EDITORIAL

Selective Graft Preservation in Peripheral Vascular Graft Infections: Sound Practice or Risky Compromise?

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One of the most demanding complications in vascular surgery is the peripheral vascular graft infection (PVGI). Even as perioperative care, antimicrobial regimens, and prosthetic technologies have advanced, infection of a lower-limb graft remains a potentially catastrophic event. It threatens not only limb viability but also patient survival, often entailing prolonged hospitalization, repeated operations, and major psychological and economic consequences. Over time, the field has evolved from the dogma of graft excision toward a nuanced, evidence-based, patient-specific strategy combining infection control, graft preservation, and biological or engineered reconstruction. The modern surgeon faces not a binary choice of removal versus salvage but a sophisticated spectrum of possibilities—each dependent on infection extent, microbial virulence, host resilience, and available materials.

Despite its apparent rarity, PVGI remains one of the most devastating vascular complications. Reported incidence ranges between 0.5 % and 6 % depending on anatomic location and patient risk profile. According to the ESVS 2020 guidelines, infrainguinal reconstructions carry the highest risk, particularly when prosthetic material is placed in the groin or subcutaneous plane.

A recent multicenter retrospective series—one of the most recent real-world datasets—reported an 8 % infection rate among 196 prosthetic bypasses, with mortality of 17-30 % and major amputation rate of approximately 27 %. Such figures reaffirm that PVGI, although infrequent, has disproportionate impact. In the era of endovascular dominance, open bypass is reserved for the most complex cases: patients with diffuse multilevel disease, failed endovascular interventions, or chronic limb-threatening ischemia. These individuals are typically elderly, diabetic, and immunocompromised—the very conditions that predispose to wound infection. The burden therefore concentrates in a smaller yet frailer cohort, making prevention and individualized management even more critical.

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The groin remains vulnerable to infection owing to its complex anatomy and proximity to contaminated areas. Its dense lymphatic network, proximity to perineal flora, and frequent use for prosthetic anastomoses create an ideal environment for contamination. Once bacteria reach the graft surface, they exploit the biofilm—a polymeric shield that renders them resistant to both antibiotics and host immunity.

PVGI results from three interrelated mechanisms: intra-operative contamination, contiguous spread from nearby infection, or hematogenous seeding from distant sites. Each pathway underscores the delicate host-device interface. Dacron and ePTFE grafts, though durable and hemodynamically efficient, remain intrinsically foreign; their microstructure facilitates bacterial adherence. Host factors such as diabetes, renal failure, malnutrition, chronic steroid use, or immunosuppression further compromise the local defence barrier.

Traditionally, *Staphylococcus aureus* and *Staphylococcus epidermidis* have dominated the microbiologic spectrum, responsible for up to 60 % of infections. The recent shift, however, toward Gram-negative pathogens—notably *Pseudomonas aeruginosa* and *Escherichia coli*, together comprising almost one-third of isolates in a recent series—poses new therapeutic challenges. These organisms often exhibit multidrug resistance, form aggressive biofilms, and precipitate anastomotic rupture or sepsis.

The ESVS guidelines advocate a comprehensive diagnostic approach combining clinical assessment, microbiology, and imaging. High-resolution CT angiography delineates fluid collections or pseudoaneurysms, while 18F-FDG PET/CT and labeled-leukocyte scintigraphy distinguish sterile inflammation from active infection. Direct tissue sampling of perigraft fluid or graft material remains the diagnostic gold standard—superficial swabs are inadequate.

Temporal classification retains practical value. Early (< 4 months) infections are typically high-grade, caused by *S. aureus* or Gram-negative rods, and present with local erythema, purulence, or systemic sepsis. Late (> 4 months) infections are indolent, often involving *S. epidermidis* or low-virulence flora, and may manifest through pseudoaneurysm, bleeding, or graft occlusion.

The Samson-Szilagyi classification, although decades old, remains a useful guide—distinguishing superficial wound in-

fections (Groups I-II), limited graft involvement (Group III), and anastomotic or systemic infections (Groups IV-V). The ESVS framework extends this by incorporating imaging and microbiologic data, encouraging individualized decision-making rather than adherence to a single algorithm.

Historically, "infected graft = excision" was an unassailable rule. Yet the current era recognizes degrees of infection and patient heterogeneity. The ESVS 2020 recommendations explicitly endorse selective graft preservation when feasible—particularly in early, localized infections without systemic sepsis or anastomotic breakdown.

De Caridi et al. demonstrated that conservative management—meticulous debridement, vacuum-assisted closure (VAC) therapy, and muscle-flap coverage—achieved successful infection control and limb salvage in one-third of patients. These outcomes rival, and occasionally surpass, those of excisional strategies, provided strict patient selection and close surveillance are maintained. Nevertheless, when sepsis, bleeding, or anastomotic rupture occur, complete graft removal remains lifesaving. The art lies in balancing infection eradication against preservation of perfusion and functional outcome.

Antibiotic therapy is both preventive and therapeutic. The ESVS guidelines outline a staged regimen: 1) empirical coverage directed at Gram-positive cocci (including MRSA) and Gram-negative bacilli until cultures specify pathogens. 2) targeted intravenous therapy for 4-6 weeks, followed by oral continuation up to six months depending on infection control and reconstruction. 3) lifelong suppressive therapy may be warranted when complete excision is impossible. In a recently published cohort, cefazolin or vancomycin served as preoperative empiric therapy; targeted regimens were adjusted by antibiogram. Integration of systemic antibiotics with VAC therapy yielded an impressive 69 % limb salvage rate—proof that local control and systemic therapy must operate synergistically. Adjunctive measures include optimization of nutrition, glycemic control, and cessation of smoking. Early consultation with infectious-disease specialists is strongly recommended, ensuring proper antimicrobial stewardship and prevention of resistance.

When excision is inevitable, the choice of conduit dictates both immediate and long-term outcomes. Autologous vein grafts remain the gold standard due to their biocompatibility and resistance to infection. The great and small saphenous, arm veins, or even femoropopliteal segments may be employed, though harvesting can be technically demanding and occasionally limited by patient factors. When suitable autologous conduit is unavailable, cryopreserved arterial allografts (CAAs) provide a valuable alternative. Supported by both the ESVS guidelines and several clinical series, CAAs exhibit mid-term patency rates of 80-90 % and reinfection rates near 15 %. They are particularly suited for controlled infection environments or as bridges until definitive autogenous reconstruction. Limitations include restricted availability, structural degeneration, and uncertain long-term durability. Biologic and biosynthetic conduits have gained traction. The Omniflow II biosynthetic graft, composed of bovine collagen matrix reinforced with polyester, demonstrated promising results, achieving limb salvage without reinfection in selected patients. Similarly, bovine-pericardial xenografts and silver- or rifampicin-bonded prostheses expand the reconstructive armamentarium, though robust randomized evidence is pending.

Among recent advances, the combination of muscle-flap coverage (MFC) and negative-pressure wound therapy (NPWT) stands out as transformative. The goal is to provide well-vascularized tissue that fills dead space, delivers oxygen and antibiotics, and isolates the prosthesis from contamination. The ESVS guidelines recommend MFC—typically using sartorius, gracilis, or rectus femoris muscles—for groin infections, reserving combined or free flaps for complex or recurrent cases. Clinical reports, including De Caridi et al., document infection-control rates > 80 % and robust limb preservation. Beyond technical success, these methods represent a cultural shift: from isolated vascular intervention to multidisciplinary collaboration with plastic and reconstructive surgeons. This partnership has redefined the limits of limb salvage.

No therapy is as beneficial as prevention. The ESVS 2020 guidelines articulate a comprehensive protocol including: 1) preoperative optimization: correct malnutrition, anemia, and glycemic imbalance; decolonize nasal *S. aureus* carriers; use chlorhexidine showers. 2) intraoperative measures: administer antibiotics within 60 minutes before incision; maintain normothermia; ensure meticulous hemostasis; minimize operative time; avoid unnecessary drains; prefer oblique over vertical groin incisions. 3) postoperative vigilance: early detection of lymphoceles or wound dehiscence; limit prophylaxis to 24 hours to prevent resistance. Evidence also supports the adjunctive use of local vancomycin powder or rifampicin-bonded grafts, though high-quality trials remain sparse. Consistent implementation of these fundamentals can reduce infection risk dramatically.

Despite preventive rigor, the presence of any prosthesis maintains inherent infection risk. The next frontier lies in smart biomaterials capable of biological integration and active antimicrobial defense. Nanotechnology offers several promising platforms. Electrospun nanofibrous scaffolds can replicate extracellular matrix microarchitecture, enhancing endothelialization and cell adhesion. Nanoparticles of silver, copper, or zinc provide sustained antibacterial activity through reactive oxygen species and ion release, while polymeric nanocarriers enable localized, controlled antibiotic delivery. Experimental studies reveal excellent biocompatibility and infection prevention in animal models. Yet key questions persist: long-term patency, host immune response, degradation kinetics, and scalability. Bridging the laboratory-clinic divide will demand rigorous translational research, standardized testing, and regulatory harmonization. Ultimately, the vision is a biointegrative vascular conduit—one that supports endothelialization, resists colonization, and interacts harmoniously with host tissue. Such technology would transform PVGI from a surgical complication to a preventable relic.

The ESVS 2020 document represents a global consensus on best practice, but implementation in daily clinical settings often encounters practical constraints: limited access to allografts, variable microbiologic support, or lack of specialized reconstructive teams. Recent studies highlight this gap—demonstrating that real-world decisions frequently rely on surgeon judgment and resource availability as much as on formal algorithms. To bridge this divide, vascular centers should establish multidisciplinary vascular infection teams, comprising vascular, plastic, and infectious-disease specialists, radiologists, and microbiologists. Regular case reviews, shared databases, and adherence audits can align practice with evidence. National or international registries will further enable benchmarking and foster collaborative research on this relatively rare yet critical complication.

Behind statistics lie patients enduring repeated operations, extended antibiotic therapy, and functional loss. The psychological toll of amputation, coupled with prolonged dependency, cannot be overstated. For health-care systems, PVGI represents a heavy financial burden—estimated at hundreds of millions annually in hospitalization and rehabilitation costs. For surgeons, these infections are a sobering reminder that technical perfection alone is insufficient. The true measure of excellence lies in preventing infection through preparation, discipline, and collaboration.

To advance the field, several priorities emerge: 1) standardized classification and reporting integrating imaging, microbiology, and biomaterial data. 2) prospective multicenter registries capturing incidence, management strategies, and outcomes. 3) randomized evaluation of preservation techniques, particularly VAC and MFC, to establish clear indications, 4) development of antimicrobial and bio-functional grafts through surgeon-engineer partnerships. 5) educational initiatives emphasizing infection prevention, early recognition, and multidisciplinary care within vascular training curricula. Such collective efforts will ensure that the next generation of vascular specialists approaches PVGI with both scientific rigor and clinical pragmatism.

In conclusion, peripheral vascular graft infection remains one of the most formidable challenges in vascular surgery. Despite modern prophylaxis, its incidence persists, driven by increasingly complex patient profiles and evolving microbial resistance. Yet progress is tangible: the shift from obligatory graft removal to selective preservation, the synergy of NPWT and muscle-flap coverage, and the emergence of bioengineered conduits collectively redefine outcomes once considered unattainable. The convergence of surgical expertise, infectious-disease management, and materials science promises to convert this “old problem” into a controllable, perhaps preventable, condition. Ultimately, the success of PVGI management will rest not only on operative skill but on our ability to foresee, coordinate, and innovate—safeguarding both the graft and the patient whose life depends upon it.

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