ULOGA HIPERBARIČNE OKSIGENOTERAPIJE U LEČENJU PROGRESIVNE INFEKCIJE STOPALA KOD PACIJENTA OBOLELOG OD *DIABETES MELLITUS-a DE NOVO* – Prikaz slučaja

PRIKAZ SLUČAJA

CASE REPORT

THE ROLE OF HYPERBARIC OXYGEN THERAPY IN TREATING PROGRESSIVE INFECTION OF THE FOOT IN A NEWLY DIAGNOSED DIABETES MELLITUS PATIENT – Case report

Dragana Danilović[1], Jelena Milošević[1], Predrag Brkić[2]

[1] Specijalna bolnica za hiperbaričnu medicinu, Beograd, Srbija

[2] Univerzitet u Beogradu, Medicinski fakultet, Institut za medicinsku fiziologiju „Rihard Burijan", Beograd, Srbija

[1] *Special Hospital for Hyperbaric Medicine, Belgrade, Serbia*

[2] *University of Belgrade, Faculty of Medicine, Institute of Medical Physiology "Richard Burian", Belgrade, Serbia*

SAŽETAK

Uvod: Hiperbarična oksigenoterapija (HBOT) predstavlja terapijsku i dijagnostičku metodu u kojoj pacijent udiše 100% molekulski kiseonik pod pritiskom većim od jedne apsolutne atmosfere (ATA) u hiperbaričnim komorama. *Diabetes mellitus* je heterogena grupa poremećaja metabolizma koji se manifestuju povišenjem nivoa glukoze u krvi, a uzrokovani su ili nedovoljnim lučenjem ili neadekvatnom funkcijom insulina. Dijabetesno stopalo je najčešća hronična komplikacija *diabetes mellitus*-a.

Prikaz slučaja: Predstavljamo slučaj pedesettrogodišnjeg pacijenta koji je upućen u našu ustanovu radi sprovođenja hiperbarične oksigenoterapije zbog vlažne gangrene i flegmone desnog stopala. Pacijent, novootkriveni dijabetičar, hospitalizovan je u tercijarnoj ustanovi gde je učinjena hirurška obrada rane. Uvedena je adekvatna antibiotska, antiagregaciona i insulinska terapija, radi što bolje glikoregulacije. Učinjen je rendgen (RTG) snimak desnog stopala kojim je verifikovano prisustvo gasa u mekotkivnim strukturama. S obzirom na lokalni nalaz sa progresijom i propagacijom infekcije put proksimalno, uz prisustvo gasa, odmah je započeta hiperbarična oksigenoterapija po hitnom protokolu, u cilju pokušaja spasavanja ekstremiteta. Nakon sprovedenih 30 hiperbaričnih oksigenoterapija, lokalni nalaz je bio znatno bolji, bez ugroženosti ekstremiteta.

Zaključak: Bilo kakav nedostatak u kontinuitetu kože, imunitetu i vaskularizaciji može se smatrati faktorom rizika za razvoj flegmone kod dijabetičara. Dijabetesno stopalo je posledica neuroishemijskih promena, koje se povremeno komplikuju dodatnom infekcijom. Prema preporukama Desete evropske konsenzus konferencije hiperbarične medicine, indikacije za primenu hiperbarične oksigenoterapije su klasifikovane prema jačini dokaza, a upravo za pomenutu patologiju postoji visok nivo saglasnosti. Prikazom ovog slučaja želeli smo da pokažemo da je moguće uspešno sanirati teške infekcije dijabetesnog stopala primenom hiperbarične oksigenoterapije, uz multidisciplinarni pristup.

Ključne reči: HBOT, dijabetesno stopalo, flegmona, gasna gangrena

ABSTRACT

Introduction: Hyperbaric oxygen therapy (HBOT) is a therapeutic and diagnostic method wherein the patient breathes 100% oxygen gas at a pressure of more than one atmosphere absolute (ATA) in a hyperbaric chamber. Diabetes mellitus is a heterogenous group of metabolic disorders which manifest as elevated blood glucose levels resulting from either insufficient insulin secretion or an abnormality in insulin action. Diabetic foot is the most common chronic complication of diabetes mellitus.

Case report: We present the case of a fifty-three-year-old patient referred to our hospital for the purpose of receiving hyperbaric oxygen therapy due to wet gangrene and phlegmon of the right foot. The patient was newly diagnosed with diabetes. He was hospitalized at a tertiary healthcare institution where his wound was surgically treated. Appropriate antibiotic, antiaggregation, and insulin therapy was introduced for the purpose of achieving the best possible degree of glucoregulation. An X-ray of the right foot was performed verifying the presence of soft tissue gas. Due to the local finding on the foot, the progression and the propagation of the infection proximally, with the presence of gas, hyperbaric oxygen therapy was introduced immediately, according to the emergency protocol, for the purpose of saving the limb. After 30 hyperbaric oxygen therapy sessions, the local finding was significantly improved, and the limb was no longer in danger.

Conclusion: Any abnormality in the continuity of the skin, immunity, and vascularization may be considered a risk factor for the development of phlegmon in patients with diabetes. Diabetic foot is the consequence of neuroischemic changes, which occasionally become complicated with further infection. According to the Tenth European Consensus Conference on Hyperbaric Medicine recommendations, indications for the application of hyperbaric oxygen therapy are classified according to the strength of evidence, and there is a high level of consensus for the above-described pathology. With this case presentation we wanted to demonstrate that it is possible to resolve severe infections in diabetic foot through the application of hyperbaric oxygen therapy, with the implementation of a multidisciplinary approach.

Key words: HBOT, diabetic foot, phlegmon, gas gangrene

Autor za korespondenciju:
Dragana Danilović
Specijalna bolnica za hiperbaričnu medicinu
Mačkov kamen 24 a, 11000 Beograd, Srbija
Elektronska adresa: draganica16@gmail.com

Corresponding author:
Dragana Danilović
Special Hospital for Hyperbaric Medicine
24 a Mačkov kamen Street, 11000 Belgrade, Serbia
E-mail: draganica16@gmail.com

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UVOD

Hiperbarična oksigenoterapija (HBOT) predstavlja terapijsku i dijagnostičku metodu u kojoj pacijent udiše 100% molekulski kiseonik pod pritiskom većim od jedne apsolutne atmosfere (ATA) u hiperbaričnim komorama [1]. Diabetes mellitus je heterogena grupa poremećaja metabolizma koji se manifestuju povišenjem nivoa glukoze u krvi, a uzrokovani su ili nedovoljnim lučenjem ili neadekvatnom funkcijom insulina [2]. Hiperbarična oksigenacija je danas široko prihvaćena terapijska metoda, koja se primenjuje u terapiji niza kliničkih stanja, kao što su: komplikacije dijabetesa, hronične nezarastajuće rane, opekotine, rezistentne bakterijske infekcije, kompartment sindrom, kompromitovani graftovi, intrakranijalni abscesi, radijacione povrede, refraktorni osteomijelitis i okluzija *arteriae centralis retinae* [3,4]. Dijabetesno stopalo je najčešća hronična komplikacija *diabetes mellitus*-a. Pod dijabetesnim stopalom se podrazumevaju promene koje nastaju međusobnim delovanjem dijabetesne neuropatije i angiopatije. Klinički se manifestuje u vidu ulceracija (sa infekcijom ili bez nje), tipičnog deformiteta stopala, hroničnog otoka, ishemičnih promena, pa sve do nastanka nekroze i gangrene, koje mogu posledično dovesti do amputacije, koja je značajni uzročnik morbiditeta i invalidnosti u populaciji obolelih od *diabetes mellitus*-a [5]. U 80% amputacija, prethodila je ulkusna bolest stopala [6].

Cilj ovog prikaza jeste da se pokaže kako multidisciplinarni pristup u lečenju dijabetesnog stopala, uz primenu hiperbarične oksigenoterapije, može da sačuva ekstremitet, čime se izbegava amputacija dela ili celog ekstremiteta.

PRIKAZ SLUČAJA

Pacijent star 53 godine hitno je upućen u našu ustanovu radi sprovođenja hiperbarične oksigenoterapije, zbog vlažne gangrene i flegmone desnog stopala. Prethodnog dana je hospitalizovan kao hitan slučaj u tercijarnoj ustanovi u Beogradu. Pacijent je bio novootkriveni dijabetičar. Na prijemu je utvrđena vrednost glikemije od 23 mmol/L, te je odmah uvedena insulinska terapija od strane endokrinologa. Pacijent se žalio na malaksalost, pojačanu žeđ i povišenu temperaturu, do 39 °C. Naveo je i da je deset dana pre prijema zadobio žulj na prvom prstu desnog stopala, zbog nošenja neadekvatne obuće. Izmeren je arterijski krvni pritisak od 130/75 mmHg, dok su vrednosti za C-reaktivni protein i leukocite iznosile CRP = 267, Le = 15 x 10^9/L.

U lokalnom nalazu utvrđeno je da je desno stopalo bilo otečeno, crveno, bolno, povišene lokalne temperature, sa znacima flegmone i sa dve ulkusne promene. Jedna promena je bila na dorzalnom delu prvog prsta, a druga je bila sa medijalne strane stopala u nivou glavi-

INTRODUCTION

Hyperbaric oxygen therapy (HBOT) is a therapeutic and diagnostic method wherein the patient breathes 100% oxygen gas at a pressure of more than one atmosphere absolute (ATA) in a hyperbaric chamber [1]. Diabetes mellitus is a heterogenous group of metabolic disorders which manifest as elevated blood glucose levels resulting from either insufficient insulin secretion or an abnormality in insulin action [2]. Presently, hyperbaric oxygen therapy is a widely accepted therapeutic method applied in the treatment of a series of clinical conditions, such as the following: diabetes complications, chronic non-healing wounds, burns, resistant bacterial infections, compartment syndrome, compromised grafts, intracranial abscesses, radiation injuries, refractory osteomyelitis, and occlusion of the central retinal artery [3,4]. Diabetic foot is the most common chronic complication of diabetes mellitus. Diabetic foot involves changes that occur as the result of the interaction of diabetic neuropathy and angiopathy. It clinically manifests in the form of ulcerations (with or without infection), typical foot deformity, chronic swelling, ischemic changes, and may even progress to necrosis and gangrene, consequently leading to possible amputation, which is a significant cause of morbidity and invalidity in the population of diabetes mellitus patients [5]. Foot ulcer disease precedes 80% of amputations [6].

Our goal was to demonstrate that the implementation of a multidisciplinary approach in the treatment of diabetic foot, with the application of HBOT, may preserve the patient's limb, thereby avoiding amputation of a part or of the entire limb.

CASE REPORT

A fifty-three-year-old patient was urgently refereed to our hospital for hyperbaric oxygen therapy, due to wet gangrene and phlegmon of the right foot. He had been admitted to hospital on the previous day at a tertiary healthcare institution in Belgrade. The patient was newly diagnosed with diabetes. At hospital admission, his glucose blood level was 23 mmol/L, which is why insulin therapy was immediately prescribed by an endocrinologist. The patient complained of general malaise, increased thirst, and he reported a fever of 39 °C. He also reported developing a blister on the big toe of his right foot, after wearing ill-fitting shoes. An arterial blood pressure of 130/75 mmHg was registered, his level of C-reactive protein (CRP) was CRP = 267, while his leukocyte count was Le = 15 x 10^9/L.

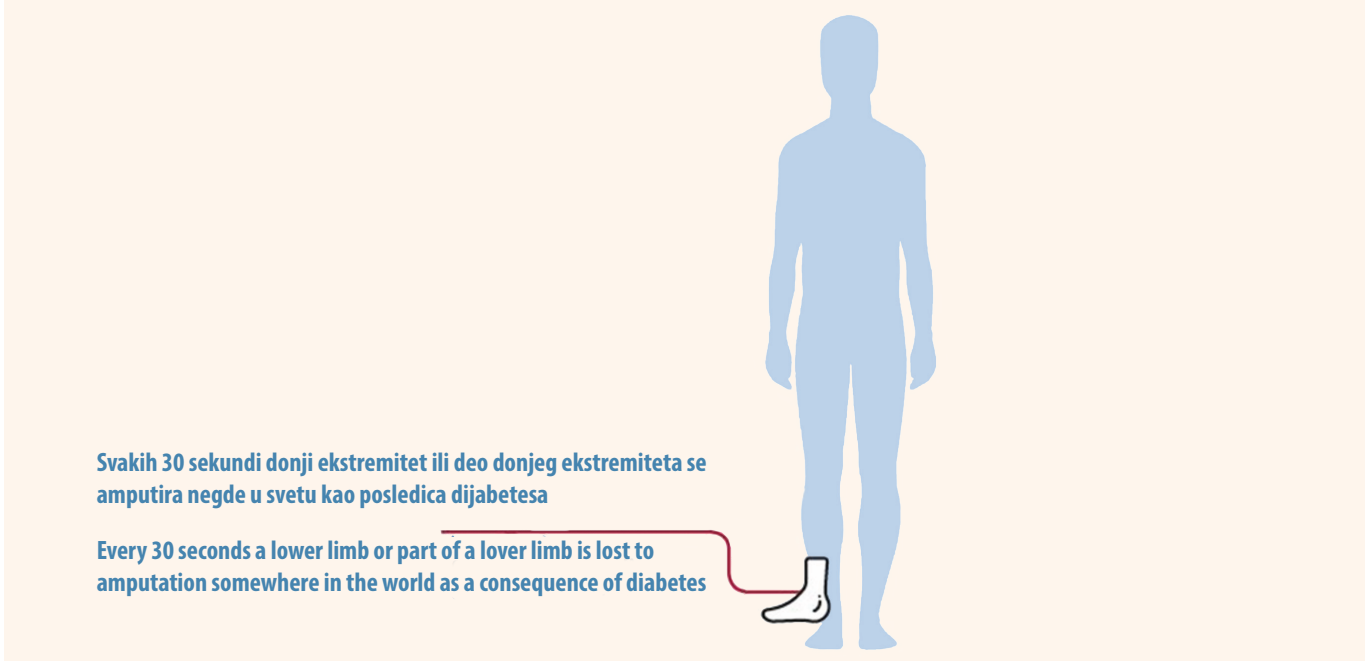
The local finding revealed that the right foot was swollen, red, painful, with elevated local temperature, signs of phlegmon and with two ulcerous lesions. One of the lesions was on the dorsal aspect of the big toe,

ce prve metatarzalne (MT) kosti. Pritiskom od skočnog zgloba (*TLC*), (lat. *articulatio talocruralis – ATC*) put distalno dobijena je obilna količina gnoja neprijatnog, putridnog mirisa. Učinjena je neophodna hirurška obrada rane (lateralna i dorzalna incizija u cilju drenaže gnojnog sadržaja) i ordinirana je antibiotska terapija (*ceftriakson* 2 g, i.m.; *amikacin* 500 mg, 2x1 i.m.; *metronidazol* 3 x 400 mg). RTG snimak stopala dao je sledeći nalaz: osteoliza proksimalne i distalne falange prvog prsta i rasvetljenje u mekotkivnim strukturama stopala – gas. S obzirom na lokalni nalaz, godine pacijenta, komplikacije osnovnog oboljenja i tešku infekciju desnog stopala uz prisustvo gasa, odmah je uključen u program hiperbarične oksigenacije po hitnom protokolu. HBO terapija je sprovedena u višemesnoj *HAUX* komori pri pritisku od 2,8 ATA, po 90 minuta, na 8 sati (5 terapija), a zatim je pacijent preveden na terapijski protokol od 2,5 ATA, po 70 minuta, svakodnevno. Sprovedeno je ukupno 30 HBO terapija, uz redovno previjanje i praćenje od strane lekara Specijalne bolnice za hiperbaričnu medicinu. Na otpustu, lokalni nalaz je bio znatno poboljšan i pokazivao je ulcere ispunjene čistim granulacionim tkivom, bez znakova infekcije u fazi sanacije. Pacijent je redovno kontrolisan u našoj ustanovi do potpune sanacije promena, uz savet o strogoj kontroli glikemije i nošenju adekvatne obuće.

DISKUSIJA

Prema podacima Međunarodne dijabetičke federacije (*International Diabetes Federation – IDF*), amputacija kod osoba obolelih od dijabetesa je 10 do 20 puta češća nego kod pacijenata koji nisu oboleli od dijabetesa [7].

while the other one was located on the medial aspect of the foot, at the level of the head of the first metatarsal (MT) bone. As the result of pressure applied from the ankle (talocrural joint – TLC) and directed distally, a large quantity of foul, putrid smelling puss exuded from the ulcers. The necessary surgical treatment of the wound was performed (lateral and dorsal incision for the purpose of draining the puss) and antibiotic therapy was prescribed (ceftriaxone 2 g, i.m.; amikacin 500 mg, 2x1 i.m.; metronidazole 3 x 400 mg). Radiography of the foot revealed the following finding: osteolysis of the proximal distal phalange of the big toe and gas in the soft tissue of the foot – light zones on the X-ray image. Bearing in mind the local finding, the age of the patient, the complications of the underlying disease, and the severe infection of the right foot with the presence of gas, the patient was immediately put on the HBOT program, according to the emergency protocol. HBO therapy was carried out in the multiplace HAUX hyperbaric chamber, at a pressure of 2.8 ATA, lasting 90 minutes, every 8 hours (5 treatments), upon which the therapeutic protocol of 2.5 ATA, for 70 minutes, daily, was applied in the patient. A total of 30 HBO treatments was carried out, with regular changes of the wound dressing and regular follow-up by the doctors of the Special Hospital for Hyperbaric Medicine. At hospital discharge, the local finding was significantly improved and showed that the ulcers were filled out with pure granulation tissue, with no signs of infection in the healing phase. Patient follow-up was carried out regularly at our hospital until the lesions fully healed,



Slika 1. Slika preuzeta sa https://www.idf.org/ ouractivities/careprevention/diabetic-foot.html

Figure 1. Figure taken from: https://www.idf.org/ouractivities/careprevention/diabetic-foot.html

Pojava ulceracija na stopalu, zatim nastanak gangrene i posledične amputacije su značajni uzroci morbiditeta i invalidnosti kod obolelih od dijabetesa.

Procenjuje se da, usled komplikacija dijabetesa, na svakih 30 sekundi neko, negde u svetu, izgubi donji ekstremitet ili deo donjeg ekstremiteta [7], (Slika 1).

Primenom hiperbarične oksigenoterapije, zaustavlja se i redukuje obim i progresija infektivnog procesa i potreba za dodatnim hirurškim intervencijama i amputacijama (Slika 2).

Prikazom ovog slučaja želeli smo da pokažemo da je moguće uspešno sačuvati ekstremitet kod progresivne gasne infekcije dijabetesnog stopala, pravovremenim uključivanjem pacijenata u program HBO tre-

while the patient was advised on strictly monitoring his blood glucose level and wearing appropriate footwear.

DISCUSSION

According to the data of the International Diabetes Federation (IDF), amputation in people with diabetes is 10 to 20 times more common than in people without diabetes [7]. The development of ulcerations on the foot, gangrene development, and consequent amputation are causes of morbidity and invalidity in patients suffering from diabetes.

It is estimated that every 30 seconds a lower limb or part of a lower limb is lost somewhere in the world as a consequence of diabetes complications [7], (Figure 1).

Slika 2 – A, B, C, D, E, F. Lokalni nalaz na početku, u toku i na kraju HBO terapije

Figure 2 – A, B, C, D, E, F. Local finding in the beginning, during and at the end of HBO therapy

tmana, uz konsultaciju i saradnju sa svim specijalistima uključenim u dijagnostiku i terapiju, kako osnovne metaboličke bolesti, tako i posledičnog stanja.

SPISAK SKRAĆENICA

HBOT – hiperbarična oksigenoterapija
ATA - apsolutna atmosfera
CRP – C-reaktivni protein
Le – leukociti
IDF - Međunarodna dijabetička federacija (engl. International Diabetes Federation)
MT – metatarzalna
TLC – talokruralni
RTG – rendgen

Sukob interesa: Nije prijavljen.

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The application of hyperbaric oxygen therapy stops and reduces the scope and progression of the infection process as well as the need for additional surgical treatment and amputation (Figure 2).

With this case presentation we aim to demonstrate that it is possible to successfully preserve a limb affected by progressive gas-forming infection of the diabetic foot with timely inclusion of the patient into the program of HBO therapy, with consultations and cooperation amongst all the specialists involved in the diagnostics and treatment of both the underlying disease and the condition resulting from it.

LIST OF ACRONYMS

HBOT – hyperbaric oxygen therapy
ATA – atmosphere absolute
CRP – C-reactive protein
Le – leukocytes
IDF - International Diabetes Federation
MT – metatarsal
TLC – talocrural

Conflict of interest: None declared.