Chronic wound healing with hyperbaric oxygen

May K • Hodgson M

Abstract

The clinical podiatrist, along with other wound management specialists, provides chronic wound management to the patient with diabetes. In this challenging patient group, clinicians need to consider the use of appropriate and available wound management therapies. Many modalities are available to the wound management practitioner to facilitate wound healing. Options available include wound dressings and pressure relief strategies, as well as the 'newer' technologies such as human dermal replacement and hyperbaric oxygen.

Hyperbaric oxygen therapy (HBO_2) essentially reverses tissue hypoxia and may facilitate wound healing in the patient with a compromised vascular supply. Background information on lower limb wounds in people with diabetes and HBO_2 is discussed, followed by three case studies on the use of HBO_2 as part of a holistic wound management strategy.

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Introduction

One of the widely documented complications of diabetes is that of lower limb ulceration and amputation. This has the potential consequence of expensive and prolonged hospitalisation and may decrease the ability of the affected person to undertake activities of daily living independently [1-3]. Lower limb ulceration, as a complication of diabetes, consumes the most resources allocated to the management of this patient group, with diabetes related foot problems accounting for more hospital in-patient days than any other complication of diabetes [4, 5]. Foot lesions not only cause high costs to society, but also pain and disability, and diminished quality of life, for people with this condition [6].

Lower limb ulceration not only has its own associated costs, but is also a major predisposing factor for some 85% of lower limb amputations [7]. It has been estimated that 50-70% of all non-traumatic amputations occur in people with diabetes, which equates to an amputation rate that is 15 times that of the general population [8]. In addition, those who suffer the amputation of one lower limb also face a 50% chance of amputation of the remaining limb within 5 years [9]. Mortality after lower limb amputation is also high [9].

The impact of lower limb amputation and ulceration cannot therefore be underestimated, both on a personal and economic level [1-3]. Lower limb amputation and ulceration are usually the result of two specific complications of diabetes – neuropathy and vascular disease. The aim of all health professionals should be to prevent the development of these complications of diabetes and the progression to limb-threatening situations. However, in the presence of ulceration as a result of these complications, timely and appropriate management is essential to ensure optimal health and well being for the affected person. Lower limb ulceration in the person with diabetes requires a team approach if management is to produce the most desired outcome.

Kerry May
BPod GradDipVET
Manager – Podiatry
The Royal Melbourne Hospital
Grattan Street, Parkville, Vic 3050
Tel: (03) 9342 7134
Fax: (03) 9342 8440
E-mail: kerry.may@mh.org.au

Martin Hodgson
MBBS GradDipOccH DipDHM
Director of Hyperbaric Medicine
Vaucluse Hospital Hyperbaric
Medicine & Wound Care Facility
82 Moreland Road, Brunswick, Vic 3056
Tel: (03) 9383 6505
Fax: (03) 9384 1580
E-mail: hyperbaricmart@bigpond.com

All correspondence to Kerry May

Podiatrists are an integral part of the team required to manage acute foot complications in individuals with diabetes. Techniques such as moist wound dressings and pressure relief are commonly used, along with the 'newer' technologies such as human dermal replacement and hyperbaric oxygen. Hyperbaric oxygen therapy (HBO_2) can play an important part in facilitating wound management where diabetes related vascular disease is the major cause of a wound failing to heal.

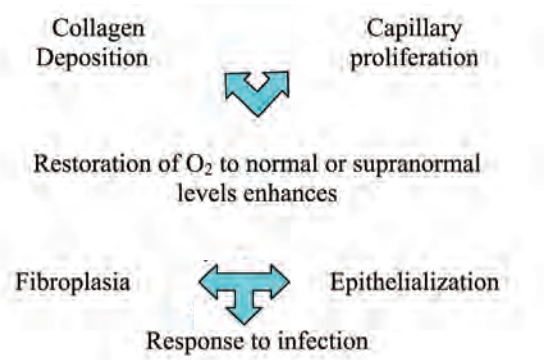
Hyperbaric oxygen therapy

HBO_2 facilitates wound healing by increasing oxygen delivery to ischaemic tissue. It is known that oxygen is essential for cell replication, and that collagen deposition occurs at a rate proportional to tissue oxygen levels [10]. The formation of new blood vessels occurs most rapidly when oxygen levels are higher at the wound edge and lower at the wound centre, creating a gradient to draw oxygen into the wound [11, 12]. Leucocytes are able to fight infection more effectively via an oxidative pathway [11, 12]. Thus, as the level of oxygen in the tissue decreases, so does the ability of the body to heal that tissue and fight infection [10]. By reversing tissue hypoxia, HBO_2 promotes normal repair mechanisms to stimulate slow or stalled healing.

HBO_2 is indicated for selected diabetic foot ulcers because it can often circumvent micro-vascular disease, most probably by stimulating growth factors in the base of the wound and promoting new blood vessel growth in the underlying tissues – although the exact mechanism is not yet fully understood (Figure 1) [10].

HBO_2 was approved by the Medicare Services Advisory Committee (MSAC) in 2001 for use as part of the management strategy for foot wounds in people with diabetes. This decision was supported by the available literature, with two studies in particular providing statistically significant evidence that the use of HBO_2 does result in a reduction of risk for major amputation [13, 14]. Although there is clearly a reasonable amount of literature to support the efficacy of HBO_2 in promoting wound healing, it must be noted that to date there has not been any literature published which demonstrates the efficacy of HBO_2 in a prospective, placebo controlled, double blind study. The lack of 'gold standard' evidence should not lead us to undervalue the available evidence and extensive clinical experience that does demonstrate the efficacy of this treatment modality.

Figure 1.



Case study 1

A 57 year old lady with type II diabetes (insulin requiring) of 25 years' duration with a medical history significant for peripheral vascular disease, ischaemic heart disease, chronic foot ulceration, toe amputations and a left below knee amputation was receiving regular podiatry management at the Royal Melbourne Hospital.

The wound presented here developed during an in-patient stay for a toe amputation. A balloon angioplasty was undertaken on the remaining lower limb but there was minimal improvement to the chronic foot wound post angioplasty. This lady was desperate to avoid a further major amputation. The wound was improving slowly with wound dressings and pressure relief. On referral to HBO_2, the wound was approximately 2x3cm (Figure 2). Improvement was noted at 30 sessions and treatment was therefore continued to 50 sessions (Figure 3). This wound went on to complete healing. The wound remained healed until the patient deceased.

Case study 2

This 68 year old man had type II diabetes (controlled with Glimel and Glucophage). He required bilateral femoro-popliteal bypass surgery following an episode of acute leg ischaemia in November 2001. Recovery was complicated by a nasty infection in the right leg that required intravenous antibiotics and a large 20cm area of split-skin graft.

After 9 weeks in hospital the wounds had not healed. By January 2002 he had large areas of necrosis in the extensive graft on the medial side of the right leg, particularly at the anterior and posterior margins (Figure 4). There were two large necrotic ulcers on the back of the right calf. He also had gangrene on the right 3rd toe, left great and 4th toes and both heels. Both legs were quite swollen. During the time between assessment for HBO_2 and actually commencing HBO_2, the current dressing regime had resulted in the whole graft becoming moist and vulnerable to breakdown.

Figure 2. Case study 1 on presentation.

Figure 3. Case study 1 after $HB0_2$ treatment.

After 30 HBO_2 treatments, the graft had stabilised and the necrotic areas had demarcated and were sharp debrided. The ulcer bases were much improved and most of the gangrene had resolved. His legs were still swollen but he struggled with compression because of the pain it induced at night. Further grafting was not considered appropriate, so HBO_2 was continued for a few more weeks.

After 50 sessions the graft had healed (Figure 5). His swelling was down and his pain much improved. Had the graft failed to take he would have been in danger of below knee amputation.

Case study 3

A 53 year old male truck driver with type II diabetes (insulin requiring) of 7 years' duration had a right heel ulcer that commenced as a blister. Dermagraft had been applied eight times by his podiatrist. This significantly reduced its size, but as it was not healed he was referred for HBO_2. There was also a right great toe ulcer, that had been healed previously but had recently reopened, and a small blister had appeared on the lateral aspect of the heel.

Initially the heel ulcer was 3cm with a healthy red base and quite a lot of clear exudate (Figure 6). A non-adherent high-absorbing dressing was chosen in order to control the moisture. Attention to offloading the area continued as advised by his podiatrist. The lateral blister had some underlying pus, so was de-roofed. Antibiotics were commenced, and the wound was dressed with Cadexomer Iodine and a non-adherent high-absorbing dressing. The great toe ulceration was covered with three layer foam.

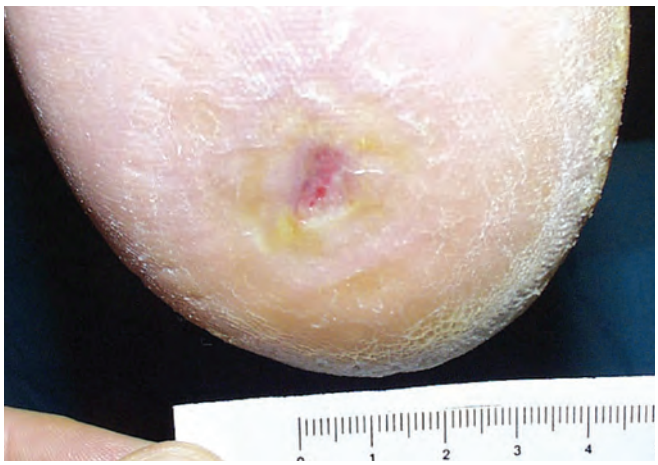
The patient completed 23 HBO_2 sessions with an excellent response. On the heel only a few millimetres remained open and this fully closed over the next two weeks (Figure 7). The lateral ulcer had healed rapidly and the superficial great toe ulceration had quickly improved. Coincident improvements in his sensory neuropathy and metabolic control were also observed.

Figure 4. Case study 2 on presentation.

Figure 5. Case study 2 after $HB0_2$ treatment.

Figure 6. Case study 3 on presentation.

Figure 7. Case study 3 after $HB0_2$ treatment.



Considerations for prescribing HBO_2

HBO_2 is not suitable for every patient or every wound. It should be considered as one treatment option among the many for healing chronic foot wounds in people with diabetes. HBO_2 cannot be utilised in isolation. It must be used in combination with appropriate wound dressings, pressure management and optimal diabetes management. A chronic foot wound in a patient with diabetes requires a management plan that is evidence based and that uses a team approach; therefore, the patient should have access to a podiatrist as part of this team approach.

HBO_2 treatment involves approximately 2 hours per day, 5-6 days per week for 6-10 weeks. This does make HBO_2 a time consuming treatment modality, but time commitment alone should not deter the patient or clinician from utilising the modality as part of a wound management plan. In order to ensure the greatest potential for success, HBO_2, like any wound management therapy, must be used in a timely manner. Contraindications for HBO_2 include a cold or hayfever that affects the sinuses to the extent where ears cannot be equalised, other chronic problems with the ear for the same reason, untreated collapsed lung and claustrophobia [15]. Caution should also be exercised in people with disease of the lung (asthma and emphysema for example). Side effects of HBO_2 may include seizures induced by oxygen toxicity. HBO_2 must be undertaken according to proper and proven protocols to minimise the potential for side effects and to accommodate other at risk medical conditions.

Conclusion

HBO_2 is a useful adjunct treatment modality in the management of diabetes related foot ulcers where there is local ischaemic tissue. Further study is required to determine the exact mode of action of HBO_2 in the management of diabetic related foot wounds, and to provide robust scientific evidence to support its use. HBO_2 should be considered as one treatment option in the available diverse modern chronic wound management arsenal. If you feel a referral for HBO_2 therapy is appropriate, then you are encouraged to discuss the idea of HBO_2 with your patient and their podiatrist or GP.

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