



## Case Report

## Photodynamic therapy in the treatment of cutaneous habronemosis in a horse: Case report



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## ABSTRACT

*Habronema muscae* is a parasitic nematode that causes habronemiasis in horses, leading to chronic skin lesions. The parasite is transmitted via flies, and larvae deposited in wounds result in difficult-to-heal “summer sores”. This case study involved treating a 9-year-old gelding male horse with recurrent habronemiasis using photodynamic therapy (PDT) concurrent with conventional treatments. The horse presented with ulcerated, exudative wounds on its limbs and face, unresponsive to traditional treatments. PDT was applied over six months, using methylene blue (MB) as a photosensitizer, combined with LED irradiation. Additionally, an ivermectin-based ointment and other healing agents were used. The results showed a reduction in lesion size after two months, complete healing of the thoracic wounds by month four, and facial wound healing after six months. In this case, PDT was an effective adjunct treatment for managing habronemiasis.

## 1. Introduction

*Habronema muscae* is a parasitic nematode that affects horses, particularly in tropical and subtropical regions, where its intermediate hosts—flies of the genera *Musca* and *Stomoxys*—are prevalent. The parasite’s life cycle involves two hosts: horses as definitive hosts and flies as intermediate hosts. Larvae (L1) are passed in feces and ingested by fly larvae, where they develop into infective third-stage larvae (L3). These L3 larvae are transmitted to horses when flies land on wounds or mucous membranes. If ingested, the larvae complete their development in the stomach. However, if L3 larvae are deposited in skin wounds or mucous membranes, such as the conjunctiva, they do not complete their cycle and provoke a local inflammatory response, with lesions known as cutaneous habronemiasis [1,2].

These lesions are characterized by chronic inflammation, ulceration, pruritus, and in severe cases, delayed healing and severe discomfort. Commonly affected areas include the limbs, face, and ventral body. Traditional treatment often involves antiparasitic drugs and wound management, but recurrences are common, especially in endemic areas [1,3].

Photodynamic therapy (PDT) has emerged as a promising alternative treatment. It combines a photosensitizer (PS), a specific wavelength light source, and molecular oxygen to generate reactive oxygen species (ROS), leading to cell death. Methylene blue (MB), a phenothiazine dye, is a widely used PS due to its strong oxidative potential, low toxicity, and hydrophilic properties, which enhance tissue penetration [4–6]. This study aimed to report a clinical case of cutaneous habronemiasis in a horse and to evaluate its treatment with methylene blue-mediated photodynamic therapy.

## 2. Clinical case description

## 2.1. Ethical approval

The owner provided authorization for the treatment by signing the free and informed consent form. The study protocol was approved by UNIVAP Animal Care and Use Committee (Approval number, A12/CEUA2024; approved on December 11, 2024).

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## 2.2. Case report

A gelding male horse of unknown breed, 9 years old, was examined for presenting wounds in the distal region of the right and left thoracic limbs. The lesions measured approximately 15 cm in diameter. The case were presented by the owner at the equestrian center where the horse is currently stabled. These lesions were exudative, with exuberant granulation tissue, ulcerated, and had serosanguineous secretion. A histopathological examination, conducted by the veterinarian responsible for the previous treatment, confirmed the diagnosis of habronemiasis. Upon general clinical examination, the horse appeared to be healthy. One month after starting treatment with ivermectin and ointments, a wound was observed on the face located in the right antimer, between the eye and the nostril, which was quite extensive.

The horse had a medical history of recurrence of these lesions for approximately 2 years according to the information provided by the owner. Conventional treatment was performed with cleaning the wounds, mechanical removal of larvae and devitalized tissues and topical application of cream compounded at a pharmacy based on ivermectin 0,5 %, neomycin 0,5 %, dexamethasone 0,1 %, lidocaine 5 %, allantoin 2 %, citronella 0,6 %, and gel base 250g. It was recommended by the veterinarian to apply this ointment once a day until complete healing of the wounds is observed. Systemically, the treatment was carried out with Anequim plus® (Syntec), based on Oxibendazole and Trichlorfon, in the months of August, October, and December of 2024, alternating with the dewormer Platelmin® (UcbVet), based on

Mebendazole, in the months of February, April, and June 2024. Tricloril® (Vansil), based on Trichlorfon, was used from January to May 2025.

This was done for approximately two years, without complete healing of the wounds being observed, according to the information provided by the owner.

Based on this information provided to us by the horse's owner it was decided to perform PDT, using MB at 1 % concentration, administered topically, irradiated with an LED-based device (IrradLed1—biopdi), 400 mW (milliwatts), 10J/cm<sup>2</sup>, 25 seconds. Initially, two weekly treatments were performed for two months. PDT treatments were performed weekly, from the third to the sixth month.

Associated with PDT, cleaning and dressings were carried out with an compounded ointment for the treatment of habronemiasis, which consists of a mixture of ivermectin 0,5 %, Pentabiotico® (penicillins, streptomycin and dihydrostreptomycin), DMSO, allantoin 2 %, and dexamethasone 0,1 %, applied once a day, according to the information provided by the owner. It is important to mention that treatment with the ointment, as mentioned above, was already being carried out even before treatment with PDT without a satisfactory response. Furthermore, the systemic treatment with dewormers, mentioned earlier, based on Mebendazole continued to be carried out monthly, according to the information provided by the horse's owner.

In March 2024, the horse presented two exudative wounds, with exuberant granulation tissue, ulcerated and serous-sanguineous secretion in the left forelimb. During the initial three months, a progressive



**Fig. 1.** Initial granulomatous skin lesion on the left thoracic limb (A). Figures B to F show the lesion's evolution during different treatment periods. Appearance of the wound after one month of evolution, after 4 PDT treatments (B), 8 PDT treatments (C), 12 PDT treatments (D), 16 PDT treatments (E), and after 24 PDT treatments (F).

increase in the diameter of the distally located wound and healing of the most proximal wound was noted; in the subsequent two months, the edges approached and, consequently, a decrease in the diameter of the most distal wound was observed (Fig. 1).

The horse also had a wound on the right thoracic limb, with a macroscopic appearance similar to that described on the left thoracic limb. Healing of the wound was observed four months after treatment (Fig. 2).

After 30 days, the horse presented with a wound on its face with the same macroscopic appearance. This wound evolved in the first two months after its appearance, becoming extensive. Healing of the wound was observed after three months after the beginning of treatment (Fig. 3).

### 3. Discussion

Conventional treatment of habronemiasis is based on the routine use of macrocyclic lactones (ivermectin or moxidectin) systemically, applied directly to the lesion, or intralesionally. Topical and systemic application of corticosteroids may be indicated for some lesions to reduce inflammation-related tissue proliferation [7]. Mixtures of glucocorticosteroids and dimethyl sulfoxide (DMSO) applied topically may also be used to treat *Habronema* lesions. Surgical reduction of the lesion, with or without cryotherapy, may help the response to other therapies [8]. In the case reported the horse appeared to be sensitive to parasitism by *Habronema sp* due to the high recurrence of the lesions found and the resistance to conventional treatments.

Previous reports of habronemiasis do not mention PDT as a treatment for skin lesions; however, it has shown to be a promising therapeutic modality in eliminating pathogens and contributing significantly to accelerating the tissue repair of wounds [9,10].

Studies have already shown that PDT contributes in different ways to the wound healing process, such as eliminating microorganisms and stimulating the proliferation of fibroblasts and, consequently, collagen and elastic fibers [11–13].

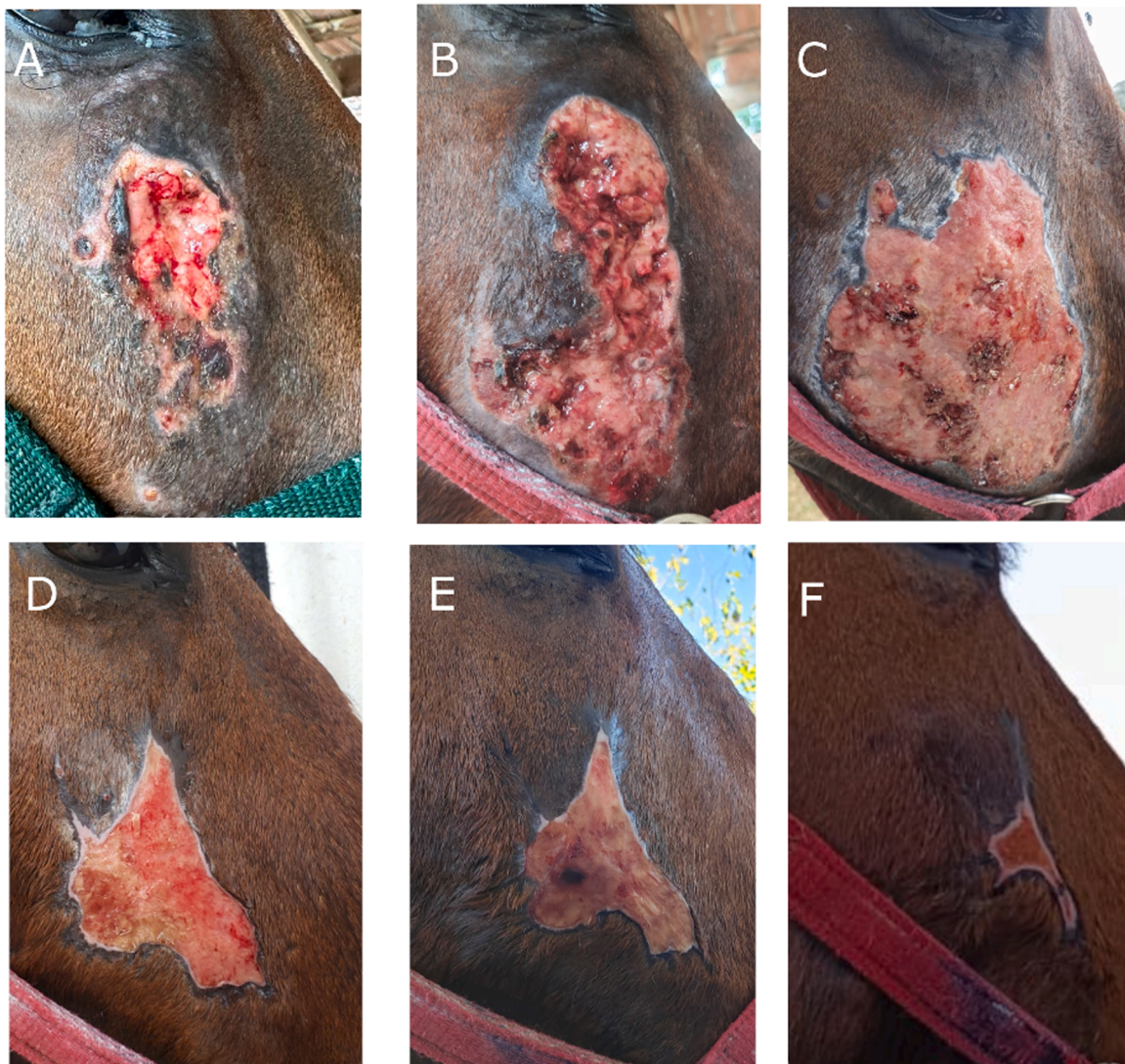
PDT is a process that involves biological, chemical, and physical factors. In it, a photosensitizer (PS) is applied and irradiated with light at a specific wavelength [14]. After the PS interacts with the target cells, a phototoxic response occurs, inducing cell death, mainly due to oxidative damage generated by reactive oxygen species (ROS), such as singlet oxygen and free radicals.

The choice of PS is essential for good therapy results as it is considered a photochemical compound capable of absorbing photons and transferring the acquired energy to molecular oxygen, resulting in the formation of reactive oxygen species and causing damage to the components [15,16]. To ensure the effectiveness of PDT, the PS must present specific characteristics such as low cytotoxicity in the absence of light, water solubility, low aggregation in solutions, adequate internalization to the target tissue or cell, high quantum yield in the singlet and/or triplet states to produce a large amount of cytotoxic products inducing cell inactivation, among others [17–19].

This study used MB as the PS, as it is a compound of the phenothiazine family, formed by cationic, hydrophilic molecules of low molecular weight and has a high potential for interaction with various cell



**Fig. 2.** Initial granulomatous skin lesion on the right thoracic limb (A). Figures B to F show the lesion's evolution during different treatment periods. Appearance of the wound after one month of evolution, after 4 PDT treatments (B), 8 PDT treatments (C), 12 PDT treatments (D), 16 PDT treatments (E), and after 24 PDT treatments (F).



**Fig. 3.** Initial granulomatous skin lesion on the face (A). Figures B to F show the lesion's evolution during different treatment periods. Appearance of the wound after one month of evolution, after 4 PDT treatments (B), 8 PDT treatments (C), 12 PDT treatments (D), 16 PDT treatments (E), and after 24 PDT treatments (F).

types. In addition, it is a PS with light absorption in the red region, low toxicity, and efficient formation of singlet oxygen when activated by light [20].

In habronemiasis, it is believed that PDT may act on the larvae present in the lesions and damage their cell membranes and internal structures. This induces oxidative stress through the formation of ROS, resulting in cell death and a reduction of the parasite load in the lesion.

In the inflammatory response induced by PDT, inflammatory and epithelial cells in the lesion region can be targeted. The inflammatory response activates the immune system, attracting cells such as macrophages and lymphocytes, which aids in the response against secondary infections and promotes healing [21].

In addition, PDT can be used as an adjunct to conventional therapies and can play an important role in reducing the use of antibiotics and antiparasitic drugs, thus contributing to the reduction of the development of resistance to these treatments [22].

Drug resistance is one of the most significant challenges in modern medicine, both veterinary and human. The excessive use of antibiotics and antiparasitics can lead to the selection of resistant strains, making treatments less effective and complicating the treatment of infections [22]. In this context, PDT emerges as a promising alternative because when interacting with conventional therapies, it can enhance the effect of drugs, acting directly on target cells, generating reactive oxygen

species, and destroying infected cells, thus contributing to the elimination of pathogens, enabling the reduction of doses of conventional drugs and minimizing dependence on drugs.

#### 4. Conclusion

In this case report, photodynamic therapy was effective as an adjunct treatment for cutaneous habronemiasis, favoring the healing process of chronic lesions refractory to conventional treatments. The response in this case obtained indicate the potential of PDT as a therapeutic alternative for difficult-to-resolve cases of equine habronemiasis.

#### CRedit authorship contribution statement

**I. Ferreira:** Writing – review & editing, Writing – original draft, Supervision, Resources, Methodology, Formal analysis, Conceptualization. **J.G. Pinto:** Writing – review & editing, Writing – original draft. **E. G.L. Oliveira:** Resources, Investigation. **M.C.B.S. de Azevedo:** Visualization, Resources. **L.M.C. Marcolino:** Visualization, Resources. **J. Ferreira-Strixino:** Writing – review & editing, Writing – original draft, Conceptualization.

## Declaration of competing interest

None of the authors has any financial or personal relationships that could inappropriately influence or bias the content of the paper.

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