Cardiovascular Revascularization Medicine 20 (2019) 523–527

Contents lists available at ScienceDirect

Cardiovascular Revascularization Medicine

Percutaneous Placement of Amplatzer Duct Occluder Device to Seal a Saphenous Vein Graft Pseudoaneurysm

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ARTICLE INFO

Article history:
Received 26 July 2018
Received in revised form 5 September 2018
Accepted 5 September 2018

Keywords:
Amplatzer duct occluder device
Saphenous vein graft pseudoaneurysm

Contents

1. Introduction

Aneurysmal dilation of saphenous vein graft is a rare but serious complication of coronary artery bypass grafting with an estimated incidence of less than 1% [1]. Its exact mechanism of formation is not entirely known. However, vascular trauma, imperfect suture placement and atherosclerotic degeneration are amongst the proposed pathophysiology. Conservative management, percutaneous closure as well as surgical resection have been employed in their management. However the optimal approach is yet to be explored. In the recent years, the applications of Amplatzer devices have been expanded beyond their original indications with a few case reports demonstrating their use in the closure of saphenous vein graft aneurysms and pseudo-aneurysms (SVGAs). We report the case of a 76 year old man who presented with a ruptured saphenous vein graft pseudo-aneurysm that was successfully sealed with an Amplatzer duct occluder II device. To our knowledge, this is the first reported case of aneurysmal dilation of saphenous vein graft managed with Amplatzer duct occluder II. Our case highlights the usage of duct occluder device as an effective strategy to close SVGAs. We also review the literature pertaining to SVGAs managed with Amplatzer devices.

2. Case

A 76-year-old male presented to the emergency department complaining of dyspnea and chest discomfort that had been going on for a few weeks. He was found to have severe anemia with hemoglobin of 6.1 g/dl for which he was given two units of packed red blood cells. His past medical history was significant for ischemic heart disease, a coronary bypass surgery 9 years ago and a known aneurysm of the saphenous venous graft (SVG) to the posterior descending artery (PDA)

Abbreviations: ADO-II, Amplatzer duct occulder-II; AL2, Amplatz left 2; CABG, coronary artery bypass grafting; CT, computed tomography; PDA, posterior descending artery; SVG, saphenous vein graft; SVGAs, saphenous vein graft aneurysm and pseudo-aneurysms.

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https://doi.org/10.1016/j.carrev.2018.09.004

that was treated with percutaneous coil embolization at another institution one year ago. Chest X-ray done on admission showed a large circumscribed shadow superimposed on the right lung field (Fig. 1). A computed tomography (CT) scan of the chest was done that showed evidence of a ruptured aortic aneurysmal dilatation at the site of prior SVG to PDA with resultant anterior mediastinal hematoma, right sided hemothorax and right lower lobe compressive atelectasis.

Cardiac catheterization for further characterization was performed that showed an occluded SVG to PDA and a large pseudo-aneurysm at the location of the anastomosis of the ostium of SVG to the aorta with evidence of previously placed coils distally (Fig. 2). There was communication between the aortic lumen and the lumen of the pseudo-aneurysm with free flowing of contrast. In consultation with cardiothoracic surgery and after discussion of risks and benefits of percutaneous intervention versus surgery with the patient, we decided to proceed with percutaneous closure of SVGA.

Using standard access in the right common femoral artery with an 8-French × 11 cm sheath, an 8-French Amplatz Left 2 (AL2) guiding catheter was advanced and used to selectively engage the site of the ruptured pseudo-aneurysm. Angiography was performed demonstrating active leak from the aortic lumen into the pseudo-aneurysm. An Advantage glide exchange length wire was advanced through the guiding catheter into the pseudo-aneurysm over which a Navicross catheter was advanced into the pseudo-aneurysm. There was inability to advance the guiding catheter further; therefore, a 6-French multipurpose 125 cm length guiding catheter was advanced over the Advantage wire, and over the Navicross catheter the 6-French guiding catheter was advanced into the cavity of the pseudo-aneurysm; this allowed further advancement of the 8-French guiding catheter. The wire and the Navicross catheter were removed. A 4 mm Amplatzer Duct Occluder II was then advanced and the disc was deployed inside the pseudo-aneurysm cavity. The guiding catheter was retracted and the opposing disc was advanced; however, after taking multiple angiographic views, it was apparent that this device was small and not able to sit flush with the aortic side at the orifice of the pseudo-aneurysm; therefore, it was recaptured and the guiding catheter was advanced again into the pseudo-aneurysm. At this point, a 6 mm Amplatzer duct occluder II with its distal disc was deployed inside the pseudo-aneurysm cavity. The second disc was then deployed inside the aorta at the orifice of the pseudo-aneurysm cavity. Angiography was performed through the guiding catheter that demonstrated complete apposition of the aortic disc and complete occlusion of the pseudo-aneurysm. The device was then released. The patient tolerated the procedure well with no complications (Figs. 3, 4).

The patient also had a right sided chest tube placed during his admission for the hemothorax that was removed after six days. His clinical condition improved significantly and he was discharged in a stable condition. He was seen two weeks later as outpatient and was found to be doing well.

3. Discussion

Coronary artery bypass graft (CABG) is one of the most common major surgical procedures with roughly over 400,000 operations performed every year in United States [2]. Although arterial grafts are associated with longer survival, both arterial and venous grafts are used quite frequently in patients undergoing CABG [3]. Saphenous vein graft aneurysm or pseudo-aneurysm formation is an extremely rare but potentially fatal complication of CABG that was first reported in 1975 by Riahi and colleagues [4]. Its true incidence is not clear however, according to one single center study, it is estimated to be less than 1% [1]. An aneurysm in general is defined as a permanent localized dilation of a blood vessel with at least 50% (or at least 1.5 times) increase in diameter compared to the normal diameter of the blood vessel in question [5].

In literature pertaining to aneurysms and pseudo-aneurysms of bypass grafts, there appears to be a great deal of confusion into separating one from the other and often the two terms are used interchangeably. However, in the true sense, an aneurysm is a dilation involving all the three layers of the vessel wall and usually occurs five or more years after the bypass graft surgery whereas a pseudo-aneurysm results from collection of blood between two layers of the vessel wall, arises at the anastomotic sites and can occur early or late after the initial surgery [6]. The exact pathophysiology of SVGAs formation is poorly understood. However, several mechanisms have been proposed. Early pseudo-aneurysm formation has been speculated to result from imperfect suture placement, injury to the wall of the graft during surgery, weakness in the vein graft itself especially at the site of the valves and

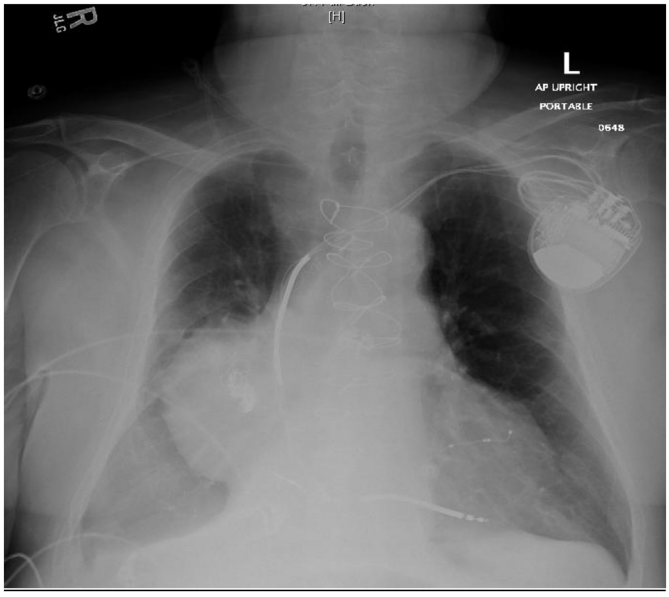

Fig. 1. Chest X-ray on admission showing a large circumscribed shadow superimposed on the right lung field.

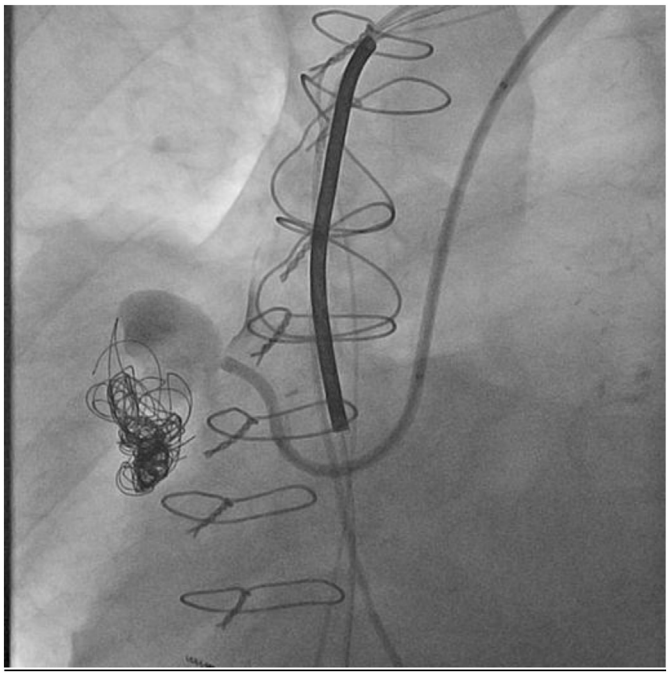

Fig. 2. Angiography in the left anterior oblique view showed the SVG to PDA occluded in its ostial to proximal segment with evidence of previously placed multiple coils. Evidence of multilobes to the pseudo aneurysm with a large superior lobe and additional communication that goes inferiorly.

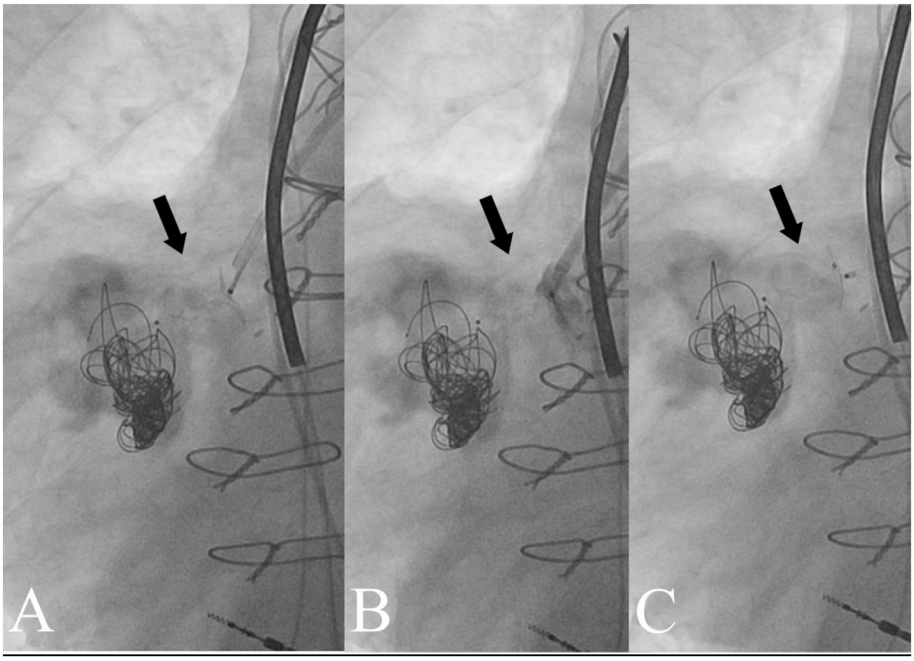

Fig. 3. Left anterior oblique views showing the Amplatzer duct occluder II device deployed (panel A), with angiography demonstrating contrast bouncing off the aortic disc (panel B). Post release position is shown in panel C.

from infection causing suture dehiscence at the site of anastomosis [6–9]. Late aneurysm/pseudo-aneurysm formation that occurs five or more years after CABG has been postulated to result from weakening of the blood vessel walls due to degeneration and dilation by atherosclerotic disease [10,11]. High pressure with increased wall tension the vein is subjected to when grafted into arterial circulation is also proposed to contribute to aneurysm formation [12].

SVGAs have been most commonly seen in vessels grafted to right coronary artery followed by left anterior descending artery, the reason being that saphenous veins are frequently used for RCA grafting whereas internal mammary arteries are mainly used for left sided coronary circulation [13]. SVGAs can present in miscellaneous ways. Approximately, one third of SVGAs are incidentally noted on imaging studies done for other reasons or during autopsy. The most commonly presenting symptom of SVGAs is angina or chest pain followed by shortness of breath [13]. Occasionally, SVGAs may form a fistulous connection with lung parenchyma and present as hemoptysis [14]. A triad of chest pain, mediastinal mass on imaging and a previous CABG surgery should raise suspicion for SVGA [15]. SVGAs may cause serious and life threatening complications. Cardiac tamponade by direct compression of the heart or by leakage into the pericardium, hemothorax, fistula formation, aneurysm rupture, thrombus formation with distal embolization, myocardial infraction and even death can occur [13,16–18].

Given the lack of comparison trials between the imaging techniques for SVGA assessment, there is no consensus on the best modality for accurate diagnosis of SVGAs. There has been a report of SVGA missed on angiography but later confirmed on surgery [19]. In other instances echocardiography has led to misdiagnosis of SVGA as intra-cardiac mass [20–22]. Some physicians advocate cross-sectional imaging study such as a computed tomography (CT) scan or magnetic resonance imaging (MRI) as an initial assessment modality to establish the presence of an SVGA and to assess for mechanical complications [13]. With advances in CT angiography, the need for an invasive angiography for anatomic evaluation of the grafted and native vessels can potentially be obviated [23]. However, rather than a single imaging study, a multi-modality approach should be adopted in the evaluation of SVGAs so as to assess their true dimensions, rule out complications and establish the underlying cardiac status of the affected patients before selecting the appropriate management strategy [13].

Surgical treatment, percutaneous intervention as well as conservative management has been done in cases of SVGAs [1,23–27]. There is no optimal approach in regards to treatment of SVGAs, however,

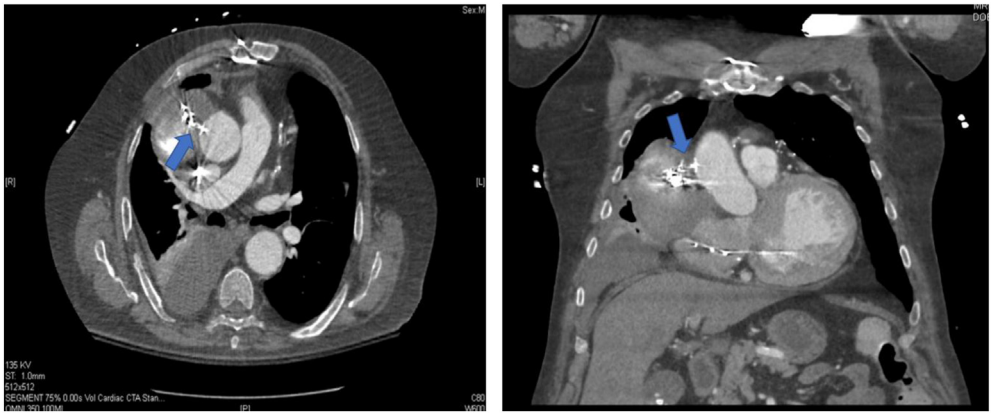

Fig. 4. CT chest after the procedure showing the occluder device in place.

Table 1
Available literature on percutaneous closure of saphenous vein graft aneurysms [SVGAs] using Amplatzer devices.

Author	Year	Pt age	Pt sex	Target vessel	Year post CABG	Mechanical complication	Clinical presentation	Amplatzer device used	30 day/in hospital outcome
Shammas et al. [37]	2017	76	M	RCA	15 Y	RA/RV compression	Chest pain	10-mm Amplatzer muscular VSD occluder	Alive
Vizzi et al. [38]	2015	75	M	RCA	NA	RA/SVC compression	Chest pain	Two 8 mm Amplatzer vascular plugs 4	Alive
Shreenivas et al. [39]	2013	80	F	1st OM	7 M*	Mediastinal bleeding, hemothorax	Bleeding chest wound	8-mm Amplatzer vascular plug II	NA
Brooks et al. [40]	2013	67	M	1st OM	15 Y	–	Dyspnea	6 × 6 mm Amplatzer vascular plug II	Alive
Khan et al. [41]	2012	58	M	2nd OM	15 Y	LIMA compression	Incidental	12-mm Amplatzer vascular plug I	Alive
Ayub et al. [42]	2012	74	M	PDA	NA	RA compression	Incidental	8.0-mm Amplatzer vascular plug II	Alive
Sura et al. [43]	2010	78	M	RCA	NA	Diaphragm impingement, Liver compression	Dyspnea	4-mm Amplatzer Septal occluder	Alive
Hatrick et al. [44]	2008	66	M	LAD	26 Y	–	Incidental	10 mm Amplatzer vascular plug	Alive
Möllmann et al. [45]	2008	75	–	1st diagonal	22 Y	–	Chest discomfort	4 mm Amplatzer septal occluder	Alive
Mylonas et al. [27]	2006	85	M	OM	10 Y	–	Incidental	8 mm Amplatzer vascular plug	Alive
Tonelli et al. [46]	2008	81	M	Circumflex	NA	Pseudoaneurysm rupture	Hemoptysis	12 mm × 8 mm Amplatzer vascular plug	Alive

CABG: coronary artery bypass grafting; F: female; LAD: left anterior descending artery; LIMA: left internal mammary artery; M: male; M*: Months; NA: not available; OM: obtuse marginal artery; PDA: posterior descending artery; Pt: patient; RA: right atrium; RCA: right coronary artery; RV: right ventricle; SVC: superior vena cava; Y: years.

management should be tailored depending on the clinical situation. Patients with mechanical complications or other indication for cardiac surgery who have a viable and salvageable myocardium are best managed with surgical repair or resection of the SVGA. Percutaneous intervention is becoming an emerging option especially in those who are poor surgical candidates and those with no other indication for cardiac surgery. Percutaneous interventions include covered stent placement, coil embolization and occlusion by using Amplatzer devices. There are no studies that compare various percutaneous intervention strategies for SVGA management.

Our patient was successfully treated with Amplatzer duct occluder II (ADO-II). Amplatzer devices include a wide range of nitiniol wire mesh containing self-expanding devices that are emerging as alternative to surgery in a wide variety of clinical conditions including blood vessel embolization, closure of arteriovenous fistulas, closure of portosystemic shunts and closure of patent ductus arteriosus and cardiac septal defects amongst others [28–35]. Their use is being expanded to the treatment of SVGAs. In the comprehensive literature review regarding the natural history and management of SVGAs published in 2012 by Ramirez and colleagues, only 5 out of 209 patients were treated with Amplatzer device [13].

We performed literature review in Pubmed using the search strategy "(amplatzer OR percutaneous) AND saphenous AND (aneurysm OR pseudoaneurysm)". This yielded 87 matching articles out of which eleven articles had patients with SVGA managed with Amplatzer devices (Table 1). All of these eleven articles were case reports. Eight patients had Amplatzer vascular plug whereas three patients had Amplatzer septal occluder placed for closure of SVGA. Except for one patient regarding whom no follow-up information was available, 10 out of the 11 patients were alive after 30 days post Amplatzer device placement. We did not find any reported case pertaining to the use of Amplatzer duct occluder device II (ADO-II) for the closure of SVGA as was done in our patient.

ADO-II is a self-expanding occlusion device that was originally designed to close patent ductus arteriosus. Each ADO-II features a radio-opaque micro-screw attachment for a delivery wire, a cylindrical central waist with two retention discs, one on each side of the central waist and a radio-opaque distal marker. The ADO-II size is defined by the waist diameter and nominal length. The ADO-II device is currently available in 8 sizes with four waist diameters i.e. 3 mm, 4 mm, 5 mm and 6 mm with each in either 4 mm or 6 mm nominal length [36]. To our knowledge our patient is the first reported case to have had ADO-II placed successfully for the management of SVGA. We advocate its use for such lesions.

It is worth mentioning that an 8-French sheath was used for access in our patient. We chose a larger diameter access sheath in order to allow the use of a larger guiding catheter, provide good support and allow delivery of a wider range of devices. However, an alternative approach could've been to use a 5-French diagnostic catheter to enter the pseudo-aneurysm and then exchanging it over a wire to a 5-French TorqVue Sheath which allows closure of the defect with a 5-French arterial access. Another option is to use the Amplatzer vascular plug IV (available outside the United States) that can be introduced through a 4-French diagnostic catheter.

4. Conclusion

Saphenous vein graft aneurysm/pseudoaneurysm (SVGA) is a rare but potentially life threatening complication of coronary artery bypass graft surgery. The optimal approach to management of SVGAs is not yet established however, conservative treatment, percutaneous intervention as well as surgical resection can be employed depending on the overall clinical status of the patient. Use of Amplatzer devices is an emerging percutaneous approach for closure of SVGAs. Amplatzer duct occluder II device can be used very effectively to seal SVGAs without having to undertake the risks of major surgery.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

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