

Application of HBOT and Wolf Grafting in Chronic Diabetic Foot Ulcer

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Abstract

Diabetic foot ulcers are a serious complication of poorly controlled diabetes, often leading to amputations. This study presents a 60-year-old man with diabetes and severe foot ulcers who opted for a Wolfe skin graft with Hyperbaric Oxygen Therapy (HBOT) instead of amputation.

Key points of study

1. The patient had poorly controlled diabetes and severe foot ulcers, resulting in 2 amputated toes.
2. Further amputations were anticipated for a chronic Wagner 3 diabetic ulcer. (Wagner, et. al., Foot and Ankle international)
3. A Wolfe skin graft limited debridement and minimally invasive surgery followed by HBOT sessions were successful in healing the ulcers and saving the toe.
4. This approach shows promise as an alternative to amputation for diabetic foot ulcers, potentially reducing costs and improving patient outcomes.

Overall, this study suggests that Wolfe skin grafting combined with HBOT can be a viable alternative to amputation for treating diabetic foot ulcers. This approach may offer cost savings and improved quality of life for the patient by preserving limbs.

Keywords: Diabetic foot ulcer; Wolfe skin graft; Hyperbaric oxygen therapy; Amputation; Limb salvage; Wound healing.

Background

In 2013, diabetes mellitus had been affected by 382 million people worldwide [1]. Of this disease, diabetic foot ulcers are the most common complications of patients from poorly controlled diabetes mellitus. Foot

ulcers happen because of poor glycemic control, underlying neuropathy, peripheral vascular disease, or poor foot care [2]. The most prevalent organism in diabetic foot ulcers is *Staphylococcus aureus*, but other organisms include *Escherichia coli*, and

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Klebsiella [3]. While *Staphylococcus aureus* can be recovered by using antibiotics, but there is a resistant strand being Methicillin-resistant *Staphylococcus aureus* (MRSA)[4]. Despite the standard procedure for *Staphylococcus aureus* being treated by using antibiotics once it is advanced either amputation or a skin graft is required to treat the foot ulcer. An amputation is an approach to treat the foot ulcer but may result in further amputations down the line [5]. A skin graft can increase the healing rate of a diabetic foot ulcer and accelerates the recovery of the patient [6]. Hyperbaric Oxygen Therapy (HBOT) can be used as an accelerator in the healing of the skin graft along with salvaging limbs [7]. This is especially as it is used as a regenerative medicine for a variety of uses [8]. Hence the

technique update presented will be a Wolfe skin graft accompanied by HBOT.

Approach

A 60-year-old man with diabetes mellitus presented with a deeply penetrating ulcer to his second toe. Conservative measure had failed for over 6 months and amputation was advised. He also had fatty liver, severe diabetic retinopathy, albuminuria, and bilateral foot diabetic neuropathy. This had resulted in 2 amputated toes prior to presentation. A photo of the ulcer can be seen in FIGURE 1. From the photo, the necrosis of the surrounding skin can be seen due to the discoloration of the affected area. Diabetic foot ulcers cause ulceration and sepsis which can lead to gangrene, the necrosis of the affected area that leads to amputation [9].



Figure 1: Diabetic foot ulcer shown on the toe of the patient.

The patient had been advised to amputate the toe; however, the patient was keen to avoid further amputation and was referred to the senior author.

After a few consultations, was advised to complete debridement of the necrotizing tissues, a Wolfe skin graft, minimally invasive

image guided correction of the hammer toe using a 3mm cannulated screw then followed by HBOT sessions. The machine used for hyperbaric treatments was an Integrant TROJEN model TKBO_1 available from Regen U. Skiing was harvested from the ipsilateral posterior elbow. These techniques are shown to be effective in other studies [10].

Results

Surgery was performed as a day case. Infective HBOT protocol was used 90-minute sessions, 100% O₂, 2 atm. Figure 2 post op appearance day 3. The necrotized tissue from Figure 1 is removed because of the debridement completed prior to the skin graft. Following the skin graft, HBOT sessions were used to aid the recovery of the skin graft. Figure 3

shows the result of the skin graft which is following one session of HBOT 2 days after surgery.

A slight improvement can be seen as there is the healing of the graft with a reduced amount of dead tissue. Along with a slight growing of the toe nail that can be seen on the affected toe.



Figure 2: Patients affected foot following the skin graft.



Figure 3: Patients affected foot following first HBOT session.

The patient would be booked for 5 total HBOT sessions. After three weeks of the procedure, the patient completed the 5th and final session where the result can be seen in Figure 4.

The foot is shown to be completely healed. This can be observed by the color of the toe, along with a healthy and final session where the result can be seen in Figure 4.

The foot is shown to be completely healed. This can be observed by the color of the toe,

along with a healthy amount of toenail growing at the end of the toe.



Figure 4: Skin graft following 5 HBOT sessions.

Significance

As previously mentioned, the patient was recommended to amputate the affected area due to failure to respond to non-operative measures.

This was combatted by Wolfe graft and minimally invasive correction of deformity accompanied by HBOT sessions. The authors believe that it is better to retain limbs in comparison to amputation. Amputation costs an average of \$44,790. 65% of the costs are from the amputation and 13% from ulcer treatments [11].

Further significant costs from prosthetic are involved and significant changes in the

kinematics of the limb occur. It is advised limiting the amount of debridement as aggressive debridement leads to eventual inability to close defects particularly with diabetics.

Initial success was achieved with patients using hyperbaric oxygen in combination with surgery and antibiotics.

Disclaimer

Dr. Gordon Slater has a pecuniary interest in Integrant a biotechnology company and Regen U clinics where he actively advises on treatment protocols and implant design.

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