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Royal Australasian College of Surgeons

Deep venous arterialization for no-option critical limb-threatening ischaemia

Critical limb-threatening ischaemia (CLTI) represents a significant source of morbidity and mortality. With advanced disease, occlusion of the pedal arteries commonly used for angioplasty or distal bypass often leads to failure of all conventional revascularization attempts and leaves major amputation as the last treatment option (Fig. 1a,b). In such cases of no-option CLTI, salvage modalities using lumbar sympathectomy, prostanoids, stem cells therapies and spinal cord stimulation have been used to varying efficacy.[1–4]

Deep venous arterialization (DVA) represents another viable option that involves arterialization of the disease-free venous beds

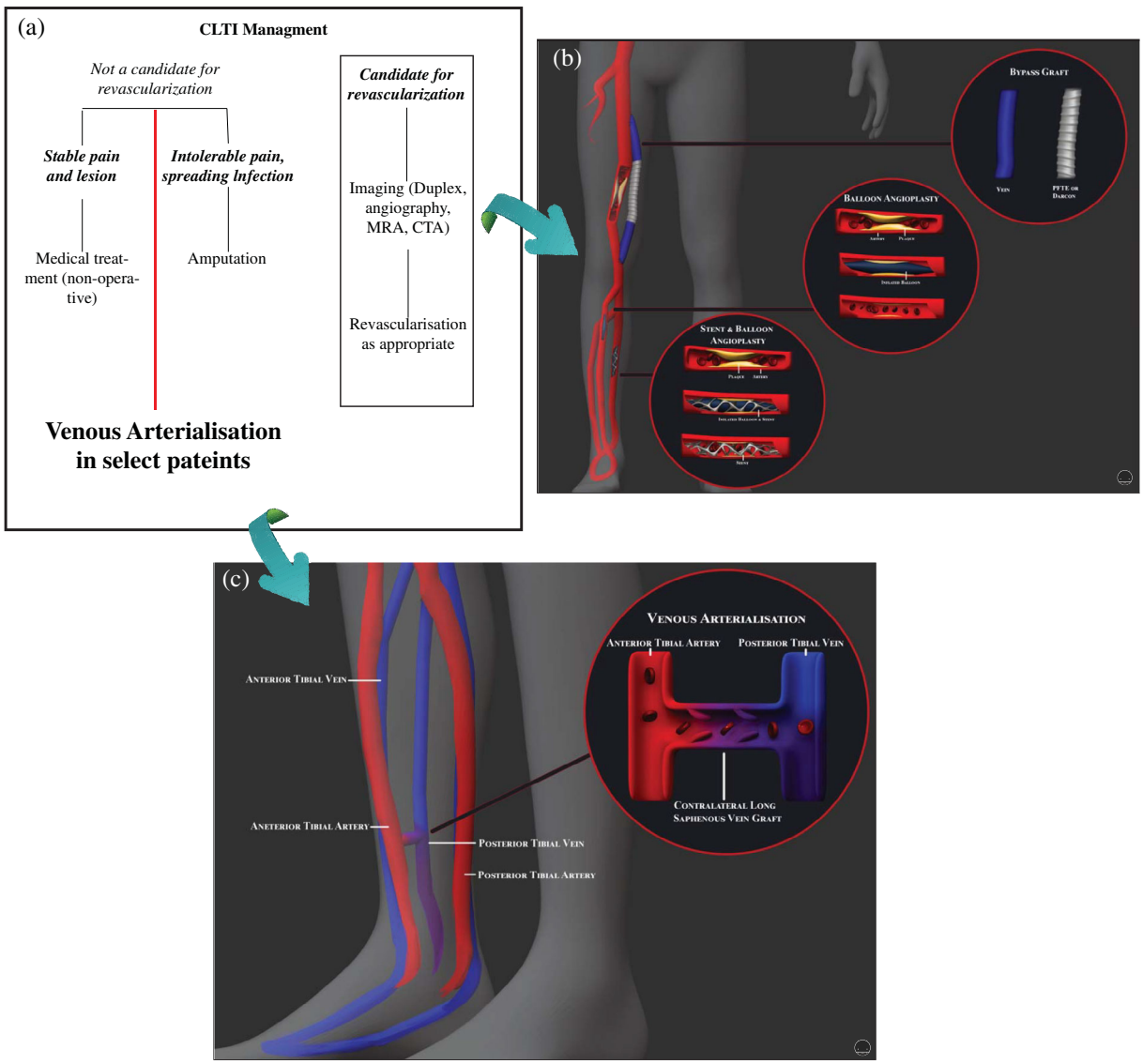

Fig 1. CLTI management. (a) Surgical treatment pathway in peripheral artery disease. (b) Schematic representation of lower limb endovascular methods: bypass graft, balloon angioplasty and balloon stenting. (c) Schematic representation of venous temporal arterialization reverse bypass graft in lower limb for the treatment of CLTI (flow chart adapted from Noergen *et al.*,[11] with permission). CLTI, critical limb-threatening ischemia; CTA, computed tomography angiography; MRA, magnetic resonance angiography.

Fig 2. Photographic clinical progress of wound healing in a no-option critical limb-threatening ischemia case. (a–i) Nine-month chronological progress photographs of distal trans-metatarsal wound after reverse venous bypass graft, where (i) shows good wound healing at 9 months.

of the ischaemic foot using a venous conduit from a more proximal arterial source, while destroying the venous valves, ensuring adequate perfusion to the forefoot.

We report a 65-year-old female with Society for Vascular Surgery (SVS) wound, ischemia, wound infection (WIfI) score of 6 for diabetic and ischaemic foot disease, Fontaine and Rutherford grade IV peripheral artery disease.[5] Patient consent was obtained for the acquisition and deidentified publication of progress photographs and case report. She was an ex-smoker and had type 2 diabetes mellitus, diabetic retinopathy, peripheral neuropathy, ischaemic heart disease, dyslipidaemia and hypertension. Her angiograms showed patent vessels above the knee with extensive occlusive disease in her crural and pedal arteries and no demonstrable arteries below the ankle. She underwent multiple angioplasties of her proximal tibial arteries and a guillotine trans-metatarsal amputation. Unfortunately, there was further tissue loss at the level of the

Fig 3. Neovascularization of distal pedal tissues. (a) CTA at 4 months post venous arterialization of ATA–PTV using LSV reverse bypass graft with infrapopliteal balloon angioplasty demonstrating neovascularization and increased blood flow to peripheral pedal tissues. (b) Thrombosis of ATA–PTV graft requiring balloon angioplasty of graft 5 months post-operatively; post angioplasty images demonstrate the lasting benefits of initial grafting with evidence of new vessels providing blood flow to the peripheral tissues. ATA, anterior tibial artery; CTA, computed tomography angiography; LSV, long saphenous vein; PTV, posterior tibial vein.

forefoot amputation with significant pain and no further revascularization options. She was therefore offered a DVA procedure as a last resort to avoid a major limb amputation.

The anterior tibial artery (ATA) in lower leg and the posterior tibial vein (PTV) at ankle were individually dissected and slung. Reversed long saphenous vein harvested from the contralateral leg was tunnelled through a bony tunnel through the anterior border of the tibia and anastomosed to the ATA and the PTV (Fig. 1c). Routing the vein graft from the distal ATA to the PTV would have caused a kink due to the prominent anterior border of tibia. Hence, a bony tunnel was created through the anterior cortex of tibia using bone drills and the vein tunnelled through it without a kink. The valves were lysed using a 4-mm angioplasty balloon into the pedal venous arch, deployed through an arterial sheath in the PTV proximal to the anastomosis. Intraoperative angiograms and intraoperative doppler examination were used to assess the patency of the graft and the adequacy of flow into the pedal venous arches. The foot perfusion improved immediately after the operation. The ischaemic rest pain settled completely. She required two sessions of debridement of the amputation wound in the post-operative period. The graft occluded 5 months after the surgery and was successfully reopened endovascularly. The graft has remained patent since then, and 8 months after the bypass the forefoot amputation wound has completely healed (Fig. 2). The patient has remained ambulant and functionally independent.

While not a new idea, the recent improvement in DVA practices has been shown to promote angiogenesis by supplying arterial blood to the ischaemic peripheral tissues and salvaging the affected limb.[6,7] The effect of forward pressure and neovascularization stimulated by increasing perfusion pressure of the capillary bed has lasting beneficial effects even if the graft eventually thromboses (Fig. 3).[8,9]

The short- and medium-term results have been promising. The 2017 meta-analysis by Schreve *et al*. of DVAs performed in CLTI patients showed a 75% or higher pooled limb salvage rate at 12 months with overall survival ranging from 54% to 100%.[4,10]

While comparative studies are lacking, this figure represents a great improvement to the 'watch-and-wait' conservative management group.[10]

Current work has focused on patient selection, proposing that DVA be reserved for CLTI patients with no arterial revascularization options.[4] While the most distal patent artery has commonly been used for proximal anastomosis, varying distal anastomotic targets have been used to date. Principles in target vein arterialization/access choices have described consideration of the size of the vein, using the adjacent vein to the most distal patent artery as well as incorporation of the angiosome/venosome concept of healing.[4,9] The choice of instrument for valve lysis represents another area of discussion, with valvulotomes as well as angioplasty balloons having been used successfully. Finally, percutaneous endovascular means to create a DVA have also been reported.[10] DVA represents an exciting frontier in no-option CLTI treatment.

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