Acta Scientiae Veterinariae, 2024. 52(Suppl 1): 980.

CASE REPORT
Pub. 980

ISSN 1679-9216

Supurative Meningoencephalitis and Endophthalmitis in a Calf caused by *Streptococcus pyogenes*

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ABSTRACT

***Background*:** Bacterial meningoencephalitis is a disease originating from the meninges and brain that presents with multiple neurological signs. In cattle, it occurs in any age group, with animals up to 90 days of age being the most affected, due to omphalophlebitis causing sepsis. To date, there are no reports of meningoencephalitis in cattle caused by *Streptococcus pyogenes*. Suppurative meningoencephalitis and endophthalmitis caused by *S. pyogenes* should be included in the differentials of neurological diseases in calves.

***Case*:** A 4-day-old male mixed-breed calf, from a beef cattle farm was submitted to necropsy, with a history of absence of colostrum consumption. The clinical signs presented were permanent lateral decubitus, respiratory difficulty and bilateral opacification of the anterior chamber of the eyes. On the aforementioned farm had a total amount of 300 cattle, 6 calves of which died by similar means. Euthanasia was performed on the calf followed by necropsy, where all organs were collected in 10% formaldehyde and subsequently histopathological evaluation was executed. Additionally, a meningeal swab and an eyeball for aerobic microbiological culture was also carried on, with the purpose to determinate the etiological agent involved. At necropsy, multiple petechiae were noted in the meninges, multiple foci of malacia that coalesced in the occipital and frontal lobe, discrete purulent exudate in the cerebral gyro of the occipital and temporal lobes, markedly xanthochromic cerebrospinal fluid, in addition to marked opacity in the anterior chamber of the eyeballs. On histopathology, the meninges revealed an accentuate diffuse infiltrate predominantly of neutrophils, with a smaller amount of macrophages, lymphocytes and plasma cells with accentuate diffuse fibrinous exudation, in addition to multifocal mild gliosis, malacia and hemorrhage in neuropil. In the anterior chamber of the eyeball was shown an accentuate diffuse neutrophilic infiltrate, associated with fibrin and cell debris, which also infiltrated the ciliary body and choroid. In the bacterial culture of meningeal and eyeball swabs, pure growth of *Streptococcus pyogenes* was observed.

***Discussion*:** The diagnosis of meningoencephalitis is commonly severe and frequently associated with sepsis. Bacterial meningoencephalitis is particularly prevalent in cattle aged 1 to 90 days, with an even higher incidence observed in animals aged between 4 and 12 months. In the present study, the affected animal was only 4-day-old and still in the umbilical healing phase. Typically, bacterial meningitis and encephalitis occur in early-weaned cattle, as these animals have compromised immunity and incomplete umbilical healing. The primary macroscopic finding in the brain revealed the presence of purulent exudate in the cerebral gyri, along with malacia in the occipital and frontal lobes. The histological lesions observed in this case align with those documented in the study of suppurative infectious diseases affecting the central nervous system in ruminants, conducted in the state of Rio Grande do Sul, Brazil. Differential diagnosis of suppurative meningoencephalitis caused by *Streptococcus pyogenes* should be performed by excluding other concurrent causes of bacterial and viral suppurative leptomeningitis. Both bacterial and viral infections are recognized as the leading etiologies of neurological diseases in ruminants.

Keywords: calf, infectious disease, necropsy, neuropathies.

DOI: 10.22456/1679-9216.139934

Received: 30 April 2024 Accepted: 29 July 2024 Published: 27 August 2024

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INTRODUCTION

Neurological conditions hold significant importance in livestock farming owing to their frequent incidence [1], it is worth noting that all diseases that affect the central nervous system must be distinguished from rabies, a disease with zoonotic potential [13].

In a study conducted in Brazil, in cattle up to 12 months of age, diagnoses of neurological disorders were significant, among animals up to 90-day-old, cases of encephalitis and meningoencephalitis accounted for 11.3% of diagnoses, with some of these cases associated with omphalophlebitis shortly after birth [1].

Infection of the central nervous system (CNS) by infectious agents can occur through four pathways: via hematogenous or lymphatic dissemination originating from different locations in the body [5,16,17], through direct penetrating injuries, by extension from an adjacent suppurative lesion, or by centripetal ascending infection via peripheral nerves [5,16]. Abscesses in the CNS primarily occur in young animals under 1 year of age [5]. The most involved pyogenic bacteria are *Trueperella pyogenes*, *Staphylococcus aureus*, *Escherichia coli*, *Streptococcus* spp., *Fusobacterium necrophorum*, and *Pseudomonas* spp. [11,16].

This study aims to report the epidemiological, clinical-pathological, and microbiological findings of a case of bacterial meningoencephalitis and endophthalmitis caused by *Streptococcus pyogenes* in a calf.

CASE

The epidemiological and clinical data of the disease were obtained in conjunction with the producer and the veterinarian during a technical visit to a property located in the municipality of Lages, Santa Catarina, Brazil. A 4-day-old male calf was referred to the Laboratório de Patologia Animal, Centro de Ciências Agroveterinárias (CAV), Universidade do Estado de Santa Catarina (UDESC).

The calf was euthanized, and subsequent necropsy was performed. Aseptic swabs of the meninges and an eyeball were collected for bacterial isolation, after the collection, the samples were inoculated onto blood agar Petri dishes using streaking techniques. The plates were then incubated at 35-37ºC for 24-48 h. Beta-hemolytic colonies observed on the blood agar were transferred into Brain Heart Infusion[1] (BHI) broth, and after 24h of incubation, Gram staining was performed. Gram-positive cocci forming beta-hemolytic colonies were subjected to catalase testing to characterize the microorganism as belonging to *Streptococcus* genus. Differentiation of *S. pyogenes* from other streptococci was achieved through bacitracin sensitivity tests and serological grouping.

Samples of brain, eyeball, lung, thyroid, heart, liver, spleen, kidneys, adrenal glands, rumen, omasum, abomasum, reticulum, intestines, lymph nodes, and urinary bladder were collected. These samples were fixed in 10% buffered formalin for routine histological processing, embedded in paraffin blocks, and then stained with hematoxylin[2] and eosin[3] (H&E) for the evaluation of histological lesions.

There were approximately 300 beef cattle destined for breeding and rearing, 6 of which died. According to the producer, all calves exhibited the same clinical signs, characterized by neurological alterations, opacity of the eyeballs, and respiratory difficulty, ultimately dying within 2 days.

The present calf was born through normal birth without complications; however, it did not ingest colostrum after birth but, resumed normal feeding in the following days. Additionally, it was reported that the animal urinated while lying down and, on the last day of life, remained in decubitus, no longer assuming a standing position.

At the necropsy, eyeballs with markedly diffuse anterior chamber opacity were observed (Figure 1A). In the brain, multiple petechiae were found on the meninges, along with multiple foci of softening in the occipital and frontal lobes associated with mild purulent exudate in the cerebral gyri of the occipital and temporal lobes (Figure 1B), and markedly xanthochromic cerebrospinal fluid.

In histopathology, there was marked diffuse infiltration of neutrophils in the anterior chamber of the eyeball, associated with fibrinous exudation, which also infiltrated the ciliary body and choroid (Figure 1C). In the brain, there was marked diffuse predominantly neutrophilic infiltration, with lesser amounts of macrophages, lymphocytes, and plasma cells, involving the meninges, accompanied by marked diffuse fibrinous exudation (Figure 1D), as well as multifocal discrete gliosis, malacia and hemorrhage in neuropil. Additionally, in the trigeminal ganglion, there was moderate multifocal predominantly neutrophilic infiltration, along with lymphocytes, plasma cells, macrophages, and fibrinous exudation.

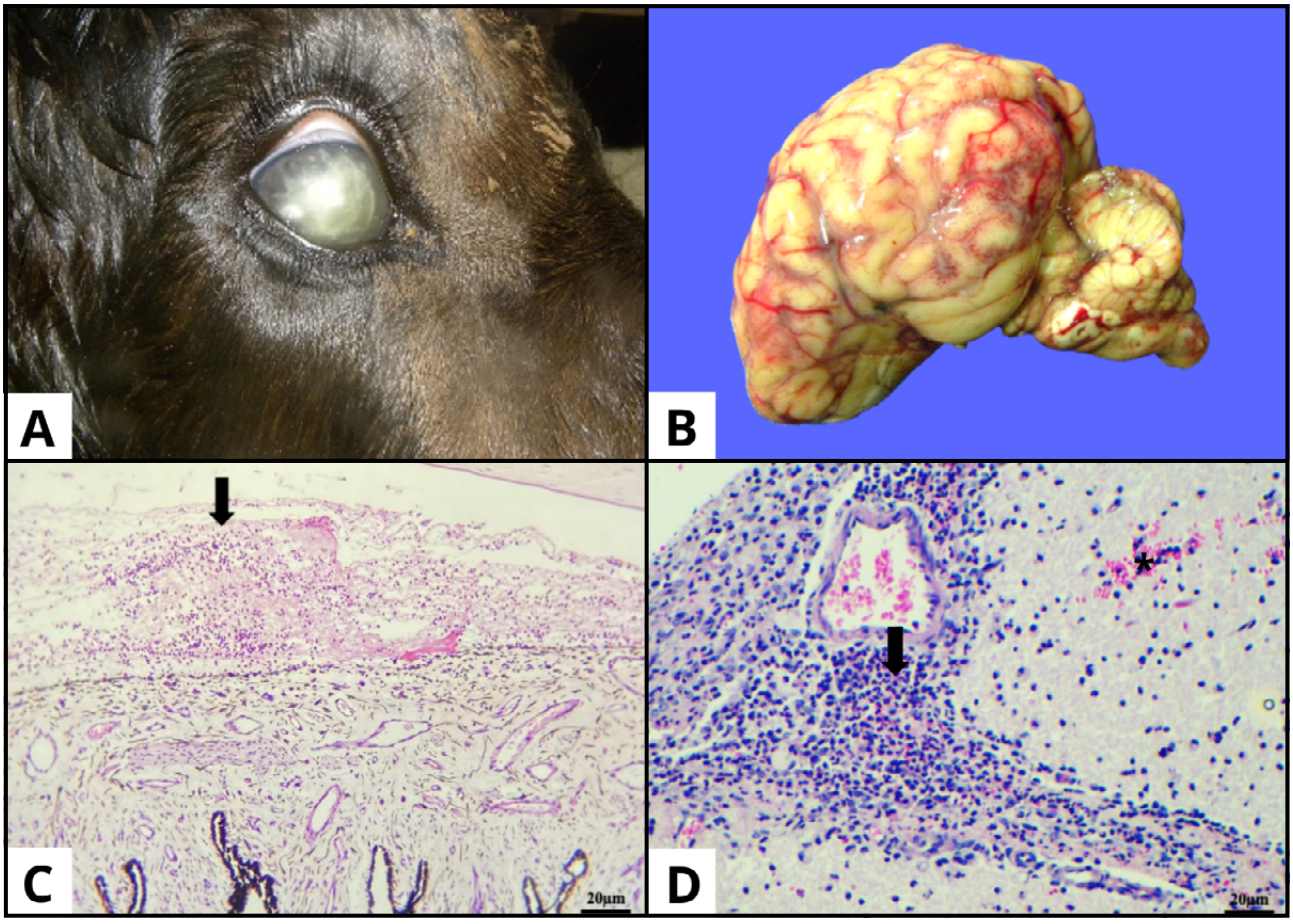

Figure 1. Meningoencephalitis and endophthalmitis caused by *Streptococcus pyogenes* in a calf. A- Eyeballs with markedly diffuse anterior chamber opacity. B- Brain with multiple petechiae in the meninges, mild multifocal purulent exudate in the cerebral gyri of the occipital and temporal lobes. C- In the anterior chamber of the eyeball had marked diffuse neutrophil infiltration associated with fibrinous exudation (arrow). [HE; obj.20]. D- Brain with marked diffuse predominant neutrophil infiltration, with lesser amounts of macrophages, lymphocytes, and plasma cells (arrow), accompanied by discreet multifocal hemorrhages (asterisk). [HE; obj.20].

In the meninges and eyeball swab, *Streptococcus pyogenes* was isolated in pure culture.

DISCUSSION

Diagnosis of meningoencephalitis is considered severe and are often associated with sepsis [3]. Meningoencephalitis caused by viral etiological agents occurs more frequently than of bacterial origin [15]. In this study, bacterial culture was performed in order to isolate the causative agent of meningoencephalitis, with *Streptococcus pyogenes* being isolated. *Escherichia coli*, *Streptococcus* spp., *Staphylococcus* spp., and *Corynebacterium* spp. are some bacteria reported as causative agents of meningoencephalitis in cattle [1, 21].

The main agents involved in cases of suppurative meningoencephalitis are pyogenic bacteria, responsible for various clinical manifestations in animals. Among the most common isolated agents in cattle are *Streptococcus* spp., *Fusobacterium nucleatum, Pseudomonas aeruginosa, Klebsiella* spp., *Trueperella pyogenes, Pasteurella* spp., *Haemophilus somnus, Listeria monocytogenes*, and *Escherichia coli* [18]. Therefore, this study demonstrated that in a calf, the causative bacterium was *Streptococcus* spp.

Streptococcus suis is the most common causative agent in bacterial meningitis, with zoonotic potential. This pathogen is a natural reservoir in pigs, mainly causing meningitis, endocarditis, and sepsis [12]. The most commonly *Streptococcus* spp. associated with meningoencephalitis in cattle is *Streptococcus agalactiae*, being an important pathogen causing severe diseases in animals, including infections of the central nervous system such as meningoencephalitis. *Streptococcus agalactiae* can also be involved in other conditions such as mastitis in dairy cows [4].

Cases of bacterial meningoencephalitis are more frequently observed in cattle aged 1-90 days, with

a higher incidence in infections occurring in animals aged 4 to 12 months [16]. In the present study, the animal was 4-day-old, still in the umbilical healing phase, as a rule, bacterial meningitis and encephalitis occur in cattle that are weaned early because these animals have low immunity and incomplete umbilical healing [7].

Suppurative leptomeningitis is one of the main causes of infectious neurological diseases (SIND) diagnosis in cattle in Rio Grande do Sul [1]. SIND in cattle had a frequency of 13.2% among cases of inflammatory central nervous system disorders [8]. Bacterial leptomeningitis is the primary neurological condition in newborn ruminants, as evidenced in this study, given that the animal was only 4-day-old [2]. The predisposition of animals in this age group is primarily related to failure in passive immunity transfer due to various factors such as inadequate colostrum intake, malnutrition, and concurrent viral and bacterial infections [5]. Like in the case of this calf, which did not ingest colostrum, making it susceptible to bacterial infections.

In a study conducted in Rio Grande do Sul, 10 of 14 cases of meningoencephalitis occurred in calves up to 90-day-old, with 2 of these cattle having a history of omphalophlebitis shortly after birth [1]. Previous studies have reported that, in the majority of cases, meningoencephalitis is directly related to umbilical infection in animals [6]. In the present study, omphalitis and omphalophlebitis did not occur. However, the entry point of the bacteria may have occurred through another route, such as the digestive tract, associated with the absence of colostrum intake.

The main macroscopic finding in the brain was purulent exudate in cerebral gyri and malacia in the occipital and frontal lobes. The histological lesions observed in this report are consistent with those described in studies of suppurative infectious diseases in the central nervous system in ruminants in the state of Rio Grande do Sul [8,19].

The literature reports that the bacterium *Streptococcus pyogenes* is common in humans, causing streptococcal pharyngitis and pyoderma, and it can also infect various organs and tissues of the human body and lead to suppurative complications [21]. *Streptococcus pyogenes* is responsible for a range of clinical manifestations in humans, from mild skin and soft tissue infections, pharyngitis, to more serious diseases such as bacteremia, cellulitis, puerperal sepsis, meningitis, pneumonia, and necrotizing fasciitis [10]. In 1998, 1 case was reported of an 18-day-old newborn with neonatal meningitis caused by *Streptococcus pyogenes* [9]. There is a report from 2008 of a 14-year-old teenager with acute otitis media, which progressed to fatal meningitis caused by *Streptococcus pyogenes* [14].

However, *Streptococcus pyogenes* can occasionally infect cattle, mainly through close contact with humans or in environments contaminated with this bacterium. In cattle, it can cause local infections such as mastitis, or even systemic infections in more severe cases [8]. The clinical signs observed in cattle with meningoencephalitis are varied, depending on the location of the lesions in the central nervous system [20]. Reported signs in these cases include opisthotonus, inability of the animal to maintain a standing position, prostration, and corneal opacity leading to blindness [1]. However, these occurrences are uncommon and not the primary concern regarding bacterial infections in cattle [8]. In the present study, the case occurred in 1 calf, resulting in meningoencephalitis and endophthalmitis. Additionally, streptococcal infections of the oropharynx can be followed by a severe sequela, rheumatic fever, in humans [21].

The differential diagnosis of suppurative meningoencephalitis caused by *Streptococcus pyogenes* should be made by excluding other concurrent causes of bacterial and viral suppurative leptomeningitis, with bacterial and viral infections being the most important causes of neurological diseases in ruminants [7]. Some viral causes, such as rabies virus infection, bovine herpesvirus, and malignant catarrhal fever, should be considered as differential diagnoses for this case, as they are the most important viral diseases of the central nervous system in calves [20].

This appears to be the 1st report of suppurative meningoencephalitis and endophthalmitis caused by *Streptococcus pyogenes* in a calf. The diagnosis was determined by epidemiology along with associated clinical signs, necropsy findings, histopathological observations, and bacterial isolation.

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Declaration of interest. The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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