symptoms, infective complications that require explantation of the stent, and revascularization of the distal segment of the coronary artery involved in aneurysm formation to reestablish myocardial vascular supply [6]. The aneurysm may be addressed by an open or minimally invasive technique. Although the adoption of a minimally invasive approach may compromise proper exposure and evaluation of the operative site, especially in type III DES-CAA, the choice regarding the surgical approach is contingent upon surgeon preference and expertise. The aneurysm may either be dealt with by excision, ligation, or marsupialization [3]. As the epicardium and adipose tissue adjacent to the stent is usually inflamed, the stent either entirely lies loosely in the aneurysm or is partly embedded in the intimal and medial hyperplasia of the native vessel. Once the aneurysmal portion is opened, locating the stent is not so difficult and it can be extracted with a mosquito clamp or a forceps. As this part of the vessel is already inflamed, there is no additional damage sustained by the vessel. The stent can be explanted irrespective of the presence or absence of signs and symptoms of infection as there is no definitive way to exclude it other than the culture of the stent. Additionally, in our case, the aneurysmal portion was also excised and the open ends were oversewn to prevent postoperative antegrade and retrograde leaks. The decision regarding the revascularization strategy depends upon various anatomical factors like the artery involved and the distance between the ends of the artery post-resection of the aneurysm. Arterial revascularization is generally preferred due to its long-term benefits. Although most reports have mentioned revascularization with an in situ LITA graft, an end-to-end anastomosis of the LAD arterial ends has also been described [7]. The differentiation of DES-CAA into different types does not dictate the surgical strategy as management usually involves resection/ligation of the aneurysm, stent endarterectomy, and CABG with revascularization of the thrombosed vessel irrespective of the type of DES-CAA. Although infected DES-related aneurysms (type III) only occur in less than 0.5%, their mortality is quite high (38%) [8]. Hence, a high degree of clinical suspicion with early diagnosis and adoption of an aggressive treatment strategy may ensure better outcomes for this potentially devastating condition. Prior series have suggested surgical management for all post-coronary intervention CAA due to the safety, reliability, and curative intent of surgical management for this condition [7]. Our experience reinforces the recommendation regarding the safe management of CAA with surgery due to the uneventful postoperative course of the patients in this series and asymptomatic follow-up until the time of this study.

Funding None.

Data Availability The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request

Declarations

Ethics committee approval This study was approved by the institutional ethics committee dated 22. Aug. 2022 with the reference no: SH/RS/IEC/2021–2022/1006.

Consent to participate The need for informed consent from the patient was waived off due to the retrospective nature of this report.

Conflict of interest The authors declare no competing interests.

Human and animal rights declaration This study complies with the principles of The Declaration of Helsinki. There were no animals involved.

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