Transradial Treatment of Saphenous Vein Graft Aneurysm with Covered Stent: Where are We Standing?

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Abstract — Saphenous vein graft aneurysms (SVGAs) are a rare complication of aortocoronary bypass. Nevertheless, they can result in severe complications including myocardial infarction, compression of local structures and aneurysm rupture. SVGAs are broadly classified as true aneurysms or pseudoaneurysms. Although there are no definitive treatment recommendations, surgery has traditionally been the preferred method. Percutaneous treatment with covered stents is a less invasive option compared to surgery, however the long term outcomes of either strategy are unknown. We present a case of a saphenous vein graft aneurysm treated with a covered stent via the transradial approach followed by a review and discussion of the literature. To our knowledge this is the first reported case of a saphenous vein graft aneurysm treated with a covered stent using the transradial approach.

Keywords — Aneurysm, transradial, saphenous vein graft, covered stent, pseudoaneurysm

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I. INTRODUCTION

Despite ongoing advances in medical therapy and percutaneous revascularization with drug eluting stents, coronary artery bypass graft (CABG) surgery remains one of the most commonly performed surgical procedures. Approximately 350,000–400,000 procedures are performed annually in the US and an estimated 800,000 worldwide (1,2). Although the use of an arterial conduit, usually the left internal mammary artery (LIMA), is considered the gold standard for CABG, the majority of patients do not receive a secondary arterial conduit (3).

Therefore saphenous vein grafts continue to be used regularly. Degeneration and occlusion of saphenous vein grafts resulting in a 10-year patency of approximately 60% is a known issue in patients undergoing CABG (1). Saphenous vein graft aneurysms (SVGAs) on the other hand, are a rare but potentially fatal complication of CABG. First reported by Riahi et al in 1975 (5), the incidence of SVGAs is <1% based on the largest case series reviewing >5500 vein grafts (7). Coronary artery aneurysms on the other hand, occur with a frequency of approximately 5% with the right coronary artery (RCA) the most frequently affected vessel (6).

The true incidence of SVGAs may be underestimated as they often remain clinically silent or the initial presentation could be rupture of the aneurysm with subsequent tamponade or death. The literature consists mostly of case reports and small retrospective case series (13-19).

Aneurysms are defined as a localized dilation of the coronary artery exceeding 1.5 times that of the adjacent coronary artery diameter. SVGAs are broadly classified as a true or pseudoaneurysm and as either saccular or fusiform. The management options are diverse and a consensus on optimal management remains unclear. Currently no guidelines exist for screening or optimal treatment. Surgery has traditionally been the accepted management with resection of the aneurysm with or without bypass of the affected territory. However, the availability of covered stents has resulted in an alternative treatment option for SVGAs. Here we report a case of transradial treatment of a SVG with a review of the literature regarding diagnosis, incidence and management of this entity.

II. TRANSRADIAL TREATMENT OF A SVG

A 79-year old male with a prior history of coronary artery disease s/p CABG in 2001 with a LIMA to the LAD, reverse saphenous vein graft to the diagonal and reverse saphenous vein graft to the RCA, atrial fibrillation, hypertension and hyperlipidemia presented with exertional angina and dyspnea on exertion.

Given his symptoms and remote history of bypass he underwent coronary angiography. Diagnostic angiography revealed a patent LIMA to the LAD, patent saphenous vein graft to the diagonal, 90% stenosis of the native circumflex and aneurismal dilation of the saphenous vein graft to the RPDA with a tandem 95% stenosis (see Figure 1). He underwent revascularization of the native circumflex at that time and was staged for intervention of the SVG to the RPDA. The

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aneurismal segment measured 6.56 mm (by QCA) at its widest point and approximately 12 mm long. The proximal SVG was approximately 3.0 mm by QCA. After further discussion with the patient and CT surgery it was felt that percutaneous treatment would be the best option for the patient.

Access was obtained via the left radial with a 6 Fr Terumo Glide Sheath (Terumo Medical; Somerset, NJ) and then upsized to a 7 Fr sheath. Following sheath exchange a radial cocktail was administered (200 mcg nitroglycerin, 2500 U of Heparin, 2.5 mg Verapamil). A 7 Fr Vista Brite Tip MP A-1 (Cordis, Miami, FL) guide was used to engage the vein graft to the RCA. Following guide placement Angiomax (Medicines Co; Parsippany, NJ) was administered. A Runthrough (Terumo Medical) wire was then advanced distally and a 4.0 mm Spyder Rx filter (EV3, Plymouth, MN) was deployed. We then performed IVUS (Boston Scientific, St. Paul, MN) to assess the true lumen size. A primary stent of the distal lesion was then performed with a 4.0 x 18 mm Resolute drug eluting stent at 14 atm (Medtronic, Minneapolis) (Figure 2). This was complicated by slow flow. The filter was then retrieved and debris was removed from the filter with improved flow in the vessel. A second filter was then deployed with a long wire to accommodate the OTW delivery of the JOSTENT (Abbott; Abbott Park, IL). A 4.0 x 19 mm Jostent was deployed across the aneurysm (Figure 3) and overlapped proximally with a 4.0 x 8 mm Resolute DES to cover a possible edge dissection. Final angiography revealed TIMI 3 flow with resolution of the aneurismal segment (Figure 4). The guide was removed and a TR band applied. He was discharged home the next day without incident. At the time of this article, he is 19 months post PCI and has remained asymptomatic from a cardiac standpoint.

III. DISCUSSION

A. Incidence

Saphenous vein graft dilation is not entirely uncommon, occurring in approximately 14% of grafts 5 years after surgery (8). Saphenous vein graft aneurysms however, are a relatively rare but potentially fatal complication of CABG. Its estimated occurrence is <1%, however the true incidence may be underestimated as only a small number of cases may come to clinical attention (7). Aneurysms are defined as a local dilation >1.5 times the adjacent normal vascular segment (6). SVGAs are broadly classified in the literature as either a true aneurysm or pseudoaneurysm even when there is no pathologic tissue, with true aneurysms occurring more frequently (7,13). A true aneurysm is an expansion of all the three vessel layers and tends to be more fusiform (9). A pseudoaneurysm on the other hand, is a dilation of the graft with disruption of one or more walls of the vessel and tends to be more saccular in nature (10). This broad classification is important as they may differ in location as well as presentation. However, without pathologic tissue it may be difficult to differentiate the two entities. In one review, approximately two-thirds of cases diagnosed by the physician as a pseudoaneurysm were reclassified based on tissue analysis. Therefore, use of the term severe saphenous vein graft dilation instead of aneurysm has been suggested (4).
formation has been reported within the first few weeks of surgery (10,12,13,19-21). Table 1 is a general summary of the differences between the two classifications, although no single characteristic is diagnostic.

B. Presentation

SVGAs are reported in both sexes, typically within the sixth decade of life, occur predominantly in males, which account for over 75% of the cases in the literature, perhaps a result of the higher incidence of coronary artery disease in males (10,13,22,26,27). Patients usually present in the sixth decade of life, however the clinical presentation varies between the two categories of SVGAs.

Patients with true aneurysm are often asymptomatic (~45-55%) and are discovered incidentally on imaging studies. Other cases present as myocardial infarction (20-25%), unstable angina (13-20%) or a variety of other presentations (13,22,25-27). Pseudoaneurysms, on the other hand tend to be more symptomatic. The majority present with chest pain and angina (45-53%) with only a smaller percentage presenting as either a myocardial infarction (12-15%) or as asymptomatic (12-15%). (22,25)

C. Pathophysiology

The exact pathophysiology resulting in SVGAs is not well understood, however, the etiology resulting in a true aneurysm or pseudoaneurysm formation is different. A normal saphenous vein has a thin, mostly acellular, fibrous intima and thick media, which varies in structure based on relationship to the venous valves. The circular muscle of the vein is not continuous, rather it is an interlacing of smooth muscle, collagen and elastic tissue that gives way to the longitudinal layer in the vicinity of the venous valves. This results in a potential weak area where a true aneurysm is likely to form. In addition, when the vein is exposed to arterial pressure, there is endothelial denudation with early atherosclerotic changes. Within the first year the graft becomes more rigid, shrinks and tugs on the distal anastomosis. After one year the intima and media become fibrotic and increase in lipid content, resulting in progressive atherosclerosis. This fibrotic reaction may limit vessel distension and in part account for the low incidence of SVGAs. Plaque development followed by subsequent plaque rupture may be the initial event creating a vulnerable area for aneurysm formation. In addition, venous varicosities may contribute to aneurysm development. (25-27)

True aneurysms are thought to be a result of atherosclerosis, hyperlipidemia, smoking, thrombosis, or disruption of the vaso vasorum resulting in vessel wall ischemia and systolic and diastolic bidirectional flow. As described early, the weakness of the graft wall near the valve site as the muscle layer changes has also been implicated as a cause. (28-30).

Pseudoaneurysms are a result of surgical technique, vein preparation, trauma or infection and stent fracture. The early changes in the vein graft with tension on the anastomosis may account for the reason pseudoaneurysms occur at the

| **Table 1.** General comparison between true aneurysm and pseudoaneurysm. |
|-----------------------------|-----------------------------|
| **True Aneurysm** | **Pseudoaneurysm** |
| Fusiform | Saccular |
| Occur remote from surgery | Occur early after surgery |
| Occur in body of the graft | Occur in the proximal or distal anastomosis |

Figure 3. Deployment of covered stent

Figure 4. Final angiogram
anastomosis, although pseudoaneurysm formation in the body of the graft has been reported (22,27,31-34).

The majority of SVGAs are grafted to the right coronary artery, followed by the left anterior descending and then the circumflex (13). Potential explanations for this include the predominance of SVGs to the right coronary artery as well as the fact that the right coronary artery is often grafted first with the largest segment of the venous conduit. Based on Laplace’s law the larger lumen diameter conduit grafted to the right coronary artery will be exposed to greater wall tension when exposed to arterial pressure resulting in possible aneurismal formation. Also, trauma with endoscopic harvest resulting in a poorer conduit has been hypothesized (35). The true etiology, however remains speculative and is probably multifactorial (13).

D. Diagnosis

In asymptomatic patients saphenous vein graft aneurysms are often detected on chest roentgenogram as a hilar mass. In one large review of 108 cases, 57% presented with an abnormality on chest x-ray in which the subsequent work up resulted in a diagnosis of SVGAs (4). An index of suspicion is required to avoid potentially unnecessary procedures or biopsies and SVGAs should be considered in the differential of any patient presenting with chest pain, history of coronary bypass and a mediastinal mass (11,36). Subsequent work up of a hilar mass with a CT of the chest with IV contrast is useful to distinguish between a solid and cystic mass. Other imaging modalities such as MRI/MRA and TEE may provide additional information. Some form of imaging should be performed to confirm the size of the aneurysm, impingement of adjacent structures, fistula formation and to assess for any other indications that may dictate a particular form of management (i.e. presence of concomitant valve disease which may be an indication for surgery vs. a less invasive approach). Given the limitations of any single imaging modality a multimodality approach may be required. The gold standard remains coronary angiography (10). This not only establishes a definitive diagnosis, but also assesses the extent of coronary artery disease, which may guide treatment options. In addition serial angiography has been preformed to follow progression of aneurismal size (33).

E. Treatment

Currently there is no consensus on optimal management of a saphenous vein graft aneurysm. Because of the low incidence of this disease the data is derived mostly from case reports and small series of patients. As a result, the long-term prognosis is difficult to predict. Based on review of the current literature, it appears that some form of corrective treatment is warranted weather it be surgical or percutaneous correction. Conservative therapy has the highest mortality (13). Ramirez et al (13) reviewed cases with serial SVGa size during follow-up and found nearly all cases demonstrated aneurismal growth. This may result in fistula formation, compression of localized structures, myocardial ischemia, distal embolization and rupture (38,39). There appears to be a direct relationship with aneurysm size and adverse events and although most aneurysms are large at the time of diagnosis (>60 mm), one third of events occurred in aneurysms as small as 20 mm. Therefore there does not appear to be a “safe” size at which one can treat conservatively with some studies suggesting intervention when the SVG diameter is >1 cm (40) and others when >2 cm (13).

Conventional treatment had been surgical bypass with resection or ligation of the aneurysm. Dieter et al (7) reviewed 13 cases with SVGAs and found no improved short-term survival with surgical treatment compared to conservative treatment. Other reviews have suggested a benefit to surgical revascularization particularly for the symptomatic patients (25,40). Other considerations include the patient’s ability to tolerate repeat surgery, graft flow, myocardium at risk and concomitant coronary disease.

With the advancement of percutaneous techniques additional treatments have been described including coil embolization, use of an amplatzer occluder and polytetrafluorethylene (PTFE) covered stent (41-44). Alternatively conservative therapy may be considered depending on the patient and the amount of myocardium considered at risk, however this is associated with a higher mortality. Mortality rates reported for cases of surgical, percutaneous and conservative management were 13.9%, 6.1% and 23.8% respectively (13). Ultimately, both surgical and percutaneous approaches are viable options. There are no large trials to demonstrate superiority of one approach over the other. Although percutaneous therapy has a lower mortality.

One of the potential limitations of treating SVGAs via the radial approach was sheath size. The OTW JOSTENT Coronary Stent Graft (Abbott Vascular) requires a 7 Fr sheath for delivery (since this case was performed, Abbott has released an Rx version that is 6 Fr compatible). The size of the radial artery does not approach that of the femoral artery and one often cited reason for not utilizing the transradial approach is inability to upsize to a larger sheath size for treatment of complex lesions or certain device usage. Saito et al (45) demonstrated that as sheath size increases (a decrease in the radial artery lumen diameter: sheath outer diameter ratio), there is an increase in radial artery occlusion. However, based on this study, the distribution curves of radial artery diameter in men and women were 3.10 +/- 0.60 mm and 2.80 +/- 0.60 mm respectively. It can be estimated from this that 71.5% of male patients and 40.3% of female patients can physically accept 7 Fr sheaths (38). In addition, Egred M (46) demonstrated the utility of 7 Fr sheaths via a transradial approach for complex coronary interventions with successful radial access in all 77 patients. An alternative method is the use of a sheathless approach. Kwan et al demonstrated use of the a 7 Fr sheathless approach in complex coronary PCI with 95% procedural success rate and a 30 day radial artery occlusion rate of 2.5 % (47). Therefore, utilization of a 7 Fr sheath is not a contraindication to transradial access.

Limitations
This is a single case example with management based on case reviews. Treatment and management recommendations ideally should be derived from large clinical trials or consensus documents. Unfortunately, given the low reported incidence of this entity it is unlikely that such a study would occur. Therefore management strategies are based on individual case reports and small series. This approach is retrospective and may be influenced by reporting bias. Symptoms and clinical outcomes may be overestimated since only symptomatic patients are evaluated. Furthermore the inability to perform randomized trials impedes a comparison of management strategies and outcomes.

IV. CONCLUSIONS

Saphenous vein graft aneurysms remain a rare but potentially fatal occurrence. The type of SVGA may partly depend on the time of presentation from surgery; however there may be variation in the presentation as well as time of onset. SVGAs should be included in the differential when investigating a patient with a history of bypass and a mediastinal mass. Multiple imaging modalities may be required for adequate assessment and evaluation of surrounding structures. However angiography remains the gold standard to image the aneurysm. Albeit there is no consensus on optimal treatment, the literature suggests that some forms of treatment (surgical or percutaneous) are warranted to prevent thrombosis, embolization, rupture or compression of adjacent structures. The size of the aneurysm should not necessarily affect the management as even small aneurysms are associated with complications.

Optimal treatment should be based on location of the aneurysm, involvement of adjacent structures and patient co-morbidities. To our knowledge, this is the first use of a covered stent via the transradial approach for treatment of a saphenous vein graft aneurysm.

REFERENCES