**INTRODUCTION**

Rhodococcus equi (previously known as Corynebacterium equi) is an intracellular pathogen that establishes itself in macrophages by interfering with phagolysosomal fusion (Heitala and Ardans 1987). This interference eventually results in the multiplication of the pathogen within the macrophages, which leads to the formation of granulomas and, eventually, necrosis. The aerobic Gram-positive pleomorphic organisms of *R. equi* vary from cocci to rods and are commonly found in the faeces of foals and in soil contaminated by other herbivore faeces. The organism has also been isolated from rabbit and bird droppings, but not from cat faeces (Carman and Hodges 1987). *R. equi* mainly causes pyogranulomatous bronchopneumonia in foals, with gastrointestinal involvement in about 50 per cent of the cases (Giguere and Prescott 1997). It has also been reported to cause ulcerative lymphangitis, cellulitis, subcutaneous abscesses and arthritis in horses (Zink and others 1986, Perdrizet and Scott 1987). It is known to cause infections in humans with defective cell-mediated immune responses and those on immunosuppressive treatment. About 30 per cent of infected human patients have a history of having been in contact with contaminated herbivore faeces (Prescott 1991). There have also been sporadic reports in the literature of *Rhodococcus* infections in cats associated with mediastinal and mesenteric lymphadenitis (Jang and others 1975) and cellulitis and abscesses, mainly of the extremities (Higgins and Paradis 1980, Elliot and others 1986, Oxenford and others 1987, Fairley and Fairley 1999).

The present report describes a clinical presentation in a cat involving the neck and submandibular lymph node, which resembles ulcerative lymphangitis, cellulitis and pyogranulomatous disease, as seen in horses. It also describes the cytological, microbiological and histopathological findings and discusses the common pitfalls in the diagnosis of this unusual cause of pyogranulomatous disease in the species.

**CASE HISTORY**

A two-year-old neutered female domestic shorthaired cat was presented with a large ulcerated mass on the left side of the neck. According to the owner, a lump had occurred on the right side of the neck following a cat fight. Swab specimens, submitted by the referring veterinary surgeon, had identified the presence of *Staphylococcus intermedius* and *Hemolytic streptococci on three previous occasions. On the first two occasions, histopathological examination of biopsy specimens revealed a pyogranulomatous dermatitis and cellulitis. On the third occasion, intracellular organisms were found within macrophages. The organisms did not stain acid-fast with Ziehl-Neelsen (ZN) stain, but they did stain positive with periodic acid Schiff (PAS) stain.

Despite excisions with wide surgical margins and antibacterial therapy with 5 mg/kg enrofloxacin (Baytril; Bayer Animal Health) followed by 5·5 mg/kg clindamycin (Antirobe; Pharmacy and Upijohn Animal Health) twice daily, new lesions continued to appear. The cat's condition slowly deteriorated, with the onset of pyrexia, anorexia and lethargy as the
disease progressed, at which point the cat was referred.

On referral, a general physical examination revealed the cat to be in poor condition, weighing 2.9 kg, with a temperature of 39.4°C. On auscultation, the cat was found to be tachycardic, with a heart rate of 170 beats per minute. No abnormal lung sounds were detected.

The submandibular and the right prescapular lymph nodes were enlarged. However, the left prescapular lymph node was not palpable because the lesion was at the site of the node. There was a haemopurulent discharge from a draining sinus over the right parotid gland (Fig 1) and a large non-painful ulcerated mass of about 4 cm diameter, with seropurulent exudate, on the left prescapular area (Fig 2). The surface of the mass had a crater-like appearance, with exposure of the underlying subcutaneous fat and muscle. The surrounding skin was alopecic, but surface lesions were not visible. On palpation, the mass was not circumscribed and crepitus was felt under the skin, suggesting deeper involvement.

Differential diagnoses at this stage included granulomatous dermatitis caused by infectious bacterial, fungal or protozoal organisms (see Table 1).

Haematological analysis demonstrated a leucocytosis (19.2 × 10⁹/litre; reference range 5 to 18 × 10⁹/litre) with a mature neutrophilia (15.1 × 10⁹/litre; reference range 4 to 14 × 10⁹/litre). Serum biochemical analysis revealed a raised creatine kinase concentration (132 iu/litre; reference range <120 iu/litre). All other parameters were within the normal reference ranges. An ELISA and virus isolation for feline leukaemia virus antigen and immunofluorescence for feline immunodeficiency virus antibodies were negative. The antibody titre for feline coronavirus was 1/10.

Impression smears taken from the surface of the ulcerated mass and the draining tract from the right lymph node were stained with modified Wright’s stain (Diff-Quik; Dade AG) and examined under an oil immersion lens. Numerous neutrophils and macrophages containing cocci and rod-shaped organisms within clear vacuoles were detected.

Table 1. Infectious agents responsible for granulomatous skin disease in cats

| Aetiological agents         | Bacteria                      | Fungi                      | Protozoa         |
|-----------------------------|-------------------------------|----------------------------|-----------------|
| Non-acid-fast organisms     | Actinobacillus sp, Arcanobacterium pyogenes (previously known as Actinomyces pyogenes), Rhodococcus equi, Staphylococcus sp, Streptococcus sp, Pseudomonas sp, Proteus sp | Microsporum canis, Rhizomucor sp, Mortierella sp, Fusarium sp, Paecilomyces sp, Alternaria sp, Cladophialophora sp, Exophiala sp, Moniliella sp, Curvularia sp, Madurella sp, Pythium insidiosum, Sporothrix schenckii | Leishmania sp |
| Acid-fast organisms         | Nocardia asteroides, Mycobacterium leprae, M tuberculosis, M microti, M chelonae, M fortuitum, M phlei, M thermoresistible, M smegmatis | Cryptococcus neoformans, Sporothrix schenckii, Histoplasma capsulatum, Blastomyces dermatitidis, Coccidioides immitis | - |
| Subcutaneous mycoses        | Rhodococcus equi, Staphylococcus sp, Streptococcus sp, Pseudomonas sp, Proteus sp | Microsporum canis, Rhizomucor sp, Mortierella sp, Fusarium sp, Paecilomyces sp, Alternaria sp, Cladophialophora sp, Exophiala sp, Moniliella sp, Curvularia sp, Madurella sp, Pythium insidiosum, Sporothrix schenckii | Leishmania sp |
| Systemic mycoses            | M leprae, M tuberculosis, M microti, M chelonae, M fortuitum, M phlei, M thermoresistible, M smegmatis | Cryptococcus neoformans, Sporothrix schenckii, Histoplasma capsulatum, Blastomyces dermatitidis, Coccidioides immitis | - |
| Protozoa                     | Leishmania sp                 | -                          | -               |
in the cytoplasm were seen (Fig 3).

Several biopsy specimens were obtained under anaesthesia induced with 80 mg/kg medetomidine (Domitor; Pfizer Animal Health), 0·4 mg/kg butorphanol (Torbugesic; Fort Dodge Animal Health) and 5·0 mg/kg ketamine (Ketaset; Fort Dodge Animal Health), injected intramuscularly from one syringe. Biopsy specimens from the centre of the ulcerated mass and from the surrounding skin were submitted for histopathological examination and a sample from each site was submitted for bacterial, mycobacterial and mycological culture. Thoracic and abdominal radiographic examination did not reveal any abnormalities. The biopsy specimens were submitted to the Mycobacterial Reference Laboratory, Bristol, and to specialist laboratories for fungal, mycobacterial and bacterial cultures. The laboratory involved in the bacterial culture was alerted to the possibility that aerobic and anaerobic bacteria, such as R equi, Nocardia asteroides, Actinobacterium species and Actinobacillus species, could be present. The technique of culturing organisms from a tissue specimen involves crushing the material to release the intracellular organisms. In this case, the technique produced a pure culture of R equi, which was then easy to identify using routine biochemical tests for the species. The biopsy specimens were submitted to specialist laboratories for fungal, mycobacterial and bacterial cultures. The laboratory involved in the bacterial culture was alerted to the possibility that aerobic and anaerobic bacteria, such as R equi, Nocardia asteroides, Actinobacterium species and Actinobacillus species, could be present. The technique of culturing organisms from a tissue specimen involves crushing the material to release the intracellular organisms. In this case, the technique produced a pure culture of R equi, which was then easy to identify using routine biochemical tests for the species.

DISCUSSION

At the time of writing, 11 cases of R equi infections in cats have been reported and all but three of these involve either the digits or other extremities (Higgins and others 1991). In the remaining three cats, internal abscessation and lymphadenitis were present in the same cat. The biopsy specimens were submitted to specialist laboratories for fungal, mycobacterial and bacterial cultures. The laboratory involved in the bacterial culture was alerted to the possibility that aerobic and anaerobic bacteria, such as R equi, Nocardia asteroides, Actinobacterium species and Actinobacillus species, could be present. The technique of culturing organisms from a tissue specimen involves crushing the material to release the intracellular organisms. In this case, the technique produced a pure culture of R equi, which was then easy to identify using routine biochemical tests for the species. The biopsy specimens were submitted to specialist laboratories for fungal, mycobacterial and bacterial cultures. The laboratory involved in the bacterial culture was alerted to the possibility that aerobic and anaerobic bacteria, such as R equi, Nocardia asteroides, Actinobacterium species and Actinobacillus species, could be present. The technique of culturing organisms from a tissue specimen involves crushing the material to release the intracellular organisms. In this case, the technique produced a pure culture of R equi, which was then easy to identify using routine biochemical tests for the species.

The present report describes a case of cellulitis and subcutaneous abscess caused by R equi. A guarded prognosis was given, because of the extent and the chronic nature of the condition. Doxycycline (Ronaxan; Merial Animal Health), at 10 mg/kg every 12 hours, was administered. Despite supportive therapy and antibiotic treatment the cat died within two weeks of diagnosis. A postmortem examination of the thoracic and abdominal organs did not reveal any gross abnormalities. Because of the time lapse between death and necropsy, further samples were not submitted for culture.

Details of the sampling techniques used to detect R equi have not been reported before. In the present case, routine culture techniques using swab samples failed to identify the organism. Using this technique, several morphologically distinct colonies appeared on the plates and the technician inspecting the plate selected those suspected to be pathogens for identification. In this case, Staphylococcus intermedius and β-haemolytic streptococci were isolated from swab specimens taken on different occasions. It is possible that on these occasions the laboratory may have misidentified the colonies of R equi as contaminants or that they may not have grown at all from a swab specimen, since it is an intracellular pathogen. Similar difficulties also appear to have been encountered in human microbiology laboratories (Doig and others 1991).
there is no systemic infection present. In the most recent report, five out of six cats with lesions involving distal extremities recovered after antibacterial treatment, whereas one with a suspected infection of the lungs died (Fairley and Fairley 1999).

Elliott and others (1986) suggested that it might be possible to transfer the organism from one animal to another via a fomite. Therefore, the various attempts to remove infected tissue by wide margin excision by the referring veterinary surgeon may have failed due to the spread of infection during surgery, or because it may already have spread via the lymphatic system. It is postulated that in the present case the organism probably spread via the latter route, because following the initial infection on the right side of the neck, the right submandibular lymph node and parotid gland became involved, and because the clinical signs bore close resemblance to those of ulcerative lymphangitis seen in horses, pigs and ruminants.

A variety of antibacterial agents have been used in the treatment of R equi infection. The isolate in this report was sensitive to enrofloxacin, cefuroxime and tetracyclines. The cat in the present report may not have responded to doxycycline due to poor intracellular penetration, lipid-soluble, which gives it the ability to achieve good intracellular penetration, and it has been advocated as a second-line treatment for other intracellular pathogens, such as opportunistic mycobacterial infections (Gunn-Moore and Shaw 1997). The cat in the present report may not have responded to doxycycline because of the extensive spread of the organism, even though in vitro sensitivity had been demonstrated.

Conclusions

An underlying cause for infection was not identified in the present case, nor in any of the previously reported feline cases. However, bearing in mind that this is an opportunistic organism and with increased use of immunosuppressive treatments in both cancer therapy and, more recently, in organ transplantation in feline medicine, both clinicians and laboratory technicians should not overlook the potential pathogenicity of this organism. Early identification and appropriate treatment may allow successful treatment.

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