A spinal epidural abscess due to *Streptobacillus moniliformis* infection following a rat bite: case report

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The authors describe the case of a 40-year-old man suffering from an epidural abscess in the thoracic spine due to a rarely isolated pathogen, *Streptobacillus moniliformis*, the causative agent of rat bite fever. Besides diffuse abdominal pain, ataxia, paresthesia, hypesthesia, and enhanced reflexes of the lower extremities, the patient suffered from a decreased sensation of bladder filling. His history was also positive for a rat bite 6 weeks earlier. Magnetic resonance imaging showed an epidural, space-occupying lesion compressing the spinal cord at the vertebral levels of T6–8. Neurosurgery revealed an epidural abscess, which was drained via laminectomy (T-7) and excision of the ligamentum flavum (T6–8). The etiological agent *S. moniliformis* was identified by 16S rRNA-based polymerase chain reaction and sequencing as well as by culture and mass spectrometry. Treatment with penicillin G led to complete resolution of the abscess and clinical recovery of the patient, who regained his bladder-filling sensation and free walking ability.

This case demonstrates that careful attention to the patient's history is essential in suspecting unusual bacterial pathogens as the cause of an epidural abscess and initiating the optimal diagnostic procedure and antimicrobial therapy.

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Streptobacillus moniliformis belongs to the class of *Fusobacteriia* and is a member of the family *Lep-totrichiaceae*. It is a fastidious, facultatively anaerobic, nonmotile, gram-negative, rod-forming bacterium with a variable morphology. The worldwide reservoirs of *S. moniliformis* are domestic and feral rats or other rodents.^{8,12} Recent studies have yielded rates of colonization with *S. moniliformis* between 17% and 92% in the nasopharyngeal tract of wild urban rats.^{11,14} Humans can become infected with *S. moniliformis* via several routes. Rat bite fever usually results from the bite or scratch by a rat or exposure to rodent excretions (for example, urine or saliva). Indirect transmission of the pathogen has been

suggested for patients who did not report direct contact with rats but instead had a history of interactions with other domestic animals such as cats, dogs, or roosters.^{2,7,18} Rat bite fever that was due to the oral uptake of food or water contaminated by the excrement of rodents has been termed “erythema arthriticum epidemicum,” or “Haverhill fever,” named after the site of a large outbreak in the United States.^{8,12} Both the classic rat bite fever and the Haverhill fever are characterized by the sudden onset of fever, chills, pharyngitis, vomiting, skin rashes (maculopapular, petechial, or purpuric; affecting the extremities, predominantly the hands and feet), and arthralgias.¹⁹ Unlike in another form of rat bite fever that is caused by an

ABBREVIATIONS CRP = C-reactive protein; MALDI-TOF = matrix-assisted laser desorption ionization with time of flight; PCR = polymerase chain reaction.

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FIG. 1. Clinical condition of the site of the rat bite at the middle finger of the left hand (arrows) of the patient as detected at Day 11 of the hospital stay. Figure is available in color online only.

unrelated bacterium (*Spirillum minus*) and seen mostly in Asia, patients with acute streptobacillosis in general do not present with a persistent skin lesion resulting from the bite.¹² Without therapy, the mortality rate ranges from 7% to 13%.^{8,12} However, following appropriate antibiotic therapy, rat bite fever has a good prognosis.^{3,19} Severe complications of rat bite fever are endocarditis, spread of the pathogen into organs leading to abscess formation (for example, brain abscess), myocarditis, respiratory failure, and overwhelming septicemia.^{3,6–8,12,15,19} Frequently, children are affected.¹⁹ *S. moniliformis* infections of the human spine can occur in the form of an epidural abscess, spondylodiscitis, or a psoas abscess and have only rarely been reported.^{2,7} We present what we believe is the first case of an epidural abscess caused by *S. moniliformis* located in the thoracic spine.

Case Report

History and Examination

A 40-year-old man was admitted to the Department of Gastroenterology complaining of diffuse abdominal pain. Initial diagnostic imaging of the abdomen (ultrasonography, radiography) showed no pathological findings except for a bulging urinary bladder indicative of a decreased sensation of bladder filling. Neurological examination and further questioning of the patient revealed a paresthesia and hypesthesia distal to dermatome T-10, which had started 10 days earlier. Furthermore, enhanced reflexes of the lower extremities and ataxia were detected, whereas motoric functions were intact except for moderate impairment in elevation of the left foot. The patient also reported that his girlfriend's pet rat had bitten his left middle finger 6 weeks prior to the onset of his current complaints (Fig. 1). The wound had not been seen by a medical doctor and

FIG. 2. Sagittal (A) and axial (B) MR images showing an intraspinal, epidural, space-occupying lesion with gadolinium contrast enhancement (arrows) at the T6–8 vertebral levels. Note the compression of the spinal cord.

had healed on its own. Fever, arthralgia, or exanthema had never developed after the rat bite.

Peripheral blood analysis on the day of admission was remarkable for prominent leukocytosis (17,000/ μ l) and an elevated level of the C-reactive protein (CRP; 20.3 mg/dl, normal < 0.5 mg/dl), whereas the patient's body temperature was normal (37.2°C). Magnetic resonance imaging revealed an epidural, space-occupying lesion at the T6–8 vertebral levels, which showed gadolinium enhancement and compression of the spinal cord (Fig. 2).

Operation and Microbiological Diagnosis

The suspected epidural abscess was drained micro-surgically via laminectomy of T-7 and excision of the ligamentum flavum at the level of T6–8. Multiple intra-operatively obtained samples of the epidural abscess were preserved for microbiological analyses.

The microbiological diagnosis was initially made by 16S rRNA molecular testing of the epidural abscess sample. The DNA was extracted with the High Pure PCR Template Extraction Kit (Roche Diagnostics) according to the manufacturer's instructions. Partial 16S rRNA gene (463-bp fragment) was amplified using the Mastermix 16S Complete Kit (Molzym). Sequencing showed 100% identity with *S. moniliformis* DSM 12112 (accession number NR_074449.1).

The abscess material was also plated on sheep blood agar, chocolate agar, and anaerobic agar. After 7 days of culture, one colony grew on blood agar at 37°C and under aerobic conditions with 5% CO₂. The bacterial isolate was identified as *S. moniliformis* by matrix-assisted laser desorption ionization with time of flight (MALDI-TOF, Bruker) mass spectrometry and subcultured on sheep blood agar and in serum-supplemented thioglycolate broth. *S. moniliformis* did not grow on chocolate agar; tested negative for catalase, indole, and oxidase; exhibited a cotton puff ball-like appearance in thioglycolate broth (Fig. 3); and showed the typical pleomorphic microscopic morphology upon Gram staining (not shown). All of these microbiological features are characteristics of *S. moniliformis*.

Antibiotic susceptibility testing using the agar diffusion methodology showed susceptibility to penicillin, cefuroxime, ceftriaxone, meropenem, gentamicin, moxifloxacin,

FIG. 3. *S. moniliformis* forming “cotton puff balls” after 2 days of incubation in thioglycolate broth containing bovine serum. Figure is available in color online only.

clindamycin, vancomycin, rifampicin, and tetracycline. The bacilli tested resistant to sulfamethoxazole-trimethoprim (co-trimoxazole) and erythromycin.

Antibiotic Treatment and Further Postoperative Course

Following the diagnosis of *S. moniliformis* by polymerase chain reaction (PCR), the antibiotic therapy was immediately switched from the empirical intravenous administration of ceftriaxone and metronidazole to the intravenous administration of penicillin G for 2 weeks. This was followed by oral penicillin V for an additional 4 weeks. Three weeks after the neurosurgical intervention, blood analysis showed a normal leukocyte count (7500/ μ l) and a CRP value < 0.5 mg/dl.

Control MRI was performed 2 and 6 months after surgery (Fig. 4). The epidural abscess and spinal cord compression were no longer detectable. However, T2-weighted sequences and short-tau inversion recovery (STIR) sequences revealed discrete signs of myelopathy.

The patient was transferred to a rehabilitation center where his clinical condition further improved. He regained bladder-filling sensation, and free walking at a quick pace became possible. However, he still reported reduced sensibility in his legs as well as gait and standing ataxia. A moderate paresis of the left toe also remained.

Discussion

To the best of our knowledge, the present report is only

FIG. 4. **A:** Sagittal MR image obtained at 2 months after surgery, showing no indications of spinal cord compression. The epidural abscess was no longer detectable (arrows). **B:** Short-tau inversion recovery (STIR) sequence revealed discrete signs of myelopathy (arrow).

the second case in the literature in which *S. moniliformis* has been identified as the cause of an epidural abscess. While this zoonotic pathogen is generally regarded as a rare cause of infection, the true incidence of *S. moniliformis* infections is not known because of the difficulties in culturing the bacterium, the nonspecific symptoms of the disease, and uncertainties regarding rat exposure and the route of infection.^{2,3,15} In cases of proven rat bite, the risk of infection is estimated to be approximately 10%.⁸ Over the past decades, cases of rat bite fever have been mostly associated with exposure to wild rat populations. Given the increasing popularity of keeping rats as domestic pets, the risk of rat bite fever rises, especially for children. Furthermore, pet store workers and laboratory technicians are at risk for *S. moniliformis* infections if the animals are not specifically pathogen free.^{2,8} The patient in the featured case reported that he had cared for his girlfriend's pet rat and was bitten 6 weeks before the onset of his symptoms. It is remarkable that the spinal epidural abscess (and the respective neurological complications) developed in the absence of the classic symptoms and signs of rat bite fever. It is important to note the publication of cases of rat bite fever in which there was no evidence of bite injuries by rats or other wild or domestic animals. In several instances, social deprivation, living on a farm, keeping cats and dogs, or injuries unrelated to animals were the only risk factors in the patient history.^{8,15,16,18}

The diagnosis of rat bite fever is a challenge due to the lack of pathognomonic clinical signs and symptoms and the possible failure to detect *S. moniliformis* by routine blood cultures. Most of the standard aerobic blood culture systems contain concentrations of sodium polyanethol sulfonate as an anticoagulant that inhibits the growth of *S. moniliformis* and can result in a falsely negative blood culture.^{2,8} In the case of positive cultures, the examiner must be aware of the variable microscopic appearance and colony morphology. The gram-negative rods are often arranged in long tangled chains and filaments with bulbar swellings.⁸ Cell wall-containing wild-type *S. moniliformis* will form convex colonies or cotton puff balls in serum containing solid or liquid medium, respectively. In aged cultures, cell wall-deficient, nonpathogenic L-phase bacteria can occur, appearing like fried-egg colonies.⁸ In

our case, blood cultures were taken upon patient admission to our hospital but remained negative. Instead, rapid diagnosis was achieved by molecular analysis (PCR and sequencing) of the drained epidural abscess.

S. moniliformis is almost universally susceptible to penicillin G, which is the treatment of choice for rat bite fever. If endocarditis is present, penicillin G is usually combined with gentamicin or streptomycin. Other antibiotics such as cephalosporins, tetracyclines, and aminoglycosides have also been reported to be effective in rat bite fever.^{2,8,19} The *S. moniliformis* isolate from our patient was fully susceptible to all tested antibiotics except for erythromycin and co-trimoxazole.

In addition to the present case, there is only one other report on a patient with an epidural abscess caused by *S. moniliformis* in the medical literature.² In that patient, the abscess was located between the L-4 and S-1 vertebrae, caused fever and decreased sensation of bladder filling, and was successfully treated with ceftriaxone. The microbiological diagnosis was made by culture of the pathogen from the abscess fluid, which was placed in a blood culture bottle, as well as by retrospective 16S rRNA PCR analysis of the primary specimen from the epidural abscess. The definitive diagnosis took 21 days because MALDI-TOF analysis for the identification of the cultured bacteria, which we used, was not yet available and because PCR analysis was not initially performed. Together, the 2 cases highlight the importance of molecular methods for routine microbiological diagnostics, emphasize the power of MALDI-TOF analysis of cultured bacteria (provided the underlying databases are constantly updated), and illustrate the success of combined surgical and antibiotic treatment.

Spinal epidural abscesses occur in up to 75% of cases in the thoracolumbar spine; approximately 50% are ventrally located. The most frequently detected bacteria are *Staphylococcus aureus* and *Streptococcus* species.¹⁷ Spinal epidural abscesses usually result from locally introduced bacteria (for example, via paravertebral or peridural injections), from the contiguous spread of a neighboring infection site (for example, spondylodiscitis or psoas abscess), or from the hematogenous dissemination of a distant infectious focus (for example, skin infection, dental infection, infected venous catheter, intravenous drug abuse, or endocarditis).⁴ As illustrated by our case, animal bites bear the risk of the inoculation of unusual bacteria,¹ which subsequently can systemically spread and cause distant infections such as an epidural abscess. Our patient's history of a rat bite was instrumental in our suspecting a rare pathogen and initiating a molecular diagnostic approach, which also covers bacteria that are difficult to grow.

If the clinical and laboratory parameters of a patient suggest the presence of an epidural abscess, gadolinium-enhanced MRI of the spine should be immediately performed to ascertain the diagnosis and to plan the neurosurgical approach.⁵ Cases treated with early surgery typically achieve better outcomes than cases treated without surgery.⁹ Especially in patients who are older than 65 years, suffer from diabetes, are infected with methicillin-resistant *Staphylococcus aureus*, or show neurological deficits, nonsurgical medical management is not recommended.¹³

Moreover, early surgery helps to avoid the development of sepsis, a leading cause of death.¹⁰

Apart from open microsurgery and antibiotics, percutaneous endoscopic debridement as well as percutaneous lavage and drainage have recently been tested as new therapies for cases of spondylitis.^{20,21} These methods certainly allow one to obtain adequate samples for microbiological diagnostics and can support the remission of neurological symptoms. Furthermore, we suggest that these approaches may also be suitable for treatment of paraspinal abscesses, for example, in patients who will not tolerate more invasive surgery.^{20,21} The percutaneous approach may also be feasible for the management of epidural abscesses.

Conclusions

In summary, after the occurrence of a spinal abscess following an animal bite, involved microbiology, neurology, and neurosurgery specialists should be aware of the possibility of rare pathogens such as *S. moniliformis* as causative agents. In these cases, rapid PCR analysis of intraoperatively obtained specimens can help to overcome the diagnostic limitations of conventional blood cultures.

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Disclosures

The authors report no conflict of interest concerning the materials or methods in this study or the findings specified in this paper.

Author Contributions

Conception and design: Hammer, Steiner, Bogdan. Acquisition of data: Hammer, Wolff, Schrey, Ziegler, Bogdan. Analysis and interpretation of data: Hammer, Wolff, Geißdörfer, Bogdan. Drafting the article: Hammer, Wolff, Bogdan. Critically revising the article: Hammer, Wolff, Geißdörfer, Bogdan. Reviewed submitted version of manuscript: Hammer, Wolff, Geißdörfer, Bogdan. Approved the final version of the manuscript on behalf of all authors: Hammer. Administrative/technical/material support: Steiner, Bogdan. Study supervision: Steiner, Bogdan.

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