Full Thickness Burns over Bilateral Patella Tendons – Adjunctive Hyperbaric Oxygen Therapy and Negative Pressure Wound Therapy for Wound Bed Preparation and Improved Graft Take

Dear Editor,

Coverage of poorly vascularised diabetic wounds is an important rising surgical challenge. Failure leads to amputations and increased morbidity. Worldwide, a limb is lost to diabetes every 30 seconds. Diabetic prevalence in Singapore is 8.2% with 13.9% having vasculopathy, 28.8% stage 2 King's Classification and 700 diabetic amputations every year.[1] We highlight how synergistic HBOT (Hyperbaric Oxygen Therapy) and NPWT (Negative Pressure Wound Therapy) can optimise wound beds in an important unique case of diabetic bilateral patellar infected with full thickness burns.

Clinical Picture

A 58-year-old Chinese man with longstanding poorly controlled diabetes mellitus (DM) presented with 2 days of fever and patellar burns from kneeling on hot concrete from 4 days earlier.

On examination, he had severe DM dermopathy and neuropathy, with bilateral full thickness patellar burns of 1% total body surface area and cellulitis. Bilateral dorsalis pedis (DP) and posterior tibial (PT) pulses were weak (1+). HbA1c was 11.2% (normal 4.2% to 6.4%) and arterial duplex confirmed 20% stenosis at femoral artery and >50% at DP and PT.

Treatment

The patient underwent surgical debridement. Intraoperatively, the burns were full thickness and involved both patella para-tenon with unhealthy tissue not ready for immediate coverage.

Traditionally, the wound may be further debrided and covered with a flap. However, in view of the poor wound bed, HBOT was done. TCOM (Transcutaneous Oximetry Measurement) showed severe hypoxia with PtcO2 (Tissue oxygen partial pressure) of 3 to 20 mmHg and 10 to 23 mmHg in the right knee (RK) and left knee (LK) respectively (Normal>50 mmHg).

In view of vascular comorbidities and good hyperbaric oxygen challenge response ($PtcO_2$ >50 mmHg in both knees on 100% oxygen), 15 sessions of 90 minutes HBOT at 2.4 ATA (Atmospheric Air) was started with DM endocrine and dietitian optimisation.[2] Concurrent application of NPWT (V.A.C.®, Texas, USA) for a bio-occlusive environment removed excess exudates and promoted healing. Intravenous Piperacillin-Tazocin was started to treat multi-resistant *Staphylococcus aureus* and *Pseudomonas aeruginosa* (on wound culture). At HBOT session 10, bilateral split-thickness skin grafts were done. Hypoxia was corrected to PtcO2 of 48-51 mm Hg bilaterally and graft take was 100% (LK) and 90% (RK) at postoperative day 26.

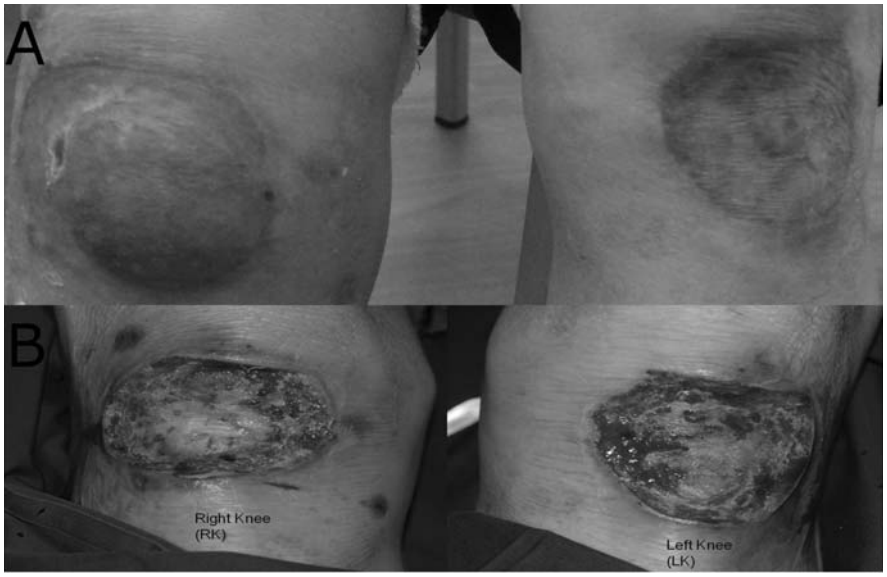

Fig. 1. Before and after HBOT and NPWT therapy. Fig 1A: Well taken split skin grafts (SSG) on the left knee and partial SSG with gastrocnemius flap on the right knee with no functional loss. 1 month post surgery. Fig 1B: Full thickness burns bilaterally down to the para-tenon on debridement.

Due to early excessive mobility and poor wound care, the right knee graft broke down and required a local right gastrocnemius flap and split thickness skin graft. Patient returned to work 3 weeks later with no functional loss.

Discussion

Full thickness patella burns are challenging as skin grafts rely solely on recipient capillary bed perfusion which is poor in tendons compared to healthy muscle bed/dermis. Coverage failure can be potentially catastrophic, particularly in diabetics and immune-compromised individuals with patella loss and knee amputations. Hence, wound bed optimisation through synergistic local infection treatment, diabetic control, HBOT and NPWT is paramount.

NPWT is an important adjunct to wound closure. It enhances microcirculation, reduces microbial exudates and improves granulation. The porous dressing also facilitates oxygen entry into the wound to kill anaerobic bacteria. There is improved healing, decreased wound closure time and enhanced skin graft survival.[3]

There is significant hypoxia in wounded tissue, where normal oxygen tensions are halved. HBOT perfuses 100% oxygen saturation to reverse or limit this hypoxia. Hypoxia correction improves diabetic-impaired polymorphonuclear leucocytes (PMNL) functions such as phagocytosis and production of bacteriocidal free radicals, limiting infection and reducing further debridements. HBOT also improves antibiotics penetration into target bacteria, tissue growth, angiogenesis, and accelerates wound healing.[4] In randomised controlled trials, HBOT have statistically significantly lower rates of major amputations than controls.[5] Success can be predicted with adequacy of TCOM measurements during a hyperbaric 100% oxygen challenge.[2]

To prevent graft breakdown, the key is to reduce shearing forces as grafted skin gains strength and thickness over 3 to 6 months. Patient education, good nutrition, knee braces with prescribed range of motion to prevent excessive flexion are needed.

Conclusion

With the diabetes epidemic, poorly vascularised wound coverage is an important surgical dilemma. A multidisciplinary approach with synergistic HBOT and NPWT, patient education, glycemic control, debridement and antimicrobial therapy is paramount to overcome complex multi-factorial healing barriers such as poor diabetic control, tissue hypoxia, para-tenon avascularity, high shearing joint forces and wound dessication. Optimised wound beds allow for simple skin grafts and avoid morbid flap reconstruction in poor vasculopathic or immunocompromised candidates.

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