History

Two calves were submitted to the California Animal Health and Food Safety Laboratory, Tulare, Calif, for postmortem examination and diagnostic testing. A 7-month-old Holstein heifer (calf 1) and a 4-month-old Holstein heifer (calf 2) from the same heifer ranch in California had developed clinical signs of anorexia, drooping head, and ataxia, with difficulty standing and walking that mainly affected the pelvic limbs. These calves were housed in a group pen containing approximately 200 heifers and had received no treatments prior to necropsy. Typically, calves that had been raised on a calf ranch until 4 months of age were then transferred from the calf ranch to this heifer ranch. The calves were vaccinated with a Brucella abortus RB51 vaccine after arrival at the heifer ranch. Standard practices at the calf ranch included movement of calves at 10 weeks of age to group drylot pens (where there were no lock ups to restrain animals) and use of autoinjectors to deliver antimicrobials if needed.

Clinical and Gross Findings

At necropsy, both calves were found to be in good nutritional and postmortem condition. No external lesions were evident on either calf. However, calf 1 had a large, firm, multinodular mass in the deep connective tissue below the left scapula, which contained discrete pockets of soft, thick, yellow, caseonecrotic, layered material surrounded by fibrous capsules (Figure 1). One abscess extended to the thoracic vertebral column at the level of the T5 vertebra, resulting in severe osteomyelitis of the spinous process and an epidural abscess between the T5 and T6 vertebral bodies. Calf 2 had a similar epidural abscess that affected the dorsal aspect of the vertebral body of T2, resulting in osteomyelitis and compression of the spinal cord by the abscess.

Formulate differential diagnoses from the history, clinical findings, and Figure 1—then turn the page →
Histopathologic Findings

Histologic examination of samples of the epidural abscess in calf 1 revealed a well-encapsulated abscess with a central core of necrotic eosinophilic debris composed of variable numbers of neutrophils, lymphocytes, macrophages, and plasma cells (Figure 2). The epidural abscess was impinging on the dorsal and ventral nerve roots, which caused mild axonal swelling and mild lymphocytic infiltration of the dura and surrounding nerve tissue (Figure 3). Histologic examination of the bone tissue was not performed. Following Gram staining of the abscess tissue, long gram-positive, branching, filamentous bacteria were evident microscopically; results of Ziehl-Neelsen acid fast staining of the abscess tissue were negative. For calf 2, histologic examination of samples of the spinal cord at the compression site revealed moderate vacuolar changes and dilation of myelin sheaths in the white tracts of the spinal cord. The abscess and bony lesions were not examined histologically.

Microbiological Findings

Abscess material from both calves was plated on 5% bovine blood agar, MacConkey agar, and chocolate agar and incubated at 37°C with 7% CO₂ for 48 hours. Bacterial colonies on blood agar were slightly dry to powdery and yellow after 24 hours of incubation, progressing to orange by 72 hours. Gram staining of the microbial growth revealed branching, filamentous, gram-positive rods; modified Ziehl-Neelsen staining with a 1% H₂SO₄ decolorizer revealed partially acid-fast coccobacilli. Colonies were catalase positive, urea positive, and resistant to lysozymes. Organisms from both calves were identified as Nocardia spp. For definitive speciation, DNA sequencing of both isolates was performed with universal 16S rRNA primers, which identified both organisms as Nocardia farcinica (100% homology with published sequences). Sequence alignment of the 567-base pair products revealed complete sequence agreement between these 2 isolates.

Morphologic Diagnosis and Case Summary

Morphologic diagnosis: for calf 1, chronic severe multinodular subcapsular abscess with extension between the T5 and T6 vertebral bodies; severe local osteomyelitis of the spinous process with epidural abscess at the level of the T5 vertebra; chronic encapsulated pleocellular epidural abscess with presence of branching, filamentous, gram-positive rods at the dorsal nerve root at the level of T5; and mild axonal swelling, degeneration of dorsal root nerves, and lymphocytic neuritis and, for calf 2, moderate vacuolar change and dilation of myelin sheaths of the spinal cord at the level of the T2 vertebra and severe focal osteomyelitis of the T2 vertebral body with compression and dorsal deviation of the spinal cord by the abscess.

Case summary: soft tissue abscesses and vertebral osteomyelitis attributable to N farcinica infection in 2 calves.
**Comments**

*Nocardia* spp are gram-positive, partially acid-fast, branching, filamentous bacteria. They are soil saprophytes and are ubiquitous in the environment. The organism grows readily in aerobic conditions, and colonies can be variably pigmented. Lesions associated with *Nocardia* spp are indistinguishable from those caused by *Actinomyces* spp and include pyogranulomatous reactions, encapsulation by fibrous tissue, and pleocellular infiltration. *Nocardia* and *Actinomyces* spp are branching, filamentous, gram-positive rods that can be differentiated biochemically.

*Nocardia* spp frequently form local abscesses after inoculation of tissues but can disseminate hematogenously to other sites, particularly lymph nodes and bones. In ruminants, infections with *Nocardia* spp are associated with udder antimicrobial infusions, teat dips, and udder washing equipment that are contaminated by soil and often result in purulent mastitis with draining sinuses. *Nocardia farcinica* has been implicated in the disease bovine farcy (causing cutaneous abscesses on the limbs) and has been ascribed as a cause of bovine abortion and stillbirth. Instances of vertebral osteomyelitis in adult cattle and in a Holstein calf have been reported, but in those cases, no etiologic agent was identified.

In companion animals, *Nocardia* spp transmission via inoculation or inhalation can result in pneumonia and thoracic empyema as well as cutaneous and subcutaneous abscesses and mycetoma. Vertebral osteomyelitis due to *Nocardia* spp infection in dogs has been reported.

Spinal cord lesions in the calves of this report were limited to thoracic vertebrae, accounting for the pelvic limb weakness and ataxia without thoracic limb involvement. Differential diagnoses for these neurologic signs included vertebral trauma, vertebral abscesses with pathological fractures, vertebral malformations, lymphosarcoma in the epidural space (mainly in adult cattle), epidural abscesses, malformations of the spinal cord, myelitis, and weakness-causing white muscle disease. Differential diagnoses for the type of chronic caseous abscesses seen in the calves of this report included infections with various bacteria (e.g., *Mycoplasma* spp, *Corynebacterium pseudotuberculosis*, *Mycobacterium* spp, *Nocardia* spp, and *Actinomyces* spp).

Tissue infection attributable to *Nocardia* spp would not be unexpected in calves because of the ubiquitous presence of the organisms in soil. Contamination from the skin surface during injection, transmission of infective organisms via multidose syringe use, and tissue damage that may occur during injection of unrestrained animals were most likely the inciting causes of lesions in these calves because no other nidus of primary infection with *N farcinica* was found. Alternatively, a penetrating injury (e.g., from faulty enclosure components) may have facilitated entry of *N farcinica* into deeper tissues, with resolution of the initial wound by the time of necropsy. Localization of suspected lesions on the basis of neurologic signs such as those detected in the calves of this report can be useful to clinicians who are formulating diagnostic and treatment plans.

Treatment of cattle and dogs for *Nocardia* spp infections can be challenging because it involves the use of antimicrobials, especially trimethoprim-sulfonamide and penicillin; surgery for relief of pressure on the spinal cord; abscess debridement; or removal of the infected tissue. The 2 cases described in the present report involved abscess extension into spinal tissues resulting in neurologic disease, which emphasizes the risks associated with practices that do not take into consideration Beef Quality Assurance guidelines and the pathogenic potential of opportunistic bacteria. Dairy Animal Care Quality Assurance guidelines are a valuable resource designed to help producers create standard operating procedures for cattle handling, housing, and administration of pharmaceuticals. The diagnosis of infection with *Nocardia* spp or other opportunistic pathogens should prompt clinicians to look for underlying concerns with standard operating procedures and for possible sources of skin or deep tissue wounds that may allow bacterial entry and soft tissue abscess formation.

**References**