

DIABETIC HAND INFECTIONS TREATED WITH HYPERBARIC OXYGEN THERAPY

HİPERBARİK OKSİJEN TEDAVİSİ İLE TEDAVİ EDİLEN DİYABETİK EL ENFEKSİYONLARI

Elif Ebru ÖZER¹ Günalp UZUN²

¹Department of Underwater and Hyperbaric Medicine, University of Medical Sciences Bozyaka Education and Research Hospital, İzmir, Turkey

²Department of Underwater and Hyperbaric Medicine, Gülhane Military Medical Academy, Ankara, TURKEY

Keywords: Diabetic hand, hyperbaric oxygen, tropical diabetic hand syndrome

Anahtar Sözcükler: Diyabetik el, hiperbarik oksijen, tropikal diyabetik el sendromu

Yazının alınma tarihi: 03.07.2018

Kabul tarihi: 12.06.2019

Online basım: 30.01.2020

SUMMARY

Introduction: The hand problems cause significant morbidity and mortality in the diabetic population such as amputation. There is a limited data about diabetic hand infection incidence in the literature in contrast to the diabetic foot. Hyperbaric oxygen (HBO) treatment is effective in all stages of wound healing, increases tissue oxygenation and has anti-infective effects. The aim of this study was to evaluate the outcomes of patients received HBO treatment for diabetic hand infections.

Material and Methods: We reviewed our patients who received HBO treatment, due to diabetic wound, between January 2013 and December 2014. Patients who had hand infections were included in this retrospective report.

Results: We identified 7 of 209 patients with diabetic wound had diabetic hand infection (%3,3). Four patients recovered without amputation.

Conclusion: HBO treatment may be beneficial in selected cases such as those with compromised arterial circulation of upper extremity or with necrotizing progressive infection.

ÖZ

Giriş: Diyabetik hastalardaki el problemleri ciddi morbidite ve mortalite kaybına neden olmaktadır. Diyabetik el enfeksiyonları ile ilgili literatürde sınırlı bilgi mevcuttur. Hiperbarik oksijen tedavisi yara iyileşmesinin her aşamasında etkilidir. Doku oksijenasyonunu artırır ve anti-infektif özelliklere sahiptir. Bu çalışmanın amacı diyabetik el enfeksiyonu nedeniyle hiperbarik oksijen tedavisi uygulanan hastaların sonuçlarını araştırmaktır.

Gereç ve Yöntem: Ocak 2013- Aralık 2014 yılları arasında diyabetik yara nedeniyle tedavi gören hastaları inceledik. Diyabetik el enfeksiyonu olan hastaları retrospektif çalışmamıza dahil ettik.

Bulgular: Diyabetik yara nedeniyle tedaviye aldığımız 209 hastanın 7'sinde diyabetik el bulguları saptadık (%3.3). Dört hasta amputasyon gerektirmeden iyileşti.

Sonuç: Hiperbarik oksijen tedavisi; özellikle üst ekstremitte arteriyel sirkülasyonun bozulduğu ve ilerleyici nekrozla seyreden vakalarda faydalı olacaktır.

INTRODUCTION

The hand problems cause significant morbidity and mortality in the diabetic population(1,2). There is a limited data about diabetic hand infection incidence in the literature (3). Hand infections in diabetic patients usually begin in a site of skin trauma or ulceration. Infection plays a major role in the pathogenesis of diabetic hands(4). Actually results deep tissue infections, multiple surgical operations, sometimes need amputation and longer hospital stay than non-diabetics. The reduction of tissue oxygenation and nutrient level leads to poor regeneration of damaged tissue and resulting in necrosis and gangrene (5). Developing peripheral neuropathy in diabetic patients prevents the recognition in the early stages of infection. It could also explain rapidly developing necrosis and gangrene after minor trauma or infection (6). All of these changes affect sufficient vasodilatation and blood flow in injury site. A triad of poor vascularity in peripheral parts, neuropathy and poor wound healing may contribute to increased susceptibility to local or systemic infection in diabetic patients (7). Recommended treatments include hospitalization and hand elevation, multiple intravenous antibiotics, optimal glycemic control, adequate and early surgical drainage, prompt amputation if necessary, vigorous rehabilitation(8). HBO treatment may be included in addition surgical debridement and antibiotherapy, can be potentiated the effects of antibiotics, decreases edema by the effect of vasoconstriction, has antimicrobial effects (bacteriostatic-bactericidal) (8). Increase in partial oxygen pressure stimulates fibroblast stimulation, collagen production, neovascularization and epithelization in hypoxic tissues. Hypoxia stimulate in many phases of wound healing, such as fibroblast migration and proliferation, protein synthesis, synthesis of growth factors and angiogenesis. In contrast, in the case of chronic hypoxia, wound healing is inhibited. Cell replication, collagen synthesis, the expression of cytokines is reduced by hypoxia. Diabetic patients are at high risk of peripheral ischemia due to vascular disease not only lower extremities but also upper extremities. High level of blood glucose can damage the blood vessels. Microangiopathy cause the basement membrane to grow thicker and weaker in small vessels that may impair the migration of leukocytes and the

hyperemic response following the injury and it causes local ischemia-tissue hypoxia and damage (6).

In hyperbaric conditions it is possible to dissolve more oxygen in plasma and thus provide the necessary oxygen pressure. When the pO_2 is 100 mmHg, the diffusion distance is 64 μm , and when it is 2000 mmHg, it reaches 246 μm . HBO therapy increases fibroblast proliferation in cell culture. This effect continue last 72 hours, after every 120 minutes of treatment. (9) HBO treatment also increases hyaluronic acid and proteoglycan synthesis from fibroblasts both scar tissue and normal tissue. It also increases endothelial cell proliferation, which starts at the 15th minute of treatment.

The aim of this study was to evaluate the outcomes of patients received HBO treatment for diabetic hand infections.

MATERIAL AND METHODS

We reviewed our patients who received HBO, due to diabetic wound, between January 2013 and December 2014. Patients who had hand infections were included in this retrospective report. The sociodemographic data, etiology, wound culture results, comorbid disease, hospitalization period, intravenous antibiotherapy, white blood cell counts, sedimentation on admission, HbA1c values for diabetes control, required amputation, previously undergone amputation, number of HBO sessions, Doppler USG (if necessary), and outcomes were recorded.

RESULTS

We identified 7 of 209 patients with diabetic wound had diabetic hand infection (3.3%)(4 male and 3 female patients). Mean age of patients was 59.4 ± 13.7 years. Four patients (57%) were hospitalized. Mean number of HBO treatments was 6.3 ± 4.3 (1-12). Two patients received only 1 HBO treatment because of claustrophobia. Since there is not a specific grading system for diabetic hand infections, we used Wagner classification. There were one patient with Wagner 0 lesion (had a history of amputation of 2-5 fingers) but deep palmar infection, two patients with Wagner 1 lesion, one patient with Wagner 2 lesion, and three patients with Wagner 4 lesion (Figure 1).

The mean duration of hospitalization period was 16.5 ± 7.9 (6-23) days. The distribution of etiology was as follows; one patient: IM injection, three patients: trauma, three patients: spontaneously. The results wound cultures were as follows: four patients: *E.coli*, two patients: no pathogen isolation, one patient: polymicrobial (*pseudomonas+citrobacter*). There were signs of bone resorption in the radiography of 5 of 7 patients. Mean WBC, ESR and HbA1c levels were $13000/\text{mm}^3$, 79/h and 7.9% respectively. The most prevalent comorbid condition was hypertension. There was chronic renal failure in two patients as their wounds were located on the

arm with hemodialysis fistula. Four patients recovered without amputation (Figure 2). One patient of them who had a history of amputation both below-knee was recovered without requiring amputation. One patient which has chronic renal failure underwent finger amputation (Figure 3). One patient with Wagner 4 wound and doppler monophasic flow in the right subclavian, axillary, ulnar and radial artery recovered after finger amputation and dialysis fistula was revised. One patient who had arterial thrombosis and polymicrobial infection, died at the 23th day of hospitalization (Wagner 4).



Fig 1. The patient with Wagner 4 wound, had neurogenic bladder, performed clean intermittent catheterization, and Doppler monophasic flow in the right subclavian, axillary, ulnar and radial artery recovered after finger amputation, but died due to subdural hematoma in the seventh month follow-up.



Fig 2. Recovered without amputation



Fig 3. The patient which chronic renal failure underwent finger amputation and dialysis fistula was revised.

Table 1. Descriptive Information of Patients

Patient	1	2	3	4	5	6	7	mean
Sex (F/M)	F	F	M	M	M	M	F	-
Age	52	62	41	53	54	73	81	59,4±13,7
HBOT (day)	11	7	6	1	6	1	12	6,3±4,3
Hospitalization (day)	0	0	22	15	0	6	23	16,5±7,9
Diabetes time (year)	15	28	10	20	23	20	5	17,3±7,9
Insulin time (year)	5	23	10	recently	6	8	OAA	10,4±7,3
Neuropathy	-	+	-	+	+	+	unknown	
Comorbidity	HT	CAD+HT	HT	dialysis	dialysis	CAD+HT	HT	
PAD	-	-	-	+	+	+	+	
Culture	-	<i>E.coli</i>	<i>E.coli</i>	<i>E.coli</i>	<i>E.coli</i>	-	<i>P.aeruginosa</i> + <i>Citrobacter</i>	
Etiology	Trauma	Spontaneously	Spontaneously	Trauma	Spontaneously	Trauma	IM injection	
Wagner class.	2	1	0	4	2	4	4	
Wbc	9,2	10,5	23,9	12,4	8,4	17	9,9	13±5,6
Sed	24	20	>120	85	140	85	85	79,8±44,7
HbA1c	9,8	8,1	5,8	8,9	Unknown	8,5	6,8	7,9±1,4
OM (XR)	+	-	+	-	+	+	Unknown	
Iv ab	-	+	+	+	-	+	+	71%
Outcome	Recovery without amp.	Recovery without amp.	Recovery without amp.	Finger amp. +Dialysis fistula was revised	Dialysis fistula was revised, without amp	Finger amp.	Ex	

HBOT: hyperbaric oxygen treatment, PAD: peripheral arterial disease, Wbc:white blood cell, Sed:sedimentation, OM:osteomyelitis, IV ab:intravenous antibiotherapy, OAA: oral antihyperglycemic agents, CAD:Coronary Artery Disease

DISCUSSION

Diabetic hand infections are rare but associated with high risk of morbidity. Our centre is a medical academy so that we experience more often these rare diseases (3.3%). Wang C and coll. found that the prevalence of diabetic hand ulcers in 17 of 4615 (0.37%) diabetic patients were admitted to the their Diabetic Foot Care Center (10).The prevalence rate of diabetic hand has been reported to be 1.4–3.2% in African countries (11,12). But hand problems such as limited joint mobility, Dupuytren's contraction and trigger fingers have been reported in diabetic patients could be defined as a diabetic hand syndrome prevalence ranging from 20 to 54% (13,14). Hand ulceration and infection in diabetic patients was first described in the United States in 1977 and in Africa in 1984 (11,15).The term "tropical diabetic hand syndrome" (TDHS) has been used to describe diabetes among patients who presented to the diabetes clinic with hand cellulitis, ulceration, gangrene, or fulminant hand sepsis (3,16).Jailil and coll. reviewed all the admissions with hand infection from January 2006-April 2010 in China. Thirty-seven patients were found with associated diabetes mellitus (7).

Abbas and colleagues reported 72 patients with TDHS case who met this definition, 61% had type 2 diabetes, 14% had peripheral neuropathy, and only one patient had evidence of peripheral vascular disease from Tanzania (16). Hand infections are also seen in the diabetic population outside the tropical regions like Turkey. The most frequently bacteria observed in diabetic hand infections are often polymicrobial, containing gram positive, gram negative and enteric anaerobic organisms (17). Our results are in accordance with other studies since we isolated gram negative organisms in five patients, four of them had *E.Coli* in our study.

Gill et al. reported risk factors for tropical diabetic hand syndrome as; poor diabetic control and/or compliance, low socio-economic status, hand trauma (often trivial), delay in treatment, female sex, local herbal remedies, ambient humidity (18). Ince et al. report that peripheral neuropathy, ESRD, and HbA1c levels greater than 10% at the time of admission were determined as poor prognosis criteria for diabetic hand treatment (19).

In our study four patients had a trauma history. Mean HbA1c levels 7.9% (5.8-9.8), indicates

poorly controlled diabetes. Compared with a predominance of women with diabetic hand ulcers in Africa (17), in our study, the number of patients is not enough to say that (4 male, 3 female patients). The most frequent comorbidity of diabetic hand was hypertension in Nthumba et al. such as our study (20).

In case series reported 35-39% of diabetic hand infection required amputation (8,15). Aydın et al. who implements HBO treatment only two amputations were required patients in a series of 10 patients. HBO treatment is added to the routine treatment of diabetic hand infection in our study, may have led to lower this rate (amputation required only in two patients) (21). It is also noteworthy that patients with finger amputation, receive only one session of HBO treatment.

Recent reports from western countries show an increase from less than 5% in 1970 to more than 10% in 1999 in the incidence of diabetes in patients who require a hospital admission for significant hand infection. Recent reports in Africa seem to show a frequency of more than 3% in patients attending a diabetic clinic more common than in a Western country (13).

Ince et al. study reported that amputation rate was significantly more common in individuals with end stage kidney failure with arterial calcification and arteriovenous shunts, which may cause

circulation problems in the hands and lead to amputation of the upper extremities because of gangrene (19).

Two of seven patients with dialysis due to kidney failure, diabetic hand infections is remarkable developing on the side of the hemodialysis fistula. According to our study we need to be careful in terms of diabetic hand infections in diabetic patients with hemodialysis fistula. Hemodialysis-associated stealing syndrome should be kept in mind in hand infections, especially in diabetic patients with dialysis catheters.

Outcomes in the diabetic hand infections are complicated because of the lack of classification of the lesions. The variability of the therapeutic outcomes from one study to another can be due to different clinical aspects and various therapeutic strategies.

As diabetic foot infections, multidisciplinary approach is required to manage hand infections.

Conservative treatments; such as blood glucose regulation, infection treatment, debridement and fistula revision, if there is a dialysis fistula, should be performed rather than amputation (22). HBO treatment may be beneficial in selected cases such as those with compromised arterial circulation of upper extremity or with necrotizing progressive infection.

REFERENCES

1. Okpe IO, Amaefule KE, Dahiru IL, Lawal Y, Adeleye AO, Bello-Ovosi B. Tropical diabetic hand syndrome among diabetic patients attending endocrine clinic of Ahmadu Bello University Teaching Hospital, Shika Zaria, North Central Nigeria. *Sub-Saharan Afr J Med* 2016; 3: 106–10.
2. Yeika EV, Tanchou JCT, Foryoung JB, Tolefac PN, Efe DT, Choukem SP. Tropical diabetic hand syndrome: a case report. *BMC Res Notes* 2017; 10: 94
3. Okpara TC, Ezeala-Adikaibe BA, Omire O, Nwonye E, Maluze J. Tropical Diabetic Hand Syndrome. *Ann Med Health Sci Res* 2015; 5(6): 473-5.
4. Fitzgibbons PG, Wiess AP. Hand manifestations of diabetes mellitus. *J Hand Surg* 2008; 33(5): 771-5.
5. Gonzalez MH, Bochar S, Novotny J, Brown A, Weinzeig N, Prieto J. Upper extremity infections in patients with diabetes mellitus. *J Hand Surg* 1999; 24(4): 682-6.
6. Jude EB, Eleftheriadou I, Tentolouris N. Peripheral arterial disease in diabetes -A review. *Diabet Med* 2010; 27(1): 4-14.
7. Jalil A, Barlaan P, Fung B, Ip JW. Hand infection in diabetic patients. *Hand Surgery* 2011; 16(3): 307-12.
8. Betotmane A, Faraoun K, Mohhamedi F, Benkhelifa T, Amani ME. Infections of the upper extremity in hospitalized diabetic patients, a prospective study. *Diabetes Metab* 2004; 30(1): 91-7.
9. Kranke P, Bennett MH, Martyn-St JM, Schnabel A, Debus SE. Hyperbaric oxygen therapy for chronic wounds. *Cochrane Database Syst Rev*; 2012; doi: 10.1002/14651858.CD004123.pub3.
10. Wang C, Lv L, Wen X, Chen D, Cen S, Huang H et al. A clinical analysis of diabetic patients with hand ulcer in a diabetic foot centre. *Diabet Med* 2010; 27(7): 848-51.

11. Akintewe TA, Akanji AO, Odunsan O. Hand and foot ulcers in Nigerian diabetics – a comparative study. *Trop Geogr Med* 1983; 35(4): 353–5.
12. Unachukwu C, Babatunde S, Ihekwa AE. Diabetes, hand and/or foot ulcers: a cross-sectional hospital-based study in Port Harcourt, Nigeria. *Diabetes Res Clin Pract* 2007; 75(2): 148–52.
13. Smith LL, Burnet SP, McNeil JD. Musculoskeletal manifestations of diabetes mellitus. *British J Sports Medicine* 2003; 37(1): 30–5.
14. Arkkila PET, Kantola IM, Viikari JSA. Dupuytren's disease: association with chronic diabetic complications. *J Rheumatol* 1997; 24(1):153–9.
15. Mann RJ, Peacock JM. Hand infections in patients with diabetes mellitus. *J Trauma* 1977; 17(5): 376–80.
16. Abbas ZG, Luule J, Gill GV, Archibald LK. Tropical diabetic hand syndrome: risk factors in an adult diabetes population, Tanzania. *Int J Infect Dis* 2001; 5(1); 19-23.
17. Kour AK, Looi KP, Phone MH, Pho RWH. Hand infections in patient with diabetes. *Clin Orthop Relat Res* 1996; 331:238-44.
18. Gill GV, Famuyiwa OO, RolfeM , Archibald LK. Serious hand sepsis and diabetes mellitus: specific tropical syndrome with Western counterparts. *Diabet Med* 1998; 15(10): 858–62.
19. Ince B, Dadaci M, Arslan A, Altuntas Z, Evrenos MK, Karsli MF. Factors determining poor prognostic outcomes following diabetic hand infections. *Pak J Med Sci* 2015; 31(3): 532-7.
20. Nthumba P, Cavadas PC, Landin L. The tropical diabetic hand syndrome A surgical perspective. *Ann Plast Surg* 2013; 70(1): 42-6.
21. Aydın F, Kaya A, Savran A, İncesu M, Karakuzu C, Öztürk AM. Diabetic hand infections and hyperbaric oxygen therapy. *Acta OrthopTraumatol Turc* 2014; 48(6): 649-54.
22. Öztürk AM, Uysal S, Yıldırım Şımşır I, Hüngör H, Işıkgöz Taşbakan M. Hand infection in patients with diabetes: a series of 17 cases and a pooled analysis of the literature. *Turk J Med Sci* 2018; 48(2): 372-7.

Corresponding author

Elif Ebru ÖZER (Uzm.Dr.)
Department of Underwater and Hyperbaric Medicine, University of Health
Sciences Bozyaka Education and Research Hospital
35170 İzmir, Turkey
Phone: +905067021482
E-mail: elifebruozzer@yahoo.com
ORCID: 0000-0001-5832-2844

Günalp UZUN (Uzm.Dr.) ORCID: 0000-0002-8717-6230