Surgical treatment for coronary artery aneurysm: a single-centre experience

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Abstract

OBJECTIVES: Coronary artery aneurysm is a rare condition with a reported incidence of 0.14–4.9% in patients undergoing coronary angiography and 0.3–5.3% in patients after percutaneous transluminal coronary angioplasty (PTCA). Optimum surgical therapy for this entity is difficult to standardize. We present here a series of 4 cases with the aim of establishing an optimal surgical therapy for this rare entity.

METHODS: Four cases of coronary artery aneurysm were admitted in the Department of Cardiology and Department of Cardiothoracic and Vascular Surgery, King George's Medical University, Lucknow, from April 2010 to April 2012. All patients underwent a surgical procedure that involved ligation and plication of the aneurysm with coronary artery bypass grafting.

RESULTS: Out of the four coronary artery aneurysm patients, 1 was atherosclerotic and the remaining 3 patients developed coronary artery aneurysm after PTCA with a drug eluting stent to the left anterior descending artery. After surgery, all patients recovered uneventfully without any recurrence of symptoms in the follow-up.

CONCLUSIONS: Coronary artery aneurysm is a rare entity and is being seen more frequently with the increasing use of stents during PTCA. Proximal ligation and plication of the aneurysm with coronary artery bypass grafting in the present series provided good results. With this case series, we seek to establish an optimal surgical therapy for this rare entity.

Keywords: Aneurysm (Coronary) • Stents (Coronary) • Coronary percutaneous intervention • Coronary artery bypass grafting

INTRODUCTION

Aneurysmal dilatation of the coronary arteries was first described by Bourgon in 1812 [1]. Since then, numerous isolated case reports and small series of patients have been described [2, 3]. Coronary artery aneurysm (CAA), defined as dilatation of the coronary artery exceeding 50% of the reference vessel diameter, is uncommon and occurs in 5% of coronary angiographic series [4]. CAAs are termed giant if their diameter exceeds the reference vessel diameter by >4 times or if they are >8 mm in diameter [5]. Up to one-third of CAAs are associated with obstructive coronary artery disease and have been associated with myocardial infarction, arrhythmias or sudden cardiac death [6]. Post-coronary intervention aneurysms are rare but are being seen with increasing frequency. The therapy for these aneurysms is still debatable. For the first time, we are reporting 4 cases of coronary aneurysm from a single centre with their surgical results with the aim of establishing an optimum surgical therapy for coronary aneurysms.

MATERIALS AND METHODS

This study was done between April 2010 to April 2012 in the Department of Cardiothoracic and Vascular Surgery and

Cardiology in 4 patients of coronary aneurysm. The clinical details of the patients are given in Table 1. The case summary of the patients is as follows:

Case 1

A 50-year old male diabetic, hypertensive, non-smoker presented with a history of worsening of angina despite full medical therapy. His 2D echocardiography (2D Echo) showed no wall motion abnormality with normal left ventricular ejection fraction. His coronary angiography showed a right coronary artery total occlusion and a mid-left anterior descending (LAD) 99% lesion. After informed consent, a decision for revascularization of the LAD with a drug eluting stent was taken and subsequently a 3.5 × 30 mm Endeavor stent (Medtronic, Minneapolis, MN, USA) was deployed at 14 atm pressure with good thrombolysis in myocardial infarction (TIMI)-3 flow. He was discharged on the second day on dual antiplatelet therapy along with atorvastatin 80 mg and metoprolol 100 mg, along with oral antihyperglycemic drugs. Three months later, the patient had an episode of high-grade fever with chills and left precordial pain which was constant and dull aching and had a dragging character. The repeat angiography showed an aneurysmal dilatation ~2.5 cm in size in the proximal part of the LAD where the stent

Table 1: Clinical details of the patient

Case	Age (year)/sex	Cause	Risk factors	Site	Size (cm)	Interval ^a (months)	Stent	Surgical procedure
1	50/male	iatrogenic (post-stenting)	DM, HT, smoker	Proximal, LAD	2.5 × 2.5	3	Endeavor	Proximal ligation of aneurysm + OPCABG (LIMA to LAD)
2	75/male	iatrogenic (post-stenting)	DM, HT, smoker	Proximal, LAD	2 × 2	1	Taxcor	Proximal ligation and plication of aneurysm + OPCABG (LIMA to LAD)
3	73/male	iatrogenic (post-stenting)	DM, HT, smoker	Mid-LAD	2 × 2	24	Xience	Proximal ligation and plication of aneurysm + On-pump beating heart CABG (rSVG to LAD)
4	60/male	Atherosclerosis	HT, smoker	Proximal, LAD	1.5 × 1.5	–	–	Proximal ligation and plication of aneurysm + OPCABG (rSVG sequential to D1 and LAD)

^aBetween percutaneous transluminal coronary angiography and aneurysm formation.

DM: diabetes mellitus; HT: hypertension; LAD: left anterior descending; LIMA: left internal mammary artery; OPCABG: off-pump coronary artery bypass grafting; rSVG: reverse saphenous vein graft.

Figure 1: Coronary angiography reveals a coronary aneurysm of 2.5 cm in diameter in the proximal left anterior descending (LAD) artery (A). Intraoperative photograph showing coronary aneurysm in the proximal LAD (B) (Source: *Indian Heart Journal* 2012;6402:198–9, permission: obtained).

had been deployed along with lesion proximal to the stent (Fig. 1A). He was advised to undergo an emergent coronary artery bypass grafting (CABG) and resection of the aneurysmal sac. During surgery, a large aneurysm of the proximal LAD ~2.5 cm in diameter was noted. It was proximally ligated and a left internal mammary artery (LIMA) graft to the LAD used to bypass the lesion (Fig. 1B). He is now well on follow-up after 2 years.

Case 2

A 75-year old male smoker who is a diabetic and hypertensive with a past history of chronic stable angina for which stenting of the LAD with a Taxcor stent (Euro GmbH, Germany) 3 × 28 at 10 atm with TIMI-3 flow was done at a private hospital presented with acute coronary syndrome 1 month after stenting. Control angiography was done at the same place which showed LAD stent patent with a 2 × 2 cm aneurysm in the proximal LAD (Fig. 2A). The patient was referred to us for surgical management. During surgery, a 2 × 2 cm size aneurysm in the proximal LAD was found. It was proximally ligated and plicated and a LIMA graft was used to bypass the lesion on beating heart (Fig. 2B). His postoperative

period was uneventful and he was discharged on the fifth post-operative day. The patient is doing well on follow-up with no recurrence of symptoms

Case 3

A 73-year old male diabetic, hypertensive and a follow-up case of old non-segment (ST) elevation myocardial infarction with drug eluting stenting to the LAD and ramus intermedius with a Xience V stent (Abbott Laboratories, IL, USA) 2.75 × 28 in September 2009 presented with sudden-onset chest pain on September 2011. His 2D Echo showed hypokinesia of the LAD territory. His coronary angiography showed 100% in-stent restenosis in the LAD stent with a 3 × 2 cm aneurysm in the mid-LAD (Fig. 3A). He was managed medically with dual antiplatelet therapy with atorvastatin, metoprolol and oral hypoglycaemic drugs. After stabilization, the patient was referred to us for surgical management. During surgery, a large aneurysm of 2 × 2 cm in the mid-LAD was found. Our attempt to harvest LIMA was not successful because of dense pericardial adhesions for which the patient was taken on bypass and on-pump beating heart CABG was performed. Aneurysm was proximally

Figure 2: Coronary angiography reveals a coronary aneurysm of 3×2 cm size in the proximal left anterior descending (LAD) artery (A). Intraoperative photograph of Patient 2 reveals coronary aneurysm of 3×2 cm size in the proximal LAD. Off-pump coronary artery bypass grafting (OPCABG) $\times 1$ (LIMA to LAD) has been done (B).

Figure 3: Coronary angiography reveals a coronary aneurysm of 2×2 cm size in the mid-left anterior descending (LAD) artery (A). Intraoperative photograph showing coronary aneurysm of 2×2 cm size in the mid-LAD. On-pump beating heart coronary artery bypass grafting (rSVG to the distal LAD) has been done (B).

ligated and plicated and reverse saphenous vein graft (SVG) was used to bypass the lesion (Fig. 3B). The patient was discharged 6 days after surgery and is well now after 6 months of the follow-up.

Case 4

A 60-year old male hypertensive and smoker presented with a history of angina on exertion for the last 3 years and rest pain for the last 2 days. Electrocardiography on admission showed ST depression in leads V5 and V6. His 2D Echo showed no abnormality. His coronary angiography showed a proximal LAD aneurysm of 9×11 mm with 50% occlusion of the left main coronary artery, 70% occlusion of the LAD and 70% occlusion of the distal left circumflex (Fig. 4A). The patient was managed medically and was referred to us for surgical management. During surgery, an aneurysm of 1.5×1.5 cm was found in the proximal LAD. Immediately after sternotomy, the patient had haemodynamic instability which settled gradually and it was decided on table to graft the LAD with SVG (which was already harvested by that time). Aneurysm was proximally ligated and plicated and beating heart CABG (sequential SVG graft to LAD and D1) was done to bypass the lesion (Fig. 4B). His postoperative period was uneventful and he was discharged on the fifth postoperative day. The patient is doing well after 6 months of follow-up.

RESULTS

The postoperative course was uneventful. The postoperative data are given in Table 2. Only 2 patients required inotropic support postoperatively. The mean ventilation time was 6.25 h and mean mediastinal drainage was 287.5 ml. None of the patients required transfusion of any blood product. All patients had an intensive care unit stay of 2 days and a hospital stay of 5–6 days. All the patients recovered satisfactorily and were discharged. During the follow-up, all the patients were found to be free of symptoms and none died during the follow-up. All the patients were followed up clinically and a non-invasive follow-up with electrographically controlled exercise test was done, which showed no reversible ischaemia in either of the cases.

DISCUSSION

CAA is an uncommon entity although it has been diagnosed with increasing frequency since the advent of coronary angiography. This is the first case report describing surgical therapy in 4 cases of coronary aneurysm from a single centre.

Based on several angiographic studies, the incidence of CAAs ranges widely from 0.3 to 5.3% of the population, and a pooled analysis reports a mean incidence of 1.65% [7]. CAAs after

Figure 4: Coronary angiography of Patient 4 reveals a coronary aneurysm of 1.5×1.5 cm size in the proximal left anterior descending (LAD) artery (A). Intraoperative photograph showing coronary aneurysm of 1.5×1.5 cm size in the proximal LAD. Off-pump beating heart coronary artery bypass grafting (rSVG to LAD) has been done (B).

Table 2: Postoperative data of the patients

Case	Ventilation time	Reintubation	Inotropic requirement	Adverse event	Total blood loss	Blood product transfused
1	5 h	No	No	No	200 ml	None
2	7 h	No	Yes	No	300 ml	None
3	7 h	No	Yes	No	350 ml	None
4	6 h	No	No	No	200 ml	None

coronary intervention are rare, with a reported incidence of 0.3–6.0%, and most aneurysms are in fact pseudoaneurysms rather than true aneurysms [8].

In all our 4 cases, coronary aneurysm developed in the LAD artery. The reason for the preferential development of CAA in the LAD is the same as that for preferential development of atherosclerosis in the LAD. LAD segments are exposed to higher wall stress during systole. This is the result of the different contractile properties of the left vs right ventricle. Moreover, the LAD exhibits twice the torsion of other arteries generating helical flow patterns. Furthermore, the increasing branching pattern of the LAD contributes to the development of disturbed flow [9].

Typical causes of aneurysms include congenital [10] Kawasaki disease, atherosclerosis and coronary trauma. Less common causes are polyarteritis nodosa, systemic lupus erythematosus, syphilis and rheumatic fever [11].

Percutaneous transluminal coronary angioplasty (PTCA) occasionally causes the unexpected adverse effect of a CAA, which is prone to rupture and thrombose and therefore requires repair [12]. With the increasing use of new devices, and newer ones appearing in quick succession, an increase in the frequency of this complication is expected. PTCA-induced pseudoaneurysm of the coronary artery is caused either by incomplete healing after perforation or by rupture of the coronary artery occurring at the time of the coronary intervention. According to a report by Ajluni *et al.* [13], perforation associated with conventional PTCA occurred in 0.14% of cases.

In the Taxus-V trial, CAAs were more prevalent after implantation of paclitaxel-eluting stents than bare metal stents (1.4 vs 0.2%), though this trend did not quite achieve statistical significance ($P < 0.07$) [14]. This did not appear to be due to differences in pressure during deployment or stent size, suggesting that aneurysms may be the result of an inflammatory reaction to the drug-coated stent [15]. The antiproliferative mechanism of the anticancer drugs were

thought to cause impaired healing effect, which ultimately may be counter-productive and lead to the formation of CAA [16, 17].

Coronary intervention-associated aneurysms usually are detected at the time of repeat angiography for recurrent symptoms or as part of routine angiographic follow-up as mandated by study protocols.

Coronary angiography is the gold standard for the diagnosis of coronary aneurysms, which are defined as a luminal dilatation 50% larger than that of the adjacent reference segment [4]. Intravascular ultrasound has become the gold standard in providing critical diagnostic information to address the anatomic considerations in the evaluation of coronary aneurysms [18].

Aoki *et al.* [16] have proposed a classification system for coronary aneurysm that forms after coronary stenting. Type I aneurysm is a type of aneurysm that demonstrates rapid early growth with pseudoaneurysm formation detected within 4 weeks. It is likely that arterial injury related to the procedure is the likely contributor to aneurysm formation in these cases. Type II aneurysm is a type of aneurysm with a sub-acute to chronic presentation and is typically detected incidentally during angiography for recurrent symptoms or as part of protocol mandated follow-up (usually detected ≥ 6 months after the procedure). Type III subtype in the published literature is mycotic or infectious in aetiology. In these rare cases, patients typically present with systemic manifestations and fever as the result of bacteraemia.

The impetus for treating coronary aneurysms is predicated on the host of complications associated with these lesions. These most commonly include angina, myocardial infarction and sudden death. Other adverse events include thrombosis, thromboembolism, formation of arterio-venous fistulae, vasospasm and rupture. These complications may, in part, be related to turbulent flow associated with aneurysms, though they could also be attendant features of atherosclerotic coronary artery disease that tend to be seen in association with aneurysms.

The management of patients with CAA is controversial. There are few data regarding medical therapy for coronary aneurysms. Medical management generally includes antiplatelet and/or antithrombotic agents, the use of which has been anecdotal.

Concerns relating to stent graft treatment of coronary aneurysms include closure of contiguous side branches arising next to the aneurysm site, stent thrombosis and recurrent restenosis. Placing coronary coils behind stents to thrombose the aneurysm sac can also be challenging and requires considerable expertise. Poly-tetra fluoro ethylene (PTFE) covered stents which are easy and rapid to deploy have emerged as a new tool for the treatment of CAAs [19, 20]. However, some multicentre randomized trials in comparing expanded PTFE stent graft with bare metal stents have shown that these stents do not improve clinical outcomes and may be associated with a higher incidence of restenosis and early thrombosis [21]. There have been very few case reports of treatment of CAA with covered stent graft and the technique is still in the evolving phase [22].

Surgical approach is thought to be safer and more reliable for repair of a coronary aneurysm/pseudoaneurysm. The indications for the surgical treatment of CAA in general are (i) severe coronary stenosis, (ii) complications such as fistula formation, (iii) compression of the cardiac chambers, (iv) high likelihood of rupture such as rapidly increasing size of the aneurysm or pseudoaneurysm and (v) any type of aneurysm developing after coronary intervention [23, 24].

Operative therapy may include aneurysm ligation, resection or marsupialization with interposition graft, and the ideal approach has not yet been formally studied [25].

In our 3 cases of coronary aneurysm, a common surgical technique was employed which included proximal ligation, plication and revascularization. In 1 case, proximal ligation and revascularization was done.

In conclusion, the treatment for coronary artery aneurysm is still controversial. We propose that post-stenting aneurysms (with or without coronary stenosis), expanding aneurysms/pseudoneurysms, infected aneurysms and symptomatic aneurysms should be surgically treated. The optimum surgical therapy for coronary aneurysms includes proximal ligation, plication and revascularization. Results after surgical therapy are excellent.

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eComment. Coronary artery dilatation: ectasia or aneurysm

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We read with great interest the paper by Singh et al [1]. They described surgical treatment including proximal ligation and plication of the aneurysm with coronary artery bypass grafting in a series of 4 cases of coronary artery aneurysm (CAA) from a single centre. We would like to congratulate the authors for bringing such a rare entity to our attention. We would also like to add a short comment on this topic.