AVG Pseudoaneurysms
Percutaneous and Surgical Treatments

DEFINITION

• Caused by a tear through all the layers of a vessel (graft), allowing a blood collection to form outside the blood vessel, but remaining in continuity with the vessel lumen.

• The blood is contained by the surrounding tissues and flows in and out of the pseudoaneurysm’s cavity during systole and diastole.

• Has 2 components: a cavity and a neck by which the cavity communicate with the lumen of the vessel.

AVG Pseudoaneurysm Formation

Incidence

• AVG Pseudoaneurysm incidence rate ranges between 2% and 10% [1-3].

• In 52 surgically excised PTFE AVGs, pseudoaneurysm formation was the main indication for surgical excision in AVGs older than 2 years [4].


Management

• Follow: - small, stable and painless
  - the overlying skin is normal
  - there are adequate sites available on the graft for needles insertion.

• Even small, stable pseudoaneurysms should not be stuck with hemodialysis needles.


Pseudoaneurysm Emergencies
Surgical Intervention

1. Infection
2. Skin necrosis
3. Rupture and bleeding
Indications for revision/repair of pseudoaneurysms

1. Infection.
2. Threatens the viability of the overlying skin.
3. Painful.
4. The cannulation sites are limited by the presence of pseudoaneurysm.


Pseudoaneurysm Infection

- Infection may be a primary cause for pseudoaneurysm development or occur as a secondary event.
- Distinguishing between sterile and infected pseudoaneurysm can be difficult as the local effect of pseudoaneurysm on skin temperature and color can mimic signs of infection.
- Surgical treatment - interposition bypass graft tunneled through non infected tissues and connected with the non infected segments of the old graft, followed by excision of the infected portion [1].
- Graft patency and wound healing achieved in 74% [2,3].


Skin Necrosis/Rupture and Bleeding

- Surgical revision
- Needs early referral for surgery while the skin overlying the aneurysm is thin and shiny before the skin necrosis occurs.

Stent-Grafts

1. Wallgraft endoprosthesis (Boston Scientific) – outer layer made of polyethylene terephthalate and inner layer of Elgiloy stent with platinum tracer wires. FDA approved for tracheobronchial applications.
2. Viabahn endoprosthesis (Gore) expanded polytetrafluoroethylene (ePTFE) inner structure with a nitinol self-expanding external stent. FDA approved for treatment of superficial femoral artery lesions.
3. Fluency (Bard) self-expanding nitinol stent encapsulated into ePTFE graft material. FDA approved for tracheobronchial applications.

- All the stents are used off-label for the AVG’s pseudoaneurysm endovascular treatment and for hemodialysis needles punctures.

Pseudoaneurysms that are too large to follow but are not emergencies either

Endovascular treatment

Surgical treatment

AVG’s Pseudoaneurysm Repair: Surgical versus Endovascular

- Endovascular repair is less invasive than surgical revision and allows continuation of HD using the same AVG without the need for catheter placement.
- If stenting is unsuccessful, the surgical revision option is still available [1].
- Surgical intervention for the treatment of AVG pseudoaneurysms has not been directly compared with the endovascular treatment.

Endovascular Treatment Technical Aspects

- Exclude skin necrosis or infection prior to treatment.
- Use endografts with diameters 15-20% larger than the graft adjacent to lesion.
- Before stent deployment consider using 3000 U. of i.v. heparin.
- The stent should overlap 10 mm of normal graft on both sides to prevent endoleaks [1].
- Use the shortest stent that covers the pseudoaneurysm without excessively overlapping with the normal graft.
- After stent placement, the blood present in the isolated pseudoaneurysm should be aspirated.
- Pseudoanerysm pulsatility was present in some cases for at least 24 h. after stenting despite successful pseudoaneurysm isolation shown by angiogram, but it disappeared at follow up visits [2].


AVG Pseudoaneurysm
Endovascular Treatment, Systematic Review

- 10 studies, 121 patients.
- Mean graft age 3.1 years (5 studies, 29 pts, 95% CI:2.2-4, CI=120.1, P=0.0001)
- Pseudoaneurysm mean diameter 34 mm (6 studies, 57 patients, 95% CI: 23.46.252.8, p<0.0001)
- Main indications for procedure (some had more than one indication):
  - large pseudoaneurysm 64%
  - rapid expansion of pseudoaneurysm 35%
  - thin or ulcerated skin 28%
- Location of pseudoaneurysm: arterial limb of AVG 71% (3 studies, 17 patients, 95%CI:36-99%,Q 4.51, p=0.11).

AVG Pseudoaneurysm Endovascular Treatment

- Venous anastomosis stenosis: 77% (2 studies, 14 patients, 95% CI: 57-97%, Q=0.62, P=0.43)
- Mean number of stents to treat one pseudoaneurysm: 1.4 (8 studies, 74 patients, 95% CI: 1.3-1.5)
- Technical success rate of pseudoaneurysm isolation: 100% in all studies.
- 100% of patients could have HD after procedure without the use of a catheter.

Immediate Complications

- Developed less than one week after the procedure: endoleaks, stent migration and AVG thrombosis.
  - 19% (2 studies, 24 patients, 95% CI: 4-35%, Q=0.62, P=0.43).
- The use of heparin and the operator’s specialty (vascular surgery versus interventional radiology) did not have any effect on the immediate complication rates.

Patency

<table>
<thead>
<tr>
<th>Variables</th>
<th>Studies</th>
<th>Patients</th>
<th>Rate</th>
<th>95% CI</th>
<th>Q statistic</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 mo. primary patency</td>
<td>25</td>
<td>16</td>
<td>0.81</td>
<td>0.76-0.86</td>
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<tr>
<td>3 mo. primary patency</td>
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<td>0.75</td>
<td>0.66-0.83</td>
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<tr>
<td>6 mo. primary patency</td>
<td>2</td>
<td>9</td>
<td>0.76</td>
<td>0.65-0.87</td>
<td>0.26</td>
<td>0.66</td>
</tr>
<tr>
<td>1 mo. secondary patency</td>
<td>9</td>
<td>17</td>
<td>0.88</td>
<td>0.80-0.96</td>
<td>1.73</td>
<td>0.80</td>
</tr>
<tr>
<td>3 mo. secondary patency</td>
<td>7</td>
<td>17</td>
<td>0.74</td>
<td>0.61-0.80</td>
<td>0.68</td>
<td>0.20</td>
</tr>
</tbody>
</table>

AVG’s angioplasty primary patency rate: 1 month - 87.4%, 3 months - 77.2%, 6 months - 65.4% [1].

Late Complications

- Occurred more than one week after the procedure: surgical revision for return of pseudoaneurysm pulsatility, large pseudoaneurysm, inability to cannulate the AVG, thrombosis of the AVG, stent migration, new pseudoaneurysm formation away from the stent, new pseudoaneurysm resulted from stent cannulation and AVG infection.
  - 30% of patients (8 studies, 101 patients, 95% CI: 22-39%, Q=0.62, P=0.62).
  - AVG thrombosis (4 studies, 50 patients) has been reported in 12% of patients (95% CI: 3-21, Q=0.76).
  - AVG infection (3 studies, 50 patients) developed in 35% of cases (95% CI: 22-48, Q=0.43).

Thrombosis

- 1 episode of AVG thrombosis per 7.4 patient-months (1.6 episodes per patient-year) of follow up.
- Before surveillance had been introduced the AVG thrombosis rate was 1-1.5 episodes per patient-year of follow up [1,2] and decreased in the range of 0.89 per patient-year with surveillance and early intervention [3].

Infections

- Infection rate 35% versus overall AVG infection rate of 11-35% [1,2].
- 34/50 patients included came from the Kim et al. [3] study who presented a single center retrospective analysis of the infections in AVG pseudoaneurysms treated endovascularly.
- 70 patients with AVG pseudoaneurysms: 34 were stented and 14 (41.2%) developed infections versus 4/36 (11.1%) AVGs with pseudoaneurysms left untreated. Developed infections (p=0.006).
- Infection rate was 41.2% if the stent graft was placed to treat a pseudoaneurysm versus 13.5% infection rate for AVG with stent grafts placed for other than pseudoaneurysm (p=0.003) [3].
- The median time from ablation to graft excision for infection was 8.9 months. The entry site of infection in the graft was the puncture site in 47-61% of cases [4].
- Avoid cannulating the portions of the AVG where the stent graft was placed to treat the pseudoaneurysm.


Stent Grafts Cannulation for Hemodialysis

- No significant differences between needle punctures through stents initiated few days after stenting or waiting 2-3 weeks [1].
- Graft stent infection is possible when needles are inserted through the stents [2].
- The safety of repeated stent graft cannulation has not been adequately studied and it is better to avoid placing needles through the stents.


Stent Grafts Cannulation for Hemodialysis

- It is unclear which stent graft offers the best results for long term cannulation. None of the stents grafts are approved for hemodialysis needles puncture.
- Inform the patient, the nephrologist and the hemodialysis unit of the stent placement, its location and make suggestions where the needles should be placed.
- 5/121 cases of new pseudoaneurysms after cannulating the stents [1].
- Most authors recommend avoiding cannulating the stents for at least 3 weeks [1].


Surgical Revision

- Resection of the affected segment of the graft followed by graft segment interposition [1,2].
- The outcome of the AVG surgical revision, performed specifically to treat pseudoaneurysms has not been reported.
- Out of 189 polytetrafluoroethylene (PTFE) AVGs, 49 required surgical revision [1] that extended their survival to a rate similar to that of non revised grafts. The secondary patency rates were 76 % at 12 mo, 50 % at 36 mo and 40 % at 60 mo.
- If stenting is unsuccessful, the surgical revision option is still available [3].


Surgical Revision for Infection

- Infected AVG pseudoaneurysms are treated with interposition bypass graft tunneled through non infected tissues and connected end to end with the non infected segments of the old graft, followed by excision of AVG’s infected portion.
- Graft patency and wound healing has been achieved using this approach in 74% of infected AVGs whose infection was not affecting their entire length [1-3].


AVG Pseudoaneurysms

Which method is better for this patient?

Endovascular or Surgery

Decision Making Algorithm

A. Surgical revision of the graft for:
1. Extensive graft degeneration
2. No appropriate areas for needle puncture
3. Advanced skin damage or infection

B. Endovascular treatment:
1. Can we isolate the pseudoaneurysm with stents?
2. Is there enough length of normal graft to ensure cannulation to avoid cannulating the AVG?
3. Is the remaining length of the AVG severely damaged and needs surgical revision soon?

Selecting the patients requires expertise and knowing the limitations of what endovascular therapy can do.