Supplement 2: Supplement to AV Access Infections

Mechanisms of AV-access infections

The underlying mechanisms responsible for the development of AV-Access infections are likely multifactorial and include both patient and system-related issues. Patients with ESKD typically have multiple comorbidities and are functionally immunocompromised. The prosthetic material that comprises the AVG is a foreign body that may be prone to develop infections. Furthermore, since AV-access are repeatedly cannulated as part of the dialysis process, they are at risk of contamination and subsequent infection. AVF infections are frequently associated with disruption of the vein wall due to development of an aneurysm/pseudoaneurysm at sites of repeated cannulation and/or the seeding of an associated hematoma. The button-hole cannulation technique for AVFs has been associated with an increased incidence of AV-access infections and positive blood cultures.[1-3] The underlying mechanisms responsible for this increased incidence include contamination of the skin and subcutaneous surrounding the cannulation site from an infected hematoma, infection of the needle track, microscopic peri-track abscesses, and development of an ulcer at the access site with breakdown of the skin.

The causative organisms align with the mechanism of infection. *Staphylococcus aureus and S. epidermidis* account for 70 – 90% of the AV-access infections in the upper extremity and relate to cannulation or soft tissue injury [4-6] Gram negative organisms account for a smaller percentage of the upper extremity AV-access infections, but occur more frequently with lower extremity AV-accesses, given their close proximity to the GU/GI tracts. Harish and Allon[7] reported that gran negative organisms accounted for 31% of the AVG infections for lower extremity AV-accesses, but only 4% in the upper extremity. A variety of organisms, including fungi and polymicrobial, have been reported to cause AV-access infections and reflect the varied environmental, practice and patient risk factors and exposures.[5,8-12]

Surgical management of AV-access infections

Generally, Infections that involve the full extent of the AVG require AV-access excision while localized infections can have attempts at AV-access salvage. The extent of infectious AV-access involvement can usually be determined by preoperative ultrasound and confirmed intraoperatively (e.g. graft appearance and degree of incorporation). Notably, AVGs that are infected are not typically incorporated into the surrounding tissue; however, non incorporation is not necessarily a sign of infected AVG as different AVG materials heal differently. Alternative surgical treatments with wound debridement/vacuum dressing[13] and percutaneous placement of an intraluminal stent[14] have been described. The latter is only a temporizing step for patients with a disruption of their AV-access and hemorrhage, and should be avoided as much as possible given concerns about placing an intraluminal stent within an infected field.[15]

AV-access Salvage Approaches

The AV-access salvage approach using the “extra-anatomic” technique for localized or cannulation-related infections requires exposing the AV-access proximal and distal to the infected segment and then tunnelling a new conduit, typically a prosthetic graft, through an uninvolved tissue plane around the infected area (Figure X). The “sterile” incisions are then

closed and dressings applied. The infected segment is then excised and the wound left open. This salvage technique was reported as possible in 17/23 (74%) of the cases.[16]. The failures required total graft excision for non-healing wounds; there were no episodes of acute hemorrhage or sepsis. Similarly, Schutte et al.[17] reported that the wound (20% vs 0) and overall complication rates (26% vs 5%) were significantly higher for patients with infected AVGs undergoing Av-access salvage (vs. total excision) although the incidence of hemorrhagic and sepsis were similar.

The "in situ" or in-line reconstruction for local AV-access infections requires excising the infected segment and then interposing a new conduit within the infected field. The new conduit should be resistant to infection (e.g. autogenous tissue or biologic type material such as autogenous saphenous or femoral vein conduits). However, it may not be appropriate for infected AVGs given the likelihood of contaminating the uninvolved prosthetic graft and the high risk of recurrent infection. Matsuura et al.[18] reported using cryopreserved, cadaveric vein grafts in this setting although concerns have been raised.[19]. Regardless of "in situ" or "extra-anatomic" salvage technique, patients undergoing these procedures require close follow-up and monitoring due to the risk of recurrent infection and the potential for anastomotic disruption and significant bleeding. Schild et al.[20] reported that 17% of the AVGs treated initially with salvage attempts or subtotal excision presented with recurrent infections.

AV-Access excision is the most appropriate treatment when the infection involves the whole AV-access, typically an AVG. This can be technically challenging for several reasons including the extent of the infection/inflammation and the close proximity to the major nerves of the upper extremity. Furthermore, the inflow artery to the AV-access needs to be repaired and/or reconstructed after dissembling the anastomosis. The outflow vein can usually be over sewn and does not require reconstruction. The potential arterial reconstruction options include vein patch angioplasty or an interposition vein graft (Figure X). Occasionally, the infection will be so extensive that it precludes in situ arterial reconstruction. Options in this setting include arterial ligation and/or extra-anatomic bypass with autogenous vein through an uninfected field. Schanzer et al.[21] reported that it is safe to ligate the brachial artery distal to the profunda brachial origin in this setting. Ryan et al.[16] have described a subtotal excision technique whereby a small cuff of prosthetic graft is left on the inflow artery (i.e. the proximal graft is over sewn leaving the anastomosis intact). This approach avoids the tedious dissection of the arterial anastomosis and may be helpful in select patients provided that the proximal graft is well incorporated. The skin is typically left open after AV-access excision and the patients started on dressing changes in the postoperative period.

The recommendations and treatment strategies outlined above are appropriate for both AV-access infections although most relevant for AVGs given the significant difference in their incidence and the inherent resistance of autogenous tissue to infection. AVF infections are more likely to resolve with antibiotics alone. However, in select situations, such as track infections associated with buttonhole cannulation, there may be a role for simply excising the involved skin and underling segment of the vein with re-approximation of the tissue.

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