HBO and gas gangrene
A case report

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A 58-year old man, in a mediocre health condition, was admitted into Landspíttalaín Fossvogur, the University of Reykjavik City Hospital, Iceland, because of fever, chills, local pain and swelling due to the presence of a big old wound in his left heel. The first clinical appearance showed a gas gangrene of the area. The patient immediately underwent a surgical debridement and a fasciotomy, and antibiotic intravenous therapy and hyperbaric oxygen therapy (HBOT) were started. During the treatment the patient suffered for a multi-organ failure syndrome (MOPS), was admitted in ICU and survived. A total of 52 HBO sessions were performed and one month since the admission into the hospital the patient received a skin transplant. He achieved a complete restituto ad integrum after 78 days of hospitalization. Gas gangrene is a fulminating infection caused by the genus of Clostridia. If not treated, it leads to the death of the host. The actual treatment for gas gangrene includes surgery, antibiotics, general resuscitative measures and HBO.

Key words: Gas gangrene, therapy - Gas gangrene, etiology - Clostridium infections - Clostridium perfringens - Hyperbaric oxygenation.

Gas gangrene is an uncommon, severe disease caused by anaerobic spore forming bacteria of the group Clostridium, such as Clostridium perfringens (also called Clostridium welchii),1 or other classes of Clostridia. The annual incidence reported in the United States of America is about 1000 new cases.2

The a. report their experience about a serious case of gas gangrene, treated at the Service of Hyperbaric Medicine of Landspíttalaín Fossvogur, the University of Reykjavik City Hospital, Iceland.

Case report

A 58-year old man, heavy smoker with a history of diabetes mellitus, was admitted into the hospital at the beginning of January 1999 because of the presence of a big wound of unknown origin in his left heel, which has been getting worse for several weeks. The day the patient was hospitalized, he was complaining about fever, chills, and local pain and swelling.
lower left external malleolus. Its measures were about 12x8 cm.

Blood tests showed an hemoglobin of 115g/l, the hematocrite was 0.35 L/L, platelets count 174x10⁹/L, ESR 100 mm/hour (normal laboratory range <15 mm/hour), WB cells count 12.6x10⁹/L, with differential of 10.42x10⁹/L neutrocytes, 0.89x10⁹/L lymphocytes, 0.99x10⁹/L monocytes, RB cells count 4.24x10¹²/L, creatinine 103 µmol/L, glucose 17.3 mmol/L, sodium 133 mmol/L, potassium 3.6 mmol/L. Neither the hepatic nor the urinary functions have been investigated at the admission.

The first clinical appearance showed a gas gangrene of the area involved by the wound. Immediately afterward the patient underwent a surgical debridement (Figs. 1 and 2) and a fasciotomy (Fig. 3), and was then recovered in the intensive care unit for antibiotic i.v. therapy (clindamycin 600 mg t.i.d. and gentamicin 360 mg per day).

Few hours after the first acute treatment the Service of Hyperbaric Medicine was involved as well. The patient was treated at 2.8 ATA for 90 minutes, twice for the first day (see below). The day after the first HBOT sessions, the patient developed renal failure,
As it is possible to understand the main pathogen in the genesis of gas gangrene is the *Clostridium perfringens*, with about the 95% of the infections. This bacterium is not a strict anaerobe and it can, actually, freely grow in oxygen tension up to 30 mmHg and in a restrict manner in oxygen tension up to 70 mmHg.

The presence of two different conditions are necessary for the onset of gas gangrene: clostridial spores and an area where the oxidation-reduction potential is low, due to a vascular accident with muscular necrosis. This let the spore grow and transform themselves in vegetative form with production of exotoxins.

*Clostridium perfringens* produces about 20 different types of exotoxins, the principal of which are listed below:

- alpha-toxin;
- theta-toxin;
- kappa-toxin;
- mu-toxin;
- nu-toxin;
- fibrinolysin;
- neuroaminidase;
- circulation factor;
- bursting factor.

The most important is the alpha-toxin that causes: jaundice, anemia, hemoglobinuria, hemolysis, tissue necrosis, renal failure. It is also cardiotoxic and could damage the brain. All the other toxins have a synergistic function.

The alpha-toxin is a lecithinase type C.
The actual treatment for gas gangrene includes surgery, antibiotics, general resuscitative measures and HBOT. Before the routine use of HBOT for gas gangrene, the main treatment was surgical. The main point was: “debride, excise and amputate as generous as possible and as soon as possible”. In any case the mortality rate was very high (20-55%).

The patients who survived very often were enrolled in long physical rehabilitation programs with a poor quality of life.

Brummelkamp and Boerema brought into use HBOT for gas gangrene in 1960. The first approach to the disease is surgical: an immediate debridement is requested to let all the necrotic material flowing out. A fasciotomy must be performed as well with the purpose to decompress the interested compartment. After the surgical procedure, the patient is treated with HBOT. The effect of hyperbaric oxygen is to inhibit the growth of Clostridium and the production and release of the alpha-toxin. The production of alpha-toxin is stopped by an oxygen tension of 250 mmHg, which does not kill the bacteria but is bacteriostatic. At 3 ATA the oxygen tension is 300 mmHg that is the best compromise between the oxygen ability of stopping the clostridial growing and the risk of oxygen poisoning. HBOT does not affect the free-circulating toxins, but promotes a quick detoxification by the normal host factor.

Furthermore, hyperbaric oxygen is able to increase the aspecific immune response promoting phagocytes killing and adhesion of leukocytes to the vascular endothelium. HBO therapy increase the ability of polymorphonuclear cells to destroy their ingested pathogens.

Considering the majority of a., the minimum amount of HBO sessions requested in order to achieve a good response should be 3 sessions for 90 minutes at 2.8-3 ATA in the first 24 hours, followed by a session at the same depth and for the same time, twice a day, for the next 4-5 days.

Experimental studies animal models showed that this protocol reduced the mortality and the morbidity after Clostridium...
infections. Moreover, it is important to administer HBO as soon as possible, because when it is delayed the results decline progressively. The prompt use of HBO drastically reduces the rate of amputations and the request for major surgery. HBO is able to demark the affected tissues from the healthy tissues, giving the surgeon the possibility of a controlled demolition.

Various a. showed a big reduction of the rate of amputation after HBO introduction as a routine treatment, when related with the traditional use of surgery and antibiotics.\(^\text{11}\)

Conclusions

The use of HBO is always indicated in all myositis and myonecrosis induced by Clostridia, because it is tissue-, limb- and life-saving. Patients with a suspect of clostridial infection must be immediately transferred to a hospital with a hyperbaric facility, where HBO must be administered as soon as possible, after the first surgical debridement, possible fasciotomy and antibiotics.

Riassunto

Ossigenoterapia iperbarica e gangrena gassosa

Un paziente di 58 anni, in mediocri condizioni di salute, è stato ricoverato al Landspitalin Fossvogur, City Hospital dell’Università di Reykjavik, Islanda, in seguito alla comparsa di febbre, tremore, dolore locale e sudorazione causati da una ferita molto estesa, di vecchia data, al calcagno sinistro. Un primo esame clinico condotto sulla lesione ha evidenziato una gangrena gassosa. Il paziente è stato immediatamente sottoposto a teletta chirurgica della lesione ed a fasciotomia, e fu subito iniziata una terapia antibiotica endovenosa ed iperbarica con ossigeno (HBO). Durante il trattamento, il paziente è andato incontro ad una sindrome da insufficienza funzionale multiorgano (MOFS), alla quale è sopravvenuto dopo il ricovero in un’unità di terapia intensiva. Sono state praticate un totale di 52 sessioni di HBO e ad un mese dal suo ricovero, il paziente è stato sottoposto ad un trapianto di cute. Il paziente è andato incontro ad una completa restitutio ad integrum dopo 78 giorni di ricovero. La gangrena gassosa è un’infezione fulminante causata dal genere Clostridium, che, se non trattata, provoca il decesso. L’attuale terapia della gangrena gassosa comprende la chirurgia, la terapia antibiotica, misure generali di rianimazione e la HBO.

Parole chiave: Gangrena gassosa, terapia - Clostridium perfringens - Medicina iperbarica - Ossigenoterapia - Camera iperbarica.

References