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CASE REPORT
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Thromboembolism treatment and preparation for osseointegrated prosthesis implantation with hyperbaric oxygen therapy in a cat

Treatment of Tromboembolism and Preparation for an Osseointegrated Prothesis Fixation with Hyperbaric Oxygen Therapy in a Kitten

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ABSTRACT

Background: Ischemic neuromyopathy is the most common reason for amputation in cats. In veterinary medicine, the use of prosthetic limbs is not widespread; therefore, in most cases total limb amputation is indicated. However, hyperbaric oxygen therapy (HBOT) is an alternative with several benefits for the treatment of vascular disorders with reperfusion, ischemia, and infection. Therefore, this study aimed to report the positive effects of HBOT on the treatment of ischemic neuromyopathy secondary to arterial thromboembolism on the patient's clinical improvement, and on the preparation of the patient for insertion of an osseointegrated prosthesis.

Case: A 6-month-old mixed-breed kitten returned for treatment after undergoing surgery seven days earlier for reduction of traumatic diaphragmatic hernia, during which it suffered a cardiorespiratory arrest. The patient presented with acute pelvic limb paralysis with 24-h evolution, absent femoral pulse, plantar cushions and dorsal part of the limbs cold and pale. After supportive therapy and diagnosis of aortic thromboembolism by arterial Doppler, the patient started adjunc tive treatment with HBOT from the first day of hospitalization. Sessions took place in an exclusive hyperbaric chamber for animals and lasted 60 min at a pressure of 2.5 absolute atmospheres and 100% oxygen, initially every 12 h. However, during the first 5 days of hospitalization, the distal region of both pelvic limbs began to show tissue devitalization and edema, and hematologic parameters showed changes on the 7th day. The right pelvic limb (RPL) showed more involve ment of superficial tissues, extending to the tarsometatarsal joint region. After 8 days of hospitalization, the devitalized tissue was debrided. The RPL had an extensive devitalized area with exposed bone in the phalanges and necrosis in the pads. The left pelvic limb (LPL) suffered minor complications, with involvement of the phalangeal region. After 12 days, with HBOT every 48 h, exuberant granulation tissue was observed. After 17 days, the patient was discharged, and HBOT sessions were performed weekly. Gangrene of the midfoot and lack of proprioception were observed in RPL, while LPL showed bone divulsion of the 1st, 3rd, and 4th phalanges. Because of the poor prognosis for limb viability, the RPL was partially amputated, and a self-threaded intraosseous prosthesis was inserted.

Discussion: The cardiorespiratory arrest that occurred during the surgical procedure to reduce the diaphragmatic hernia with out thromboprophylaxis may have contributed to the peripheral ischemia. HBOT was proposed for the adjuvant treatment of ischemic injury because it is especially indicated for cases of ischemia-reperfusion injury. The main hematological parameters were evaluated at an average interval of 7 days. While the platelet count and hematocrit increased, the leukocytosis decreased.
This demonstrates the benefit of oxygen therapy in the reported patient. The use of HBOT in orthopedic injuries is known to result mainly in stimulation of osteoblasts, promoting osseointegration of the prosthesis. We conclude that the adjuvant treatment with HBOT helped to preserve a large segment of both pelvic limbs, prevent the progression of necrosis, and pro vide a healthy bed for fixation of an osseointegrated prosthesis in the RPL, resulting in clinical improvement of the patient.

Keywords: surgery, cat, implant, therapy, thromboembolism.

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INTRODUCTION

The causes that lead to non-viability of limbs in dogs and cats are diverse. Among them, car accidents, trauma, extensive fractures or bone neoplasms and, in many cases, amputation becomes the option that will guarantee a better quality of life for the animal [8].

In cats, ischemic neuromyopathy is the disease that most commonly leads to amputation [3]. This condition is considered serious and is characterized when a thrombus breaks loose and, through the circulation, settles in the aortic trifurcation, compromising the blood supply of the pelvic limbs. Thus, uni or bilateral paresis/paralysis occurs, with decrease or absence of reflexes, cold extremities and decrease or absence of femoral artery pulse [10].

In medicine, the use of prosthetic limbs is widespread. However, in veterinary medicine, because it is a procedure that requires specialized material, difficult to access and high cost, in most cases, the choice is made for total amputation of the limb when indicated [4]. However, hyperbaric oxygen therapy (HBO) is an alternative with several benefits for the treatment of vascular disorders involving reperfusion, ischemia and infection [12].

There are no reports of the association of HBO as a form of preparation for the implantation of an osseointegrated prosthesis in animals, especially those affected by thromboembolism. Thus, the objective of the study is to report the advantages provided by HBOT in the treatment of ischemic neuromyopathy secondary to arterial thromboembolism, in the clinical improvement and in the preparation of a patient who received osseointegrated implant.

CASE

A 6-month-old mixed breed female cat returned for care after being submitted, 7 days before, to surgery to reduce a traumatic diaphragmatic hernia, in which she suffered a cardiorespiratory arrest during the procedure. The patient was lying down with acute paralysis of the pelvic limbs, with a 24-hour evolution of absent femoral pulse, plantar pads and dorsal part of the limbs cold and pale.

After supportive therapy and diagnosis of aortic thromboembolism defined by arterial Doppler, the patient began to receive adjuvant treatment with HBOT from the first day of hospitalization.

The sessions took place in an exclusive hyperbaric chamber for animals [HVM-H1®] 1 (Figure 1 A) lasting 60 min, at 2.5 absolute atmospheres (ATA) of pressure (1.5 ATA of the hyperbaric chamber plus 1 ATA environment) and 100% oxygen initially every 12 h. The previously stipulated protocol consisted of 15 min of pressurization until reaching the desired pressure in stages (one third of the therapy pressure every 5 min).

Once the therapy pressure was reached, the patient remained inside for the stipulated time (60 min), and after this period, the pressure was reduced in stages, for 15 min, until equalization with the ambient atmospheric pressure.

However, the distal region of both pelvic limbs began to show tissue devitalization and edema in the first 5 days of hospitalization (Figure 1 B & C) as well as the hematological parameters showed changes on the 7th day of evolution (Figure 2) . The right pelvic limb (RPL) showed greater involvement of the superficial tissues, extending to the region of the tarsometatarsal joint. He also presented intense edema in the phalangeal regions.

On the 8th day of hospitalization, we opted for debridement of the devitalized tissues. The MPD showed an extensive devitalized area, with bone exposure in the phalanges region and necrosis in the cushion region. The left pelvic limb (LEP) suffered minor complications, with involvement of the phalanges region. Following evolution, after 12 days, now with HBOT every 48 hours, the patient presented exuberant granulation tissue.

As an aid to the investigation of vascularized areas, a thermographic (FLIR model E2-Thermacam®)2 was used , which showed absence of temperature in the MPD in the metatarsal region and a decrease in temperature in the distal ends of both pelvic limbs (Figure 3).

At 17 days, the patient was discharged and the HBOT sessions started to be done weekly.

MPD evolves to gangrene in the metatarsal region and lack of proprioception, while MPE has 3rd and 4th phalanges tou bone divulsion of the 1st, (Figure 4).

Due to the unfavorable prognosis of limb viability, we opted for partial amputation of the MPD and application of a self-threaded intraosseous prosthesis.

After a skin and subcutaneous incision in the region of the tarsometatarsal joint and muscle divulsion, the remaining bones and phalanges were removed. Next, the calcaneal region was leveled and drilled

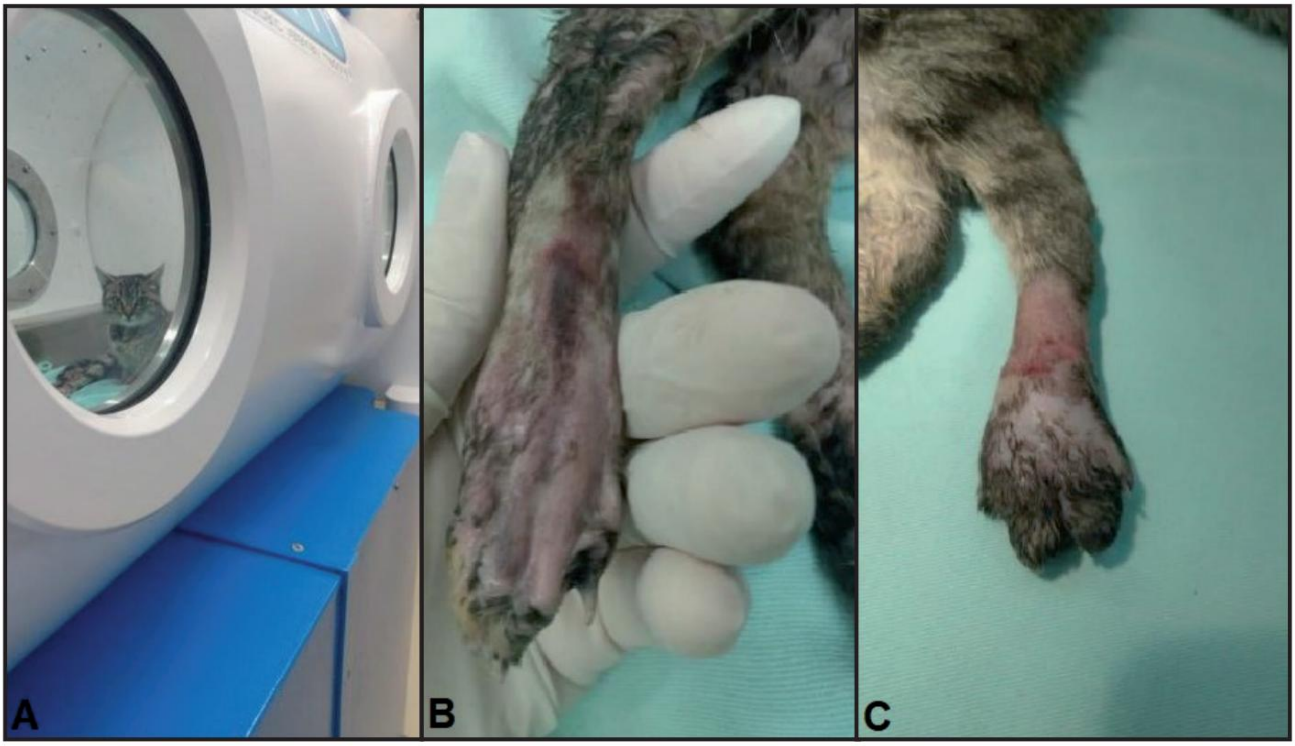

Figure 1. A- Patient inside the hyperbaric chamber (HVM model H1 - veterinary hyperbaric chamber). B- MPD lesion on the 5th day of clinical evolution. C- EPM lesion on the 5th day of clinical evolution.

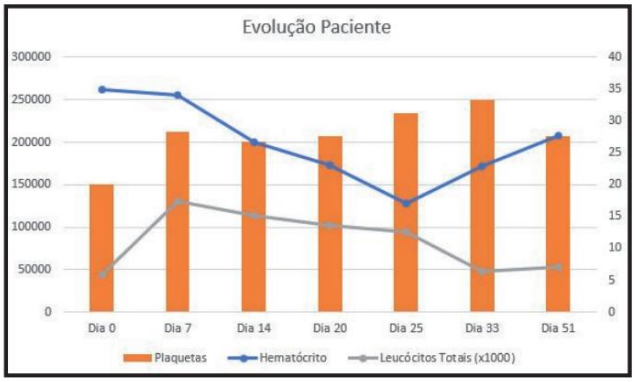

Figure 2. Graph showing the evolution of the patient's hematological parameters.

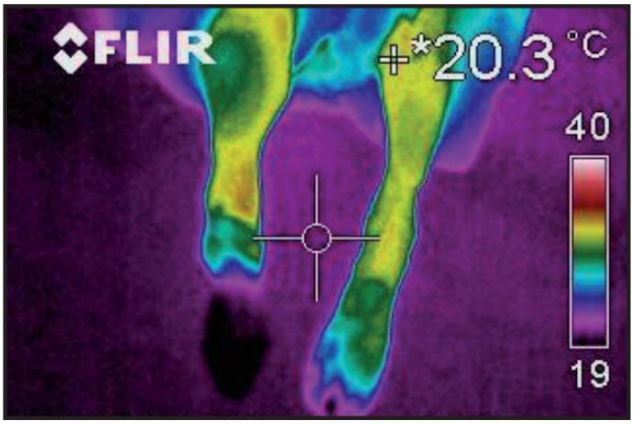

Figure 3. Image of the pelvic limbs generated by a thermograph (FLIR model E2-Thermacam), observe the absence of temperature at the end of the MPD.

Figure 4. Pelvic limbs on the 34th day of clinical evolution, observe the presence of granulation tissue in both limbs (A) and (B).

the central region of the bone with a 2 mm orthopedic drill (Medical Dog Orthopedic Drill)3 and orthopedic drill (Stryker System 6®) 4 , enlarged with a 2.7 mm orthopedic drill (Medical Dog Orthopedic Drill)2 and the self-implant fixation was performed titanium threaded, custom-made for the patient. Finally, a screw was applied to the external prosthesis of the osseointegrated implant, completing the implantation (Figure 5).

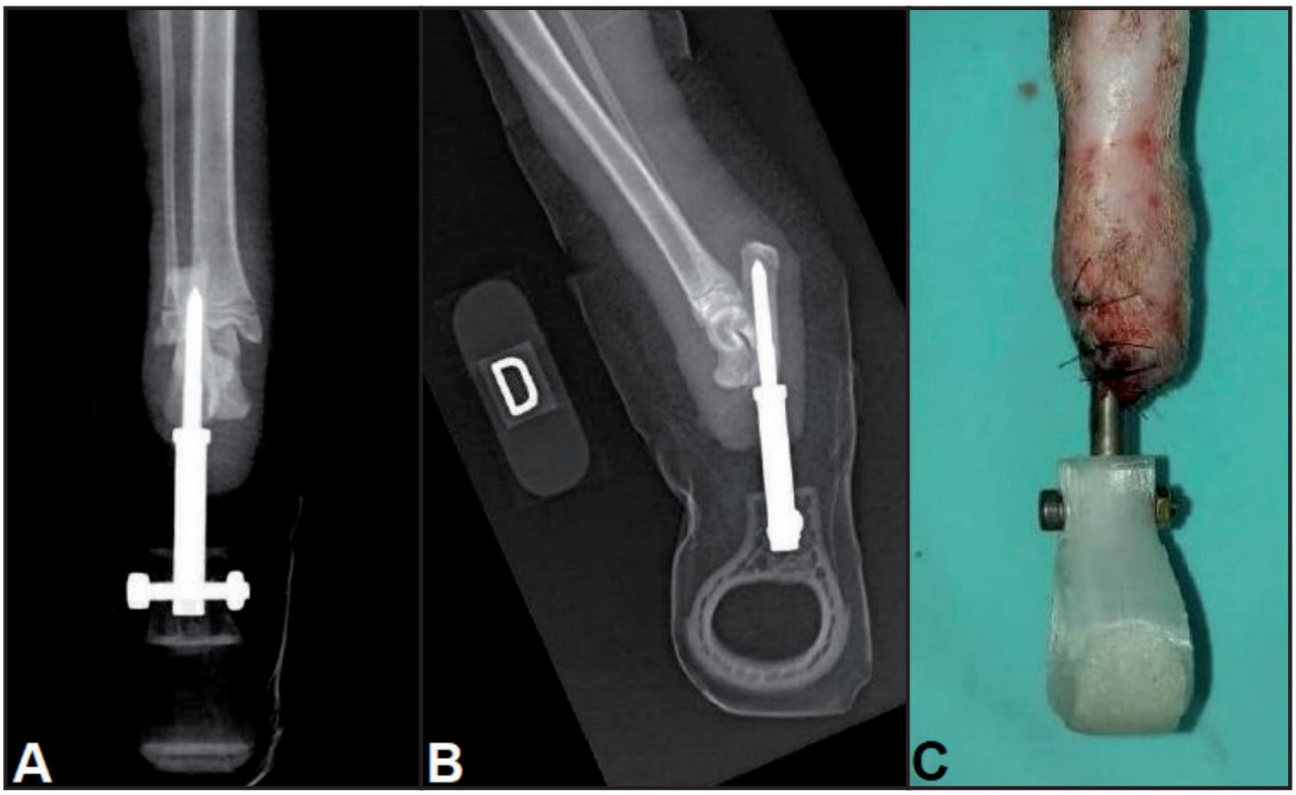

Figure 5. A- Osseointegrated prosthesis applied to the MPD, craniocaudal radiographic image of the immediate postoperative period. B- Mediolateral radiographic image of the immediate postoperative period. C- Frontal image of the immediate postoperative period.

Table 1. Therapeutic protocol used per day of hospitalization.

	Day of Hospitalization				
Procedure	1	2-32	32-38	38	40-44
Hospitalization, diagnosis, clinical treatment, HBOT1 X					
OHB1 every 24 h		X			
OHB1 every 48 h			X		X
Application of the prosthesis2				X	
hospital discharge				X	

1 45 min of daily session under 2.5 absolute atmospheres (ATA) of pressure (1.5 ATA of the hyperbaric chamber plus 1 ATA of the environment). 2 Procedure performed immediately after hyperbaric oxygen therapy (HBOT).

DISCUSSION

Ischemic neuromyopathy secondary to arterial thromboembolism in cats is a major clinical challenge. The cardiorespiratory arrest that occurred during the surgical procedure for the reduction of the diaphragmatic hernia, in which the patient was submitted, may have contributed to the peripheral ischemia, since the formation of thrombi is favored by the abrupt reduction and prolonged circulation, and by not performing thromboprophylaxis [6]. However, other causes such as senility and pre-existing diseases such as hypertrophic cardiomyopathy [3,6] do not apply to this patient, which may have contributed to the favorable prognosis.

In addition, the patient was diagnosed and stabilized in the first hours, which favored the success of the case. Unlike other results described in

literature [5,10,11], it was possible to preserve the MPE almost entirely and the MPD with partial amputation followed by osseointegrated implantation.

For the adjuvant treatment of ischemic injury, HBOT has been proposed. This is especially indicated for the treatment of complicated wounds, promoting acceleration of local growth factors [9], in addition to being effective as an auxiliary therapy in combating edema and accelerating healing [1]. In the lesions resulting from tissue necrosis, excellent granulation tissue and revived edges were observed after the HBOT sessions, corroborating previous results [7].

The main hematological parameters (hematocrit, platelets and total leukocytes) were evaluated with an average interval of 7 days, starting with the diagnosis of thromboembolism. It was possible to observe that the platelet count increased and the leukocytosis decreased, both starting on the 7th day. Hematocrit initially showed a decrease followed by an increase after 33 days of treatment.

Complete clinical improvement of the patient can be observed on the 51st day of evolution (Figure 2). According to some authors [2], it is known that HBOT does not result in significant alterations in the blood count, however, the improvement in hematological parameters may be indirectly related to the early association of HBOT in the treatment of ischemic neuromyopathy, as patients with anemia and leukocytosis are beneficiaries to undergo HBOT [1].

Evident benefits of oxygen therapy were observed in the reported patient, mainly in relation to inflamed and infected tissues, which contributed to the reduction of leukocytosis. Hyperbaric therapy enhances the activity of polymorphonuclear neutrophils and immunomodulation, acting on anaerobic bacteria susceptible to free radicals [12].

Anemia results in decreased delivery of oxygen to tissues. However, the good results observed are due to the fact that HBOT is highly recommended in the treatment of reperfusion syndrome, ischemia and/or infection. The increase in oxygen pressure between tissues helps in angiogenesis, an important action for ischemic injuries [12]. In injuries or diseases in which oxygen transport is compromised, HBOT stimulates local cell growth factors and induces the release of stem cells from the bone marrow [9]. Furthermore, when the body is debilitated, the demand for oxygen is high, in contrast to the transport capacity, which is reduced, leading the body to collapse, generating oxidative stress [14].

As for the benefit in preparing the bone bed to receive the osseointegrated prosthesis, it is known that the use of HBOT in orthopedic injuries results in stimulation of osteoblasts, improved biomineralization, increased formation of bone nodules, deposition of calcium and phosphatase activity. alkaline [13], helping in the osseointegration process.

The adjuvant HBOT treatment helped to preserve a large segment of both pelvic limbs, preventing the progression of necrosis and providing a healthy bed for the implantation of the osseointegrated prosthesis in the MPD, culminating in the clinical improvement of the patient.

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