

# Integrating Hyperbaric Oxygen Therapy Into Multidisciplinary Management Of Diabetic Finger Infection: A Case Report

Diyabetik parmak enfeksiyonunun multidisipliner tedavisine hiperbarik oksijen tedavisinin entegre edilmesi:  
Bir olgu sunumu

Dr. Mesut MUTLUOĞLU  
Doç.Dr. Günalp UZUN  
Doç.Dr. Şenol YILDIZ

GATA Haydarpaşa Eğitim Hastanesi Sualtı Hekimliği ve Hiperbarik Tıp Servisi

Gaziantep Tıp Dergisi 2009;15(3):33-35.

## Özet

Alt ekstremitte yaraları diyabetes mellitusun en ciddi ve sık komplikasyonlarından biridir. Bununla birlikte, el enfeksiyonları, nadir olmalarına rağmen, hastalığın diğer önemli sorunlarından. Diyabetik ayak enfeksiyonlarının tedavisinde multidisipliner yaklaşımın etkinliği kanıtlanmıştır. Hiperbarik oksijen tedavisi iyileşmeyen yaraların tedavisinde sıklıkla kullanılan yardımcı tedavi modalitelerinden birisidir. Bu yazının amacı parmak enfeksiyonu olan bir diyabetik hastada multidisipliner yaklaşıma ek olarak kullanılan hiperbarik oksijen tedavisinin faydalarının rapor edilmesidir.

**Anahtar Kelimeler:** Diyabet, Yara bakımı, Enfeksiyon, Üst ekstremitte, Hipoksi

## Abstract

Lower extremity wounds are one of the most frequent and serious complications of diabetes mellitus. However hand infections, though rare, are another challenging aspect of the disease. Multi-disciplinary approach has proved efficacy in the treatment of diabetic foot infections. Hyperbaric oxygen therapy is one of the adjunctive treatment modalities frequently used in patients with non-healing wounds. The objective of this paper was to report the additive effect of hyperbaric oxygen therapy in the management of a finger infection in a diabetic patient.

**Key words:** Diabetes, Wound care, Infection, Upper extremity, Hypoxia

## Introduction

Lower extremity wounds and related infections are one of the most frequent and serious complications of diabetes mellitus that leads to significant morbidity and mortality. It is estimated that every 30 seconds a lower limb is amputated as a consequence of diabetes throughout the world. However hand infections, though rare, are another challenging aspect of the disease (1-4). Multi-disciplinary wound management is regarded as the treatment approach of choice in diabetic foot ulcers (5). One of these disciplines; the hyperbaric oxygen (HBO) therapy has proved efficacy as an advanced wound therapy protocol in selective problematic and intractable wounds (6,7). Published literature on hand infections in diabetic patients is scarce and data on HBO therapy in hand infections is even more limited. The objective of this paper was to report the successful use of HBO therapy as an adjunct in the management of a finger infection in a diabetic patient.

## Case report

A 54-year-old woman with insulin-dependent diabetes of 8 year's duration presented to our clinic 20 days after a traumatic finger wound caused by a slammed door. She reported that the wound failed to heal although her initial wound care management and anti-microbial treatment and that consequently she was advised to have amputated her finger at the distal phalanx level. She didn't accept the procedure and applied to our clinic.

Her physical exam revealed necrotic tissue within the wound bed with a purulent discharge and foul odor on her 4th finger of the left hand (Figure 1). She reported a deterioration in her blood sugar following the trauma but it was adjusted and kept regular right after she was switched to a four times daily insulin dose regimen.

Doç.Dr. Günalp UZUN, GATA Haydarpaşa Eğitim Hastanesi Sualtı Hekimliği ve Hiperbarik Tıp Servisi

**Adres:** GATA Haydarpaşa Eğitim Hastanesi 34668 Üsküdar / İSTANBUL

**Tel:** 0216 542 39 01 **Fax:** 0216 348 78 80 **E-mail:** gunalpuzun@yahoo.com

Bu çalışma 3-6 Eylül 2008 tarihlerinde Graz, Avusturya'da düzenlenen 34. European Underwater and Baromedical Society Yıllık Bilimsel Toplantısında sunulmuştur.

**Geliş Tarihi:** 27.04.2009 **Kabul Tarihi:** 05.08.2009





**Figure 1.** Heavy necrotic burden and purulent discharge is seen on the wound bed.

HbA1c was 6.3%. Doppler ultrasonography of her left upper extremity showed heavy calcifications in the vessel walls. Laboratory examination at admission revealed WBC:  $9.8 \times 10^9$  /L, erythrocyte sedimentation rate: 74 mm/h and C-reactive protein (CRP): 56mg/dL. Deep tissue specimen revealed *Staphylococcus aureus* and *Pseudomonas aeruginosa*, so she was switched to i.v. ampicillin-sulbactam 1.5 gr bid and ciprofloxacin p.o. 500mg bid. HBO therapy was combined to the therapy protocol which included antimicrobial therapy, metabolic control, and daily debridement and wound care. HBO therapy was performed in a multiplace hyperbaric chamber at 2.4 absolute atmospheres for 120 minutes daily, 5 days/week. Within one week she began to show progression toward healing, the wound bed was less purulent with a newly forming granulation layer. On day 5 the CRP had fallen to 32mg/dl. Her control deep tissue specimen revealed no growth at day 12 and she was switched to levofloxacin p.o once daily regimen for one week. HBO therapy was ceased at the end of 20 sessions when the wound bed was totally free of discharge and a well granulated wound bed without necrotic tissue was achieved. She didn't need any further debridement. She was called for regular follow-up appointments. Complete epithelization of the wound was achieved at two months (Figure 2).



**Figure 2.** Wound closure is seen 2 months after discharge.

## Discussion

There is little information about the prevalence and incidence of hand infections and there isn't any classification system or any published therapy guidelines regarding hand infections in diabetics.

Diabetes mellitus significantly complicates hand infections. Houshian et al., in a study of 418 patients with hand infections, reported a 6-fold increase in complications in the diabetic group compared to the non-diabetics (8). An increased frequency is also reported for gram-negative organisms cultured in patients with diabetes mellitus compared to non-diabetics (1,2,8). Digits seem to be the predominant site of infection and are involved in 50% to 60% of the cases (2,9). Amputations are the most feared complication of the diabetic hand infections. The rate of amputation varies between 14% to 35% in previous case series (1,3,4).

Early recognition of the situation, timely intervention and a multidisciplinary team work is essential in the management of hand infections in diabetic patients. Daily wound care, culture driven antibiotherapy, and strict glycemic regulation should be optimized as fundamentals of diabetic wound care management. In addition, adjunctive wound healing modalities such as HBO therapy should be considered in selected patients. Literature on the use of HBO in hand infections is limited. Korpınar and Boynuk reported of a successful use of HBO in the treatment of a felon in a diabetic patient (10). Our patient was admitted to our department for HBO therapy after her wound failed to improve despite adequate wound care for three weeks. Her wound dramatically improved after integrating HBO therapy into the treatment protocol.

HBO therapy is widely used as an adjunct modality of treatment in the management of diabetic foot ulcers and infections. The rational for HBO therapy in problem wounds/ulcers of diabetic patients which are usually associated with infections is well described. HBO therapy increases the amount of oxygen dissolved in plasma and consequently delivers more oxygen to all tissues. It is well known that hypoxic wounds frequently fail to heal and become infected.

HBO therapy enhances wound healing by increasing the growth of new capillaries, collagen synthesis and maturation, and fibroblast replication (11,12). Hypoxia impairs the oxygen dependent defense system of the host, which makes the hypoxic wound more vulnerable to microorganisms. The bacterial killing of the neutrophils via oxygen is NADPH-oxidase dependent. NADPH-oxidase uses oxygen as a substrate to generate high amounts of oxidants to kill microorganisms. The activity of this enzyme is controlled with the availability of the substrate, namely oxygen.

While a partial oxygen pressure (pO<sub>2</sub>) between 45 and 80mmHg halves its activity, at a pO<sub>2</sub> of 300mmHg the activity of the enzyme rises to 90% (13). In addition, HBO exerts bactericidal effectiveness against anaerob bacteria by increasing the production of reactive oxygen species (14). Another role for HBO in infections is its synergistic action with a number of antibiotics such as aminoglycosides, sulfonamides, trimetoprim, fluorokinolons and vankomisin (15).

Taken together, optimal oxygen partial pressures at the wound site is of paramount importance to combat infection and promote wound healing in diabetic patients and HBO therapy favorably interferes various steps of wound healing by increasing tissue pO<sub>2</sub>. In closing, the management of hand infections in diabetic patients may be challenging and HBO should be considered as a potential adjunct in these patients when conventional treatments fail.

### References

- 1.Mann RJ, Peacock JM. Hand infections in patients with diabetes mellitus. *J Trauma*. 1977;17:376-380.
- 2.Kour AK, Looi KP, Phone MH, Pho RW. Hand infections in patients with diabetes. *Clin Orthop Relat Res*. 1996;(331):238-244.
- 3.Connor RW, Kimbrough RC, Dabezies MJ. Hand infections in patients with diabetes mellitus. *Orthopedics*. 2001;24:1057-1060.
- 4.Pinzur MS, Bednar M, Weaver F, Williams A. Hand infections in the diabetic patient. *J Hand Surg [Br]*. 1997;22:133-134.
- 5.Lipsky BA, Berendt AR, Deery HG, Embil JM, Joseph WS, Karchmer AW, et al. Infectious Diseases Society of America. Diagnosis and treatment of diabetic foot infections. *Plast Reconstr Surg*. 2006;117(7 Suppl):212-238.
- 6.Thackham JA, McElwain DL, Long RJ. The use of hyperbaric oxygen therapy to treat chronic wounds: A review. *Wound Repair Regen*. 2008;16:321-330.
- 7.Chuck AW, Hailey D, Jacobs P, Perry DC. Cost-effectiveness and budget impact of adjunctive hyperbaric oxygen therapy for diabetic foot ulcers. *Int J Technol Assess Health Care*. 2008;24:178-183.
- 8.Houshian S, Seyedipour S, Wedderkopp N. Epidemiology of bacterial hand infections. *Int J Infect Dis*. 2006;10:315-9.
- 9.Benotmane A, Faraoun K, Mohammedi F, Benkhelifa T, Amani ME. Infections of the upper extremity in hospitalized diabetic patients: A prospective study. *Diabetes Metab*. 2004;30:91-97.
- 10.Korpınar S, Boynuk B. Hyperbaric oxygen therapy in neglected felon. *Wounds*. 2006;18:352-354
- 11.Tandara AA, Mustoe TA. Oxygen in wound healing—more than a nutrient. *World J Surg*. 2004;28:294-300.
- 12.Uzun G, Yildiz S, Aktas S. Hyperbaric oxygen therapy in the management of non-healing wounds in patients with critical limb ischemia. *Therapy*. 2008;5:99-108.
- 13.Allen DB, Maguire JJ, Mahdavian M. Wound hypoxia and acidosis limit neutrophil bacterial killing mechanisms. *Arch Surg*. 1997;132:991-996.
- 14.Walden WC, Hentges DJ. Differential effects of oxygen and oxidation-reduction potential on the multiplication of three species of anaerobic intestinal bacteria. *Appl Microbiol*. 1975;30:781-785.
- 15.Park MK. Effects of hyperbaric oxygen in infectious diseases:basic mechanisms. In, Kindwall Ep, Whelan HT (eds) *Hyperbaric Medicine Practice* (2nd revised ed). Flagstaff, AZ, Best Publishing Co. 2004:205-244.