Distal bypass procedures
The gold standard of revascularization of the ischemic foot

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Diabetes mellitus (DM)

- Diabetes mellitus (DM) is a widespread pathology in the world population.

- The prevalence of diabetes for all age groups was 2.8% in 2000 and is estimated to be 4.4% in 2030.

The complications of DM such as neuropathy, retinopathy, nephropathy and **atherosclerosis** are the major causes of morbidity and mortality of this multisystemic disease.

Peripheral vascular disease in lower extremities varies from asymptomatic to **critical limb ischemia** in the presence of DM.

Vascular disease in diabetic patients provokes ulcers and gangrene, finally leading to **AMPUTATION** or even death.

The patient with diabetes and a critically ischemic limb offers some **specific challenges**!
DIABETIC FOOD

LIMB AMPUTATION
Most authors mention diabetes as an important risk factor in the development of critical and/or chronic limb ischemia and consequent amputation.

It is important to perform surgical and medical treatments for diabetic patients with lower limb ischemia.

Recovery and increasing the life quality are the targets of these procedures.
The Danish study authors analyzed the number of lower-limb amputations performed in a island region of Denmark from 1996 to 2011, finding that the amputation rate has decreased annually from 3 to 15%, depending on the type.

In total, there were 2,832 amputations, of which 1,285 occurred in people with diabetes and 1,547 in people without.
The rate of diabetes-related below-ankle amputations decreased 10% annually over the 16 years observed, whereas it was less than 1% for non-diabetic amputations.

Breaking it further down, the annual decline for below-knee amputations was 15% for people with diabetes, and 2% for people without; and less than 3% for above-knee amputations in both groups.

Moreover, because the amputation rate for non-diabetics haven’t substantially changed in that same timeframe, the researchers are confident that the decrease reflects an overall improvement in diabetes care.
A Brief History of Lower Extremity Amputation
Archeological findings reveal that amputation procedures have been performed since ancient times. The earliest amputations, though, were performed mainly to remove tissue that was already dead.

The reason for this limitation is that early surgical techniques could not control the blood loss, called hemorrhaging, that results from cutting healthy arteries.
HISTORY OF LOWER EXTREMITY AMPUTATION

Surgeons in ancient GREECE and Rome dealt with the problem of hemorrhaging by introducing the technique of tying off or ligating blood vessels during surgery.

Surprisingly, their techniques appear to have been forgotten for many centuries!!!

It was during these times that blood vessels were instead cauterized using hot irons or boiling oil.
A Civil War-era demonstration of the use of anesthesia in amputations.

(Image courtesy of the Contributed Photographs Collection, Otis Historical Archives, National Museum of Health and Medicine.)
VASCULAR SURGERY IN
ISCHEMIC LIMB SALVAGE

Distal revascularisation procedures (bypass)
The use of an *autogenous vein graft* to bypass peripheral artery occlusions, first reported by Kunlin in 1949, is firmly established as an effective method of revascularization for chronic, advanced limb ischemia.

However, perioperative morbidity after DBP may be substantial, and *graft failure* remains a significant limitation that has not been substantially reduced despite 5 decades of technical improvements.

Therefore, considerable effort has been made to define the (1)clinical, (2)anatomic and (3)technical factors which predict perioperative and long-term success.
1. **Patient Selection for Distal Bypass Procedures**

Distal (ie, infrapopliteal) bypass surgery in the leg is generally performed for signs or symptoms of critical limb ischemia (CLI);

Rutherford ischemia grade 4-6 - population at risk for limb loss.

Patients with CLI presents a large systemic burden of atherosclerosis and multiple comorbidities.
PATIENT SELECTION FOR DISTAL BYPASS PROCEDURES

- Assessment of the patient’s ambulatory function, quality of life, CLI severity, long-term survival, and periprocedural risks are key determinants in selecting a primary approach.

- Vascular anatomy plays a final critical role in decision-making, particularly in regard to the selection of endovascular vs surgical revascularization.

- The overall dire natural history of CLI is often quoted in the literature - mortality and major amputation rates between 10% and 40% at 6 months.
PATIENT SELECTION FOR DISTAL BYPASS PROCEDURES

Many patients in Rutherford classes 4 and 5, who are not good candidates for revascularization, may be managed conservatively for a considerable time.

Primary amputation may be the procedure of choice for patients at elevated systemic risk or those without good options for revascularization.
2. PREOPERATIVE DISTAL BYPASS PROCEDURES PLANNING

Developing the operative strategy
2. PREOPERATIVE DISTAL BYPASS PROCEDURES PLANNING - DEVELOPING THE OPERATIVE STRATEGY

- Selection of a revascularization strategy between **catheter-based and open surgical approaches** is often considered as a trade-off between short-term risk and longer-term efficacy. However, at least in terms of 30-day mortality, there seems to be minimal difference between the two modalities!

- Numerous single center and multicenter reports demonstrate a 2% to 5% **early mortality** for surgical bypass in the CLI population and endovascular outcomes reported have been notably similar.

- **Early major adverse cardiovascular event** rates also seem relatively similar (3% to 8%),

- Although **wound-related and other major complications** are clearly higher for open bypass, as is **length of initial hospitalization**.

Risk-prediction models in the CLI population based on a surgical bypass cohort - Project or Ex Vivo vein graft engineering via transfection [PREVENT] III

- This model (“PIII Risk Score”) assigns a point score based on 5 easily defined preoperative variables: dialysis, tissue loss (Rutherford grades 5/6), age 75, anemia and history of advanced coronary artery disease.

- Those in the highest risk category (which comprised only 9% of the 1404 patients in the PREVENT III cohort) demonstrate a markedly reduced (45% to 55%) amputation-free survival 1 year after surgical bypass.

- In contrast, those in the low or moderate risk categories (90% of those receiving surgery for CLI in the PREVENT III and the Vascular Surgery Group of Northern New England data sets) can expect a 73% to 86% rate of survival with intact limbs at 1 year after bypass.

The only randomized trial to date to compare endovascular and surgical revascularization for advanced limb ischemia.

For those patients who survived to 2 years or longer, open bypass was associated with improved survival and a trend of improved amputation-free survival.

In a treatment-received analysis, patients who initially received a vein bypass graft fared significantly better than those who had received a prosthetic.

And those who underwent bypass after failed angioplasty fared considerably worse than those who received a bypass graft initially.

Taken together, these data suggest that a vein bypass-first strategy is superior for patients likely to survive to 2 years and beyond, and critically question the “free-shot” view of angioplasty in the patients with CLI.
Other authors have advocated an “endo-first” strategy for all patients, but in our view, this is not substantiated by current evidence (eg, BASIL).

A short-term treatment mentality may do significant disservice to many patients with CLI who are bypass candidates.

The impact of diabetes and renal failure, per se, on treatment selection bear special mention.

Data from a number of large single-center series, and randomized trials (PREVENT III), have demonstrated that diabetes is not a risk factor for vein graft failure.
3. TECHNICAL FACTORS

Operative technique and graft configuration
VEIN QUALITY IS THE DOMINANT FACTOR IN DETERMINING LONG TERM OUTCOME OF DBP FOR ISCHEMIC FOOT

- Femorodistal autologous vein bypass proves to be the preferred surgical therapy for long arterial occlusions and provides excellent early and long-term results in critical lower limb ischemia.

- First and foremost among these is the availability of good quality autogenous vein conduit, recognized as a relevant limitation of lower extremity vein bypass surgery.

- Good quality ipsilateral great saphenous vein (GSV) may be lacking in as many as 40% of patients needing revascularization.
Selection of the outflow artery for revascularisation of ischemic foot

- Selection of the outflow artery requires considerable surgical judgment, correlating several anatomic and hemodynamic factors.
- In general, the most proximal vessel that provides continuous runoff to the foot is selected as the primary target.
- Extensively calcified tibial and pedal arteries should be avoided if possible.
**Selection of the Outflow Artery for Revascularisation of Ischemic Foot**

For patients with extensive tissue loss, there is controversy regarding the choice between peroneal, pedal, and plantar targets.

Some have advocated an “angiosome” approach, selecting the target artery based on location of the area of tissue loss on the foot.

In patients with diabetes, excellent long-term results have been achieved with bypass to the *dorsalis pedis artery*. 
Isolation of posterior tibial artery

RETROMALEOLAR

Isolation of posterior tibial artery

SUBMALEOLAR
Anterior tibial artery
1/3 INF.

Pedal artery
OPERATIVE TECHNIQUE

- Ipsilateral or contralateral great saphenous vein was considered the graft of first choice.
- Veins were assessed with preoperative vein mapping if needed.
- A vein diameter of 3 to 3.5 mm after vein distention was accepted.

GRAFT CONFIGURATION

- The composite configuration was chosen if the length of the harvested suitable vein was insufficient to reach the best outflow vessel.
- Patent popliteal or crural artery segments were integrated in the form of sequential anastomoses.
- The configuration was chosen according to the length and configuration of the harvested vein and the site of the recipient vessels.
OPERATIVE TECHNIQUE

- The most frequent site for proximal anastomosis was the common femoral artery (43%), whereas the posterior tibial artery was selected most commonly as the outflow artery (37%).

- Reversed saphenous grafts were used most frequently.

- Additional procedures such as endarterectomy, toe and transmetatarsal amputations, fasciotomies or skin grafting were required in 47% of the operations.
ANASTOMOTIC TECHNIQUES

- Anastomotic techniques vary widely among surgeons and have not been directly correlated with outcome.
- My strong preference is to perform the proximal anastomosis first in all cases.
- This allows the graft to be tunneled while under arterial pressure, minimizing the chance of kinks or twists.
- “Parachuting” at the distal anastomosis is an excellent technique for tibial/pedal bypass, allowing full visualization of all of the sutures placed at the critical heel and toe areas.
Compound bypasses
Prosthesis-vein

Continuous bypasses
with intermediate station
Sequentially bypasses Prosthesis-vein
Postoperative investigations before discharge were employed to document patency and graft configuration:

- duplex scan
- angiography
- magnetic resonance angiography
- digital subtraction angiography
- computed tomography angiography
MANAGEMENT OF FOOT AND EXTREMITY WOUNDS

- Recent technology, such as negative pressure wound therapy, has made a major impact on inpatient and outpatient care of patients with CLI before and after bypass surgery.
- Special attention must be paid to wounds in proximity to grafts.
- An aggressive approach to debridement, re-closure, graft repositioning, and skin and muscle flaps is preferred in all cases of questionable bypass graft coverage, and may require a team effort with plastics and reconstructive specialists.
The relationship between runoff and graft performance is somewhat unclear.

The implication from such data is that conduit quality, graft length, and adequate inflow are stronger predictors of vein graft patency than level of the distal anastomosis.

However, our retrospective data are intrinsically flawed by careful selection, and the technical challenges associated with anastomoses to small, diseased vessels with poor runoff can be a significant cause of early and late graft failure.
POSTOPERATIVE MANAGEMENT OF THE ISCHEMIC FOOT

- The issues regarding the postoperative limb are multifactorial and include infection, wound healing and management, associated comorbidities such as renal failure, nutritional/metabolic derangements, and microvascular dysfunction.

- Therefore, aggressive management of the systemic milieu and the limb is mandatory to achieve a successful outcome after revascularization for CLI.

- The efficacy of aggressive revascularization to tibial/pedal targets, multidisciplinary wound and foot care, and long-term surveillance in management of the patient with diabetes with a dysvascular limb.

- Such efforts should be led by dedicated vascular specialists with broad expertise in these areas, and promulgation of such teams would likely reduce the burden of CLI and amputation for all patients at risk.
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CONCLUSIONS

- Lower limb ischemia is a serious event in patients with diabetes mellitus.
- The consequences may include increased mortality and morbidity in this particular patient population.
- However, distal arterial revascularizations are considerably effective procedures to:
  - avoid amputation
  - to eliminate symptoms
  - to promote ulcer recovery
  - to help the patient participate in social life with acceptable short, mid- and long-term follow-up results.
CONCLUSIONS

- Surgical revascularization of the lower extremity using bypass grafts to distal target arteries is an established, effective therapy for advanced ischemia.

- Recent data confirm the primacy of autogenous vein bypass grafting, yet there remains significant heterogeneity in the utilization, techniques, and outcomes associated with these procedures in current practice.

- Experienced clinical judgment, creativity, technical precision, and fastidious postoperative care are required to optimize long-term results.
CONCLUSIONS

- The reduction in amputations among diabetic individuals is encouraging.
- The results presented here indicate that it is beneficial to adopt a multidisciplinary approach optimised for screening and treating complications linked to diabetes.
https://www.youtube.com/watch?v=Er9rAvnPG6o
Friends are like a four leaf clover... Hard to find & Lucky to have.

GOF