The early performance of hyperbaric oxygen therapy in the treatment of bothrops snakebite in a Chihuahua dog – Report Case

La realización temprana de oxigenoterapia hiperbárica en el tratamiento de mordedura de serpiente botrops en un perro Chihuahua - Reporte de caso

A atuação precoce da oxigenoterapia hiperbárica no tratamento de acidente ofídico com botrops em um cão Chihuahua- Relato de Caso

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RESUMEN. Las serpientes venenosas que con mayor frecuencia afectan a los animales domésticos en Brasil son del género Bothrops, debido a su curioso comportamiento, el perro es más susceptible a estos accidentes. El pronóstico para los animales envenenados puede ser variable. Este artículo reporta el diagnóstico y abordaje terapéutico en el caso de una mordedura de serpiente Botrophs, asociado al tratamiento convencional, oxigenoterapia hiperbárica temprana, en un perro adulto, Chiuaua, con un peso de 3 kg. Se administraron sueros polivalentes, ceftriaxona, prednisolona, tramadol y sesiones de oxigenoterapia hiperbárica. Después de la tercera sesión hiperbárica el edema remitió completamente, sin necrosis por picadura de jararaca. Se concluyó que el uso temprano de la oxigenoterapia hiperbárica, asociada al tratamiento convencional en este informe, demostró ser una herramienta diferencial en el tratamiento de emergencia de las mordeduras de serpiente, superando las expectativas, justificando su indicación primaria en tales situaciones.

Palabras clave: mordedura de serpiente, necrosis, oxígeno, tratamiento.

RESUMO. As serpentes peçonhentas que com maior frequência acometem animais domésticos no Brasil são do gênero *Bothrops*, devido ao seu comportamento curioso, o cão, está mais susceptível a estes acidentes. O prognóstico dos animais envenenados pode ser variável. O presente artigo relata o diagnóstico e a conduta terapêutica em caso de picada

de serpente *Botrophs*, associando-se ao tratamento convêncional, a oxigenoterapia hiperbárica de forma precoce, em uma cadela, Chiuaua, adulta, com 3Kg. Foi realizado soro polivalente, ceftriaxona, prednisolona, tramadol e sessões de oxigenoterapia hiperbárica. Após a realização da terceira sessão hiperbárica, averigou-se a total remissão do edema, não ocorrendo necrose decorrente da picada de jararaca. Concluiu-se que o uso do oxigenoterapia hiperbárica de forma precoce, associada ao tratamento convencional neste relato, demonstrou ser ferramenta diferencial no tratamento emergencial de acidentes ofídicos, suplantando as expectativas, justificando sua primária indicação em tais situações.

Palavras chave: ofidismo, necrose, oxigênio, tratamento

ABSTRACT. The venomous snakes that most frequently affect domestic animals in Brazil are of the Bothrops genus, due to their curious behavior, the dog, is more susceptible to these accidents. The prognosis of poisoned animals can vary. The present article reports the diagnosis and the therapeutic conduct in case of Botrophs snake bite, associated with the conventional treatment in an early way, hyperbaric oxygen therapy, in a dog, female, Chiuaua, adult, with 3Kg. Polyvalent serum, ceftriaxone, prednisolone, tramadol and hyperbaric oxygen therapy treatments were performed. After the third hyperbaric treatment, the complete remission of the edema was verified, with no necrosis resulting from the bite of the jararaca. It was concluded that the early use of hyperbaric oxygen therapy associated with conventional treatment in this report, proved to be a differential tool in the emergency treatment of snakebites, surpassing expectations, justifying its primary indication in such situations.

Keywords: snakebite, necrosis, oxygen, treatment

INTRODUCTION

FUNASA, (2001), defines venomous animals as individuals that have venom-producing glands, associated with specialized mechanisms for inoculating the same, and/or toxic substances, exemplified by spiders, scorpions, caterpillars, bees and snakes.

CHIPPAUX, (1998), lists that there are around 3,000 cataloged snake species in the world, with 10 to 14% of this total considered venomous or poisonous. In Brazil, FERNANDES et al., (2008), adds that approximately 256 species have been recorded, 70 of which are considered venomous and divided into four groups.

BRASIL, (2005), details that in humans in Brazil, snakes of the Bothrops genus are responsible for 87.5% of all snakebites reported in the country, followed by crotalic (9.2%), lachetic (2.7%) and elapid (0.6%), with small variations according to the region and geographic distribution of the snakes.

BARNI et al., (2012), point out that in veterinary medicine, statistics regarding the occurrence of snakebite accidents are not reliable because there is no obligation to report them; despite this, BICUDO, (2003), states that companion animals are frequent victims of poisoning by venomous attacks.

SAKATE, (2002), attributes the high susceptibility of dogs to such accidents to the inherent curious behavior of the species, and his thesis is reinforced by PUZZI et al., (2008), when he attributes the snout as the anatomical region most affected in snake attacks on domestic animals.

GOMES, (2008), describes that it is rare to accurately identify the species of snake involved in these occurrences, initially because the owner is not present, and when eventually captured and taken to the veterinarian, the snakes are dead or often mutilated, making their recognition difficult.

MELGAREJO, (2009), details that the Bothops genus comprises more than 60 species of snakes, distributed from northern Mexico to southern Argentina, but several species were redistributed into seven other genera; in Brazil these snakes have different designs, colors and sizes, having in common the loreal pit, the smooth end of the tail, being solenoglyphous, ovoviviparous and with very aggressive behavior, and can be found throughout the national territory.

FRANÇA and MÁLAQUE, (2009), report that Bothrops venom has more than 20 different components, of which more than 90% of its dry weight is proteins, including

enzymes, non-enzymatic toxins and non-toxic proteins, also presenting carbohydrates, lipids, metals, biogenic amines, nucleotides and free amino acids, ROCHA and FURTADO, (2005), add that there are factors that will directly interfere in this composition, such as the age of the snake, its geographic location, as well as individual characteristics of the aggressor.

BLANCO and MELO, (2014), divide the pathophysiological activities of this type of venom into four groups, namely, proteolytic, coagulant/anticoagulant, vasculotoxic and nephrotoxic.

MELO, et al., (2004), confer proteolytic activity, also known as necrotic or acute inflammatory, being caused by several components, including high concentrations of proteolytic enzymes and by indirect action in the induction or release of autacoids such as bradykinin, prostaglandins, leukotrienes and prostacyclins.

BLANCO and MELO, (2014), confer the potentiation of the acute local inflammatory process, the coagulant activity of the venom, leading to the formation of thrombi in the microvasculature, which are responsible for tissue hypoxia and consequent worsening of edema and tissue necrosis.

SAKATE (2008), attributes the rapid absorption and dispersion of the venom between animal tissues to the presence of the enzyme hyaluronidase in its primary composition.

BLANCO and MELO, (2014), attribute its coagulant activity to several compounds such as the activation of blood coagulation factors (fibrinogen, prothrombin and factor X), occurring isolatedly or simultaneously, converting fibrinogen into unstable fibrin, resulting in an increase in coagulation time or making it incoagulable.

FERREIRA JÚNIOR and BARRAVIERA, (2004), describe the formation of microclots, triggering a case of disseminated intravascular coagulation (DIC) in the affected individual.

DALLEGRAVE and SEBBEN, (2008), attribute its systemic vasculotoxic activity to metalloproteinases, a group of enzymes that contain zinc in their structure, called hemorrhagins, which disrupt vascular integrity by degrading components of the extracellular matrix and their nephrotoxic effect, resulting from the direct action of the venom on the renal tubules and vascular endothelium, progressing to acute renal failure as a predictable sequelae for the patient.

LUCIANO et al., (2009), classify the severity of accidents with Bothrops, based on the symptoms observed (Table 1).

Table 1. Classification of botropic accidents according to severity

Manifestations	Mild	Moderate	Severe
Local: Pain, edema, ecchymosis	Absent or discreet	Evident	Intense
Systemic: Severe bleeding, shock and anuria	Absent	Absent	Present
Coagulation Time - TC	Normal or changed	Normal or changed	Normal or changed

Source: Adapted from Luciano et al., (2009).

SILVA et al., (2016), characterize the majority of accidents caused by snakes of the Bothrops genus in domestic animals as having clinical signs associated with local edema, bruising, pain, prostration and hemorrhage at the site of the bite.

BERROCAL et al., (1998) consider that the clinical condition will depend on the animal's sensitivity to the venom, the amount of venom injected, the time elapsed since the accident and the affected area.

MENDEZ; RIET-CORREA, (1995), add that in the case of a regional sting to the snout, the reaction may cause severe edema, affecting the lower jaw, neck and thoracic region, causing obstruction of the upper respiratory tract, dyspnea, respiratory failure and glottis edema.

There is a consensus that the efficiency of the treatment depends on the specificity and timeliness of the antivenom administered, associated with intense fluid therapy, colloid replacement, analgesics, diuretics and systemic antibiotics; the CFMB, (1995), in its list of indications for hyperbaric therapy, includes snakebite accidents.

ODUNAYO (2019) proposes that the dose of antivenom serum be one (01) vial per patient; but suggests that patients with lower body weight may require larger doses.

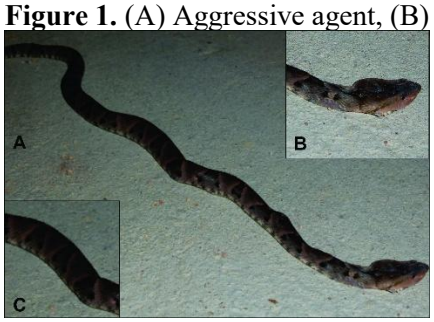
The last decades represented a period of strong expansion of veterinary hyperbaric services (MAZZI, 2020), with therapy resulting from a series of physiological and pharmacological mechanisms (THOM, 2009), and based on events in classical physics (BRASWEEL and CROWE, 2012); defined by SBMH (2018), as the inhalation of 100% oxygen with purity greater than 99%, concomitantly subjecting the patient to an increase in the pressure inside the hermetic hyperbaric chamber.

The aim of this case report was to describe the early addition of hyperbaric oxygen therapy to the conventional treatment of a dog that was a victim of Bothrops envenomation and to evaluate the condition and remission of symptoms during the treatment performed.

MATERIALS AND METHODS

A female Chihuahua dog, 6 years old, weighing 3 kg, was treated at a veterinary clinic. The owner reported that he witnessed the patient being attacked by a snake, managing to capture and photograph the animal (Figure 1). The victim quickly developed intense edema in the snout region, presenting agitation and difficulty breathing, and was immediately sent to the veterinary clinic.

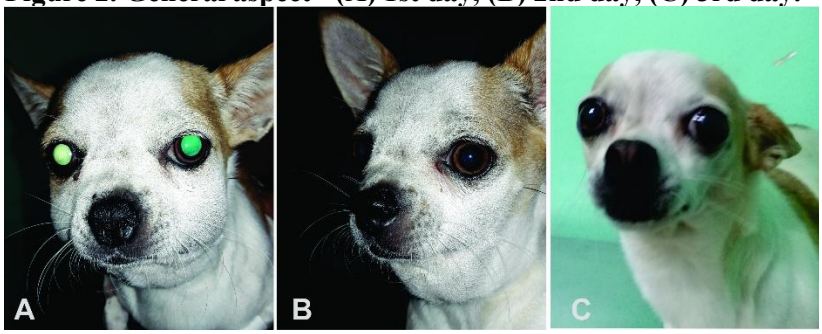
Figure 1. (A) Aggressive agent, (B) Head anatomy, (C) Standard drawings.



Source: Mazzi & Veiga, 2024.

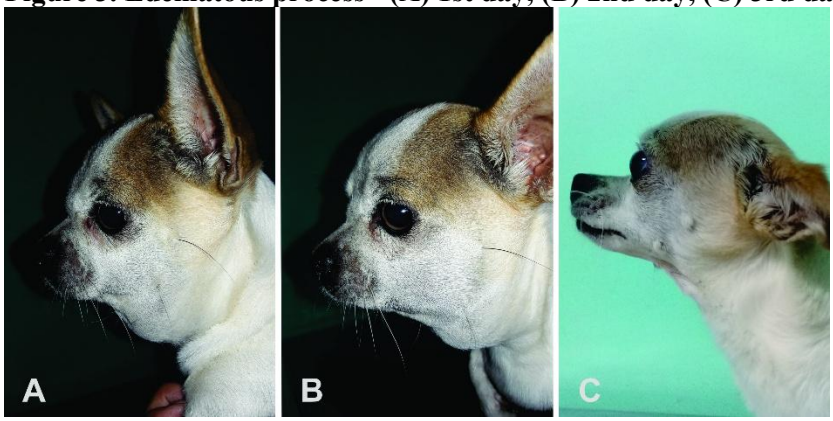
The attacking agent was identified as belonging to the Bothrops genus, its exact species was not identified. The clinical examination revealed the presence of 2 symmetrical perforations on the victim's snout, marked edema on the face and ventral cervical region, inspiratory dyspnea with tachypnea and tachycardia, bilateral mydriasis, body temperature of 39.8ºC and other parameters within physiological standards. Venous access was performed for fluid therapy with 0.9% sodium chloride saline solution, administration of prednisolone 0.5mg/kg, tramadol hydrochloride (2 mg/kg), ceftriaxone (25mg/kg) and polyvalent antivenom (30ml). No changes were observed in the blood clotting time test. After the patient started urinating, she was referred to hyperbaric treatment, where each lasted a total of 90 minutes, at a depth of 43 feet of sea water, therefore at 2.3 ATA, without the need for sedation, daily, for a total of three tratments, with a photographic record being filed at each session and the general appearance (Figure 2) and specific facial edematous process and its expectation of necrosis (Figure 3) being assessed.

Figure 2. General aspect - (A) 1st day, (B) 2nd day, (C) 3rd day.



Source: Mazzi & Veiga, 2024.

Figure 3. Edematous process - (A) 1st day, (B) 2nd day, (C) 3rd day.



Source: Mazzi & Veiga, 2024.

RESULTS

On clinical examination, the dyspneic, tachycardic and mydriatic symptoms resolved after the first session.

After the second hyperbaric treatment, the generalized edema of the face regressed, being restricted to the submandibular and ventral cervical regions. The patient presented normal eating of pasty food, active urination and subjective sensitivity in the muzzle region.

After the patient's 3rd pressurization, the edematous process reduced completely, and the patient was kept under observation and antibiotic therapy for another 2 days. She was normal and had no necrotic process or renal sequelae from the attack. She was released (Figure 4).

Figure 4. Patient in the hyperbaric chamber.



Source: Mazzi & Veiga, 2024.

DISCUSSION

It is undisputed that poisoning caused by snakes is an important problem in Human and Veterinary Medicine, due to its high incidence, severity and sequelae to those affected who always require urgent care.

SOARES et al., (2005), postulates that the only scientifically proven treatment for snake bites would be antivenom; but highlights as limiting factors the early initiation of treatment and the specificity of the serum, as well as the uncertainty of the occurrence of the accident and the exact species of the attacker, basing the treatment on the symptoms expressed by the patient, on suggestive laboratory tests or guided by clinical and epidemiological criteria. In the occurrence analyzed, there was a witnessing at the time of the attack and the careful preservation of the attacker, making it possible to verify the veracity of the fact and the identification of the variety of venom involved as being of the genus Bothrops; resulting in the maximum early and specific initiation of treatment.

FUNASA, (2001), confers a seasonality of snakebite accidents, based on climatic factors and the intensification of human activity in agriculture, attributing the highest rates of these accidents to the period between September and March; PINHO et al., (2004), corroborate this, attributing to the greater rainfall and temperature, extending the period of greatest snakebite cases until the month of April. The incident analyzed occurred in the second half of April, being at the limit of convergence with the literature.

TOKARNIA and PEIXOTO, (2006), correlate geographical aspects and snakebites, where virgin forests are home to 80% of non-venomous snakes and 20% of venomous ones, diametrically opposed, rural areas that have suffered human action have shown an inversion of 80% of venomous snakes to 20% of non-venomous ones; DALLEGRAVE and SEBBEN, (2008), corroborate this by stating that the disorderly advance of cities over less populated areas has led to the finding of bothops snakes on the outskirts of large centers, previously restricted to rural areas. This scenario of environmental degradation with subsequent urbanization is in perfect congruence with the habitat of the victim in this case report, which is the peripheral area of the federal capital of Brazil.

SAKATE, (2002), and PUZZI et al., (2008), attribute to the canine species an inherent curious behavior, which would lead to the greater involvement of the snout region in snakebites. The anatomical location evaluated in this case converges with such teachings.

The parameters of the clinical symptoms presented by the patient were the basis for classifying the severity of the incident, based on the scale proposed by LUCIANO et al., (2009), thus considered moderate to severe.

From the symptomatology developed by snake victims, a mosaic of variables is presented in the literature, with different sensitivity variations to botropic venom by certain species, in the individual peculiarities of the composition of the venom, varying between individuals of the same genus, resulting from the particular diet of each snake, but mainly varying through the amount of poison inoculated in the victim, a fact of impossible determination, as highlighted by BICUDO, (2003) and corroborated in this report.

Singularly, the accident's promoter had been immediately identified as belonging to the botrops species; the formation of the conjecture about its genus was based primarily on MELGAREJO (2003), when describing the central-west region of Brazil as the habitat with the highest incidence of the genera B. Moojeni and B. Neuwiedii; in the analysis of the image of the snake, an adult-looking specimen was revealed; correlating this fact to the teachings of OLIVEIRA et al, (2003), there was the absence of coagulation disorders in this accident, the differential property of incoagulability evaluated in the specific accidents with smaller snakes as the author proclaims; the intense swelling in the victim's snout area converged to that proposed by SGARBI et al, (1995), when it attributes to the genus B. Moojeni the ability to cause edema with greater intensity when compared to the genus B. Neuwiedii, justifying in this way that the aggressor agent in this case, was an individual botrops, adult, genus B. Moojeni.

From the main characteristic of the effects of botropic poison, the outstanding necrotizing proteolytic action was attributed by SAKATE (2002), to the direct cytotoxic action, causing a local reaction with pain, edema, congestion, hemorrhage and necrosis. In this case report, the evolution of symptoms diverged from that presented in the vast literature, with no proteolytic action of the poison, nor tissue necrosis in the areas adjacent to the attack, the absence of coagulation disturbances accentuated the observations of MO et al., (2018), when testifying its efficiency, having as its only differential the conventional treatment, the advent of hyperbaric oxygen therapy.

In analyzing the rapid regression of the edematous condition established in this case report, such efficiency converged with that proposed by MO et al., (2018), when describing the anti-edema effect of hyperbaric therapy in snakebite accidents.

MUKUNDAN et al., (2016), proposes that in humans, a minimum of six (06) hyperbaric sessions would be the tangible protocol to obtain a reduction in ophidian edema, in this case report a 50% reduction in the time of the protocol proposed by this author was observed; the discrepancy found reinforces the theory of different levels of response and sensitivity between species subjected to treatment with hyperbaric oxygen therapy.

ODUNAYO (2019), argues that the antivenom dosage protocol is 1 vial/patient, but suggests that larger doses may be necessary for individuals with small body mass. In this report, the standard protocol was maintained, despite the patient's 3 kg body mass.

The decision to incorporate hyperbaric oxygen therapy into this treatment protocol was based on KORAMBAYIL et al., (2015), LACERDA et al., (2006), who confer antimicrobial properties to this therapy through the direct action of hyperoxia on bacteria, and describe relative hypoxia as the effect responsible for stimulating neovascularization and tissue hyperoxygenation; further reinforced by MORAIS et al., (2008), in the understanding that in the face of vasculitis of venomous etiology, the vital break in the vicious cycle of the schemia would occur through the restoration of capillary angiogenesis promoted by hyperbaric oxygen.

Despite the considerable volume of literature produced and available in both human and veterinary medicine worldwide, addressing the issue of the undeniable benefits of hyperbaric oxygen therapy as a treatment for necrotic wounds caused by snakebites, and which is a subject that has been largely controversial, since it is part of the guideline of the main global regulatory entities for the activity, the innovative nature of this approach stands out, not focused on the notorious capacity for scar stimulation, but rather on the early use of HBOT in snakebite accidents, preventing the progression of such accidents to

predictable necrotic conditions; thus supporting future reviews on the choice of the appropriate clinical moment to opt for and establish this therapy.

Considering the high incidence of snakebites in both humans and animals worldwide, the relevance and severity that such cases represent, additional studies on the efficacy of early hyperbaric oxygen therapy for this clinical condition are necessary and urgent.

CONCLUSION

In this case report, the early initiation of hyperbaric oxygen therapy proved to be a differential tool in the emergency treatment of snakebite with Bothrops jararaca, effectively combating edema and preventing progression to tissue necrosis, exceeding expectations in such a situation.

CONFLICT OF INTEREST

The [1]author is an unpaid scientific consultant for BlueOcean- Hyperbaric Chambers, Colombia. There are no conflicts of interest to disclose.

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