Negative pressure wound therapy after revascularization in the management of full-thickness heel pad necrosis

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The management of heel pad tissue loss is challenging, particularly in patients with occlusive peripheral arterial disease with exposed calcaneum. Heel pad necrosis often results in osteomyelitis and amputation without timely and adequate interventions. Although successful revascularization appears to be limb saving in the majority of cases, there is still a significant number of patients who lose their limbs (Berceli et al, 1999). Delay in soft tissue cover over an exposed calcaneum can result in limb loss due to desiccation and osteomyelitis of the bone.

Negative pressure wound therapy (NPWT) is proven to promote granulation tissue (Nie et al, 2016). But does it also help to promote granulation tissue over an exposed calcaneum due to heel pad necrosis in a neuroischaemic limb after revascularization?

In this article, the author describes a successfully managed full-thickness heel pad necrosis in a patient with type II diabetes with absent distal pulses, using revascularization, NPWT, skin grafting and rehabilitation.

Case study

The patient is a 67-year-old nonsmoking, normotensive female with type II diabetes mellitus and dyslipidaemia who presented to us with complete loss of soft tissue in the right heel, following debridement for necrosis of heel pad secondary to an infection *[Figure 1]*.

At the time of presentation, her calcaneum was exposed due to loss of the full-thickness heel pad in an area of 5cm x 6cm. An examination revealed an absence of palpable pulses in the dorsalis pedis artery (DPA) and posterior tibial artery (PTA) at the level of the ankle. However, the popliteal arterial (PA) pulse was palpable behind the knee joint. Her ankle-brachial pressure index was 0.52. She had bilateral peripheral sensory neuropathy of the foot and ankle.

A duplex arterial study showed the presence of triphasic flow pattern in PA and biphasic pattern in the DPA and PTA. There was extensive atherosclerosis in the arteries below the trifurcation of the PA. There was no clinical evidence of wound infection at the time of presentation to us. A wound swab culture did not show any growth of microorganisms. The patient's haemoglobin level and renal functions were normal.

Given the clinical picture and duplex venous study findings, surgical revascularization without performing angiography was recommended. As the first step of surgery, exploration and open arteriotomy of PTA behind the medial malleolus was performed to confirm the patency of the PTA under spinal anaesthesia. As the PTA was found to be patent at the open arteriotomy, surgery was continued to end to side PA to PTA bypass using a reversed saphenous vein graft *[Figure 2]*. Initially, the wound was dressed with a saline-soaked gauze for one week after the surgery. The patient was given enoxaparin for 5 days following surgery.

One week after the surgery, minimal granulation over a small area near to the

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Figure 1. Full-thickness heel pad loss with exposed calcaneum

Figure 2. Distal bypass surgery from popliteal artery to posterior tibial artery

Figure 3. Two weeks after the negative pressure wound therapy

Figure 4. Four weeks after the skin graft

distal anastomosis was noted. In order to expedite granulation and avoid the risk of the calcaneum desiccating and osteomyelitis developing, NPWT was applied to the wound. A commercially available vacuum pump was used with a foam dressing over the wound to deliver -125 mmHg sub-atmospheric pressure on the wound. After two cycles of NPWT over two weeks, the exposed bone was completely covered with healthy granulation tissues *[Figure 3]*. A split-thickness skin graft was applied over the granulation tissues after confirming the absence of microorganisms in the wound. The patient was advised to be non-weight bearing for a further two weeks until the skin graft was matured *[Figure 4]*. Finally, the patient underwent supervised walking exercises with minimal weight bearing on the affected heel. With custom-made shoes, the patient can now walk independently with minimal disability.

During the three-year follow up, the patient developed an infection at the graft site twice, which was managed conservatively with short courses of oral antibiotics and non-weight bearing.

Discussion

Presence of minimal vasculature in adipocyte compartments in the heel leads to significant tissue damage within a short period of time in the presence of infection and ischaemia (Cichowitz et al, 1999). Furthermore, the unique anatomical arrangement of the heel with adipocyte containing compartments made of connective tissue strands, make it difficult to reconstruct (El-Shazly et al, 2008). Therefore, the loss of tissue in heels in the presence of occlusive arterial disease and diabetes mellitus is associated with poor prognosis and may lead to amputation (Berceli et al,1999). Minimal literature is published on this common problem, particularly attempts to promote granulation and to cover the skin defect with a skin graft. This may partly due to the difficulty of rehabilitation of patients with heel skin grafts.

Early adequate debridement with preservation of all viable tissues is required in heel pad necrosis. When the calcaneum is exposed, early tissue cover is essential to prevent desiccation and osteomyelitis of the bone. It is not possible to achieve granulation cover until the background problem of poor circulation is corrected after delineating the level of vascular occlusion particularly in the PTA occlusion (Faglia et al, 2013).

Angiography is advisable in the majority of patients who are recommended for revascularization to delineate the level of

occlusion. However, in an era of improved ultrasonic imaging, duplex arterial study is adequate to identify the pathoanatomy and physiology of the arteries and to guide to proceed with aggressive treatment for ischaemic limbs (Wong et al, 2013, Luján et al, 2002). Furthermore, it may not possible to perform angiography for every patient who undergoing revascularization in limited-resource settings (Weragoda et al, 2016). In the patient discussed in this case, clinical appearance and duplex findings were adequate to allow revascularization without angiography.

Successful revascularization is proven to be effective in treating heel gangrene and ulcers (Shojaiefard et al, 2013; Berceli et al, 1999). Short segmental occlusion of the arteries can be managed with interventional techniques. However, only the minority of patients with distal vessel disease eligible for this technique, others may require more technically demanding distal bypasses due to extensive atherosclerosis of the arteries as in our patient. Furthermore, outcomes after surgical revascularization appear to be better than interventional revascularization (Abu Dabrh et al, 2016)

Granulation promotion is one of the main advantages of NPWT (Venturi et al, 2005). It can also be applied over the bare structures such as bones and tendons to protect them from desiccation and infection. NPWT may reduce the size of the wound when applied for a longer period over the wound. In our patient, it was extremely important to have early granulation cover over the exposed calcaneum to prevent osteomyelitis of the bone. In the absence of adequate granulation over the calcaneum a week after the revascularization, we applied NPWT and achieved successful results. However, we suggest immediate NPWT after the surgery to facilitate early soft tissue and skin cover to wounds of this nature and when the affected bone is vital for successful ambulation.

There is a risk of recurrent ulceration following skin grafting over the heel if the patient continued to bear the weight on the heel. However, in well-motivated patients with supervised walking exercises, it is possible to minimize this complication as in our patient. There is an influx of artificial skin substitutes into the market. However, the place of these skin substitutes in areas subjected to frequent friction and pressure is debatable. In addition, most of the skin substitutes are costly and most wounds covered with skin substitutes eventually require definitive graft (Nyame et al, 2014). Custom-made, offloading shoes may be of great value to this subset of patients to prevent recurrent ulceration of the grafted area.

Conclusion

In an era of improved surgical and rehabilitation techniques and the advent of newer offloading devices, ambulation preservation following heel pad necrosis should be attempted. Early revascularization and NPWT should be considered early to prevent osteomyelitis of the exposed bones. Skin grafting, rehabilitation and shoes for offloading can be included in multimodality therapy to improve the outcomes of treatment after heel pad necrosis. WAS

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