

CASE REPORT

A Novel Approach in Treating Diabetic Foot Ulcer With Hyperbaric Oxygen Therapy: A Case Report

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ABSTRACT

Diabetes mellitus has reached epidemic levels in Malaysia due to increase in its risk factors such as obesity, dietary and sedentary lifestyle. In patients with uncontrolled diabetes mellitus, diabetic foot ulcer (DFU) is a common complication. Managing diabetic foot infection is often multifactorial and intricate. The management of DFU demands a multi-speciality approach and is often tedious. Hyperbaric oxygen therapy (HBOT) is a promising adjunctive treatment used to enhance the healing process plus reduces cost and recovery time. This is a case of a 52-year-old lady, with underlying poorly controlled diabetes mellitus, who presented with diabetic foot ulcer Wagner IV classification in sepsis. She underwent trans-metatarsal amputation followed by split skin grafting with additional adjunctive HBOT in a tertiary hospital.

Keywords: Hyperbaric oxygen therapy, Diabetic foot ulcer, HBOT, Amputation

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studies have shown the development of surgical adjuncts that show the promising potential that includes maggot therapy, early skin grafting, advanced dressing and HBOT. These interventions improve recovery time and total health care cost.

INTRODUCTION

Diabetes mellitus is among the most prevalent metabolic disease among the Malaysian population. There has been an increase in the diabetes mellitus prevalence in the local scene with the latest number at 17.5% based on the 2015 National Health and Morbidity Survey (NHMS) which was an increase in numbers of nearly 20% when compared to NHMS 2011 (1). Diabetic foot ulcer (DFU) is a common problem seen, especially in the hospital setting. The high amputation rate of 15–20% over five years stems from the fact that nearly 2% of all diabetes patients suffer from DFU (2). DFU clinical presentation varies in severity and commonly presents with pus-laden infected ulcer with clinical sepsis which demands urgent surgical debridement and major amputation. Managing DFU itself involves teamwork from a multidisciplinary team, including the orthopaedics, medical and general surgery teams. Wagner and Kings classification are among the most commonly used in the stratification of ulcer risk (3). These classifications assist in streamlining surgical intervention and clinical management. Clinical

CASE REPORT

Mrs Z, a 52-year-old Malay lady, presented to the emergency department (ED) with the complaint of blackish discoloration of her left 1st and 4th toe. She claimed that it became worse for the past two weeks. Mrs Z also complained of intermittent low-grade fever, reduced appetite and lethargy. She has been suffering from Type 2 diabetes mellitus for the last 15 years and is currently on insulin medication with poor compliance. She had a history of left 2nd and 3rd toe ray's amputation done three weeks back. Upon examination, the patient was septic looking, with tachycardia secondary to fever. Blood pressure is within the normal range. On examination of the left foot, there was blackish discoloration and swelling of right 1st and 4th toe with surrounding erythema extending to midfoot (Figure 1). The previous surgical site had been covered with slough, is foul-smelling with unhealthy surrounding tissues. There is tenderness on palpation over the dorsum aspect of the left foot with minimal pus upon milking and poor



Figure 1: Image of left diabetic foot ulcer preoperatively

border demarcation. Both the foot pulses i.e. posterior tibial artery (PTA) and dorsalis pedis artery (DPA), were palpable but had a weak volume. Popliteal pulse is well palpable with a regular and sound volume. X-ray of the left foot was done, which shows lytic changes over the head of 1st and 4th metatarsal bone which represent osteomyelitis without any gaseous shadow. Blood investigation done shows increase in the infective markers with a mildly deranged renal profile. At this moment, the diagnosis made was sepsis secondary to infected left DFU. The septic workout was performed, and the patient was admitted and started on an intravenous antibiotic. The patient had undergone TMA (Trans Metatarsal Amputation) under spinal anaesthesia. Surgery was uneventful (Figure 2). Vacuum-assisted closure (VAC) dressing was applied and given for 30 cycles HBOT with five cycles per week. The patient was kept in the ward for two cycles of VAC dressing and was discharged well.

Three weeks post-operation, split skin grafting was done (Figure 3), and the patient continued her HBOT for another three weeks as an outpatient. Post-operative six



Figure 2: Image post trans metatarsal amputation

weeks, the wound had healed entirely and prescribed special offloading rehabilitation shoes (Figure 4).



Figure 3: Image pre SSG



Figure 4: Image post SSG with adjunct HBOT

DISCUSSION

Hyperbaric oxygen therapy provides an environment which is pressurised to an atmospheric pressure higher than sea level with delivery 100% oxygen while the treatment chamber (4). The resulting increased oxygen concentration in the arterial blood emanates in reducing wound tissue hypoxia, enhancing perfusion, fibroblast proliferation, epithelialisation and neovascularisation (4). HBOT provides a bactericidal and bacteriostatic effect on both aerobic and anaerobic bacteria through the action of the superoxide enzyme in high oxygen tension atmosphere (4). Similarly, HBOT improves local oxygen levels in poor vascularity conditions (4).

A few studies have mentioned about the rate of major amputations and healing of ischaemic, non-healing diabetic foot ulcer in groups who underwent HBOT as compared with the controlled group (2,5). Results showed decreased rate of major amputations and increase healing rates in the group that was given HBOT (2,5). This shows that HBOT is considered effective as an adjunct treatment in managing DFU.

Many patients would choose major limb amputation as their last choice for treatment. Many would prefer limb saving surgery. Studies have shown that HBOT significantly improves the prevalence of wound healing

in DFU and at the same time diminishes the need for amputations, or if needed, amputation can be done at the more distal part of the limb as shown in this case. Studies had shown a significant reduction of the number of surgical interventions such as debridement and the surgical flap when HBOT used as an adjunct. However, in cases of critical limb ischaemia, revascularization is the first-line treatment.

However, there exist a few disadvantages regarding HBOT. This include, costly equipment, lack of availability trained personal, time-consuming and issues with compliance.

CONCLUSION

The management of diabetic foot ulcer remains a challenging clinical problem which will need an active multidisciplinary team approach where radical debridement and soft-tissue preservation and rehabilitation would be a mainstay of treatment. Early referral and patient morbidity stabilisation would improve wound outcome. HBOT proves to be an efficient surgical adjunct in these circumstances. Long term safety data and quantification of these dose and delivery methods would pose a tempting challenge for the future. Our case highlights the often untapped potential of HBOT in the treatment of diabetic foot ulcer. Such surgical adjunct could be the answer for reduction of the size of the lesion, shortened period hospitalisation

and lessen the medical cost burden.

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REFERENCES

1. Institute for Public Health (IPH). National Health and Morbidity Survey 2015 (NHMS 2015). Vol. II: Non-Communicable Diseases, Risk Factors & Other Health Problem. Kuala Lumpur: Ministry of Health Malaysia; 2015.
2. Barnes RC. Point: hyperbaric oxygen is beneficial for diabetic foot wounds. *Clinical infectious diseases*. 2006; 43(2):188-92.
3. Wagner F. The Dysvascular Foot: A System for Diagnosis and Treatment. *Foot & Ankle*. 1981; 2(2):64-122.
4. Bhutani S, Vishwanath G. Hyperbaric oxygen and wound healing. *Indian Journal of Plastic Surgery*. 2012; 45(2):316-24.
5. Abidia, A, Laden G, Kuhan, G, Johnson B, Wilkinson A, Renwick P. The role of hyperbaric oxygen therapy in ischaemic diabetic lower extremity ulcers: A double-blind randomised-controlled trial 2003. *European Journal of Vascular and Endovascular Surgery*; 25(6):513-8.