Imaging diagnosis and minimally-invasive management of necrotizing fasciitis in a dog

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Summary
Necrotising fasciitis is a rapidly progressive, aggressive bacterial infection of the subcutis associated with significant morbidity and mortality in both man and domestic animals. To the best of our knowledge, this is the first veterinary report of magnetic resonance imaging (MRI) findings in necrotising fasciitis, and the first reported case in a dog to be successfully treated with minimally invasive surgical intervention.

Introduction
Necrotizing fasciitis is a rapidly progressive, aggressive bacterial infection of the subcutis and fascia associated with significant morbidity and mortality in both man and domestic animals (1, 2). The most common isolate in necrotizing fasciitis is B-haemolytic streptococcus, most of which are group G streptococcus (3). Early clinical recognition of necrotizing fasciitis may be difficult, and it is challenging to differentiate the condition from infectious cellulitis (4). Cellulitis involves only subcutaneous tissue and can be treated in most cases with the administration of antibiotic medications alone, whereas necrotizing fasciitis requires emergency surgical intervention including fasciotomy, debridement and drainage (4). To the authors’ knowledge, this is the first veterinary report of magnetic resonance imaging (MRI) findings in necrotizing fasciitis, and the first reported case in a dog to be successfully treated with minimally invasive surgical intervention.

Case report
A two-year-old, 22 kg, entire female Chow Chow dog was presented as an emergency to Animal Health Trust (Newmarket, UK) with a 24 hour history of sudden onset non-weight bearing lameness of the right pelvic limb, progressing to apparent paraparesis. Radiographs obtained by the referring veterinarian on the day of onset showed signs of severe bilateral stifle effusion with osteoarthritis. Management with firocoxib\textsuperscript{a} (227 mg po bid) resulted in minimal improvement. There was no other relevant history or overseas travel.

On physical examination, the dog was found to be non-ambulatory. Severe, diffuse, intensely-painful, pitting oedema of both pelvic limbs were identified; this was worse in the right hindlimb. Neurological examination revealed non-ambulatory paraparesis and, whilst general proprioception and spinal reflexes were normal, the pelvic limbs was impossible due to the severity of the soft tissue swelling. The remainder of the orthopaedic and neurological examinations did not reveal any other abnormalities. Assessment of peripheral pulse quality was not possible in either pelvic limb due to oedema. The dog was pyrexic (40.5\textdegree C), tachycardic (160 bpm), and panting.

The results of serum biochemistry analyses were within normal limits. Haematology demonstrated a mild, non-regenerative anaemia and moderate neutrophilia (WBC 29.8 x 10\textsuperscript{9}/l, reference range 6-18 x 10\textsuperscript{9}/l; band neutrophils 1.19 x 10\textsuperscript{9}/l, reference range 0-0.5 x 10\textsuperscript{9}/l; segmented neutrophils 26.22 x 10\textsuperscript{9}/l, reference range 4-12 x 10\textsuperscript{9}/l).

The findings of thoracic and abdominal radiography were unremarkable. Ultrasonography of the abdomen and right pelvic limb was performed using a broadband curved array transducer (5–2 MHz) and a broadband linear array transducer\textsuperscript{b} (5–12 MHz). Abdominal ultrasonography demonstrated enlarged medial iliac lymph nodes (12 x 14 mm) but was otherwise within normal limits. Ultrasound examination of the right pelvic limb identified a 120 x 50 mm elliptical pocket of flocculent fluid caudolateral to the femur. The pocket extended deep within the fascia between the semitendinosus and biceps femoris muscle laterally, and the semimembranosus and the adductor muscles medially (3 cm caudal to the femoral artery), and extending the entire length of the femur (Figure 1). A 50 x 60 mm fluid filled cavity was also present in the subcutis along the medial aspect of the proximal third of

\textsuperscript{a} Previcox: Merial, Harlow, Essex, UK

\textsuperscript{b} ATL Philips HDI 5000 instrument: Philips Medical Systems, Eindhoven, The Netherlands
the right hindlimb (in the region of the coxo- 
femoral joint). The popliteal lymph node 
was enlarged. A sample of fluid from the 
larger pocket was aspirated under ultra- 
sound guidance. Ultrasound exami-

nation of the left pelvic limb showed dis-
rupted subcutaneous planes, but no dis-
crete fluid pockets.

The findings of the cytological exami-
nation of the aspirated fluid were consistent 
with a suppurative exudate with intra-
neutrophilic Gram positive cocci. Culture 
yielded a heavy growth of Streptococcus 
group G, which was sensitive to clavulani-
c acid potentiated amoxicillin, cephalaxin, 
clindamycin, marbofloxacin, lincomycin 
and trimethoprim sulphonamide, but resis-
tant to gentamicin. Urine culture did not 
yield any growth. Blood culture was not 
yielded any growth. Blood culture was not 
performed.

Initially, the dog was managed with the 
administration of Hartmann’s solution (6 
ml/kg IV), methadone (0.25 mg/kg, IV 
q4h), clavulanic acid potentiated amoxy-
clin® (20 mg/kg IV q6h), and hot packing 
and massage of the limb (q2h). The mas-
age therapy resulted in a reduction in the 
size of the limb by about 50%, but the 
swelling recurred within half an hour (no

circumferential measurements were taken).

The hair around the pelvis and both pelvic 
limbs was clipped, revealing diffuse bruising 
over the medial aspect of the right 
 thigh, but no wounds. Arnica gel® was 
applied every four hours to the sites of bruising.

Coagulation profiles and D-dimers 
were normal and Angiostrongylus vaso-
rum faecal flotation (from a pooled 
sample) was negative.

After five hours, the soft tissue swelling 
of the right pelvic limb appeared to be in-
creased and the bruising appeared more 
extensive and was also noted to be present 
on the caudal ventrum and medial aspect 
of the left thigh. The dog’s demeanour 
became depressed and it developed epistaxis.

It was decided to attempt minimally inva-
sive drainage of the fluid pockets within the 
right hindlimb.

The dog was premedicated with the ad-
ministration of methadone (0.35 mg/kg 
IV) and general anaesthesia was induced 
with diazepam® (10 mg IV) and alfalaxalone® 
(30 mg IV) intravenously. Anaesthesia was 
maintained with isoflurane® in oxygen to 
effect. Under ultrasonographic guidance, a 
skin incision was made over the most 
superficial region of the abscess on the 
proximalateral aspect of the right thigh. A 
pair of Rochester-Carmalt forceps was used 
to stab bluntly through the fascia and into 
the abscess cavity. A sheathed Poole suc-
tion tip was passed into the cavity under 
ultrasonographic guidance and approxi-
ately 250 ml of purulent material was re-
moved. The sheathed suction tip was used 
to break bluntly several thin septae within 
the cavity under ultrasound visualisation.

The cavity was then flushed with three 
litres of warm sterile saline, introduced via 
a rigid urinary catheter which extended to 
the most distal aspect of the pocket and 
flushed until the return of gross debris and 
discoloured solution ceased. The pocket 
was suctioned with the Poole suction tip. 
An active suction drain® was placed into the 
pocket and exited from a single stab inci-
The dog recovered uneventfully from anaesthesia and the previous medical management plan remained unchanged. Additionally, the drainage collection cannister was emptied every four hours. Ninety-millilitres of purulent material were removed within the first eight hours (0.51 ml/kg/h) and a further 80 ml was produced in the subsequent 15 hours (0.24 ml/kg/h), following which fluid production was minimal. Ultrasound examination of the limb was performed every 12 hours for four days to confirm that the pockets of fluid were reducing in size.

Twenty-four hours after drainage placement, body temperature was 38.3°C. After 48 hours, the limb oedema was markedly improved bilaterally and the bruising was moderately improved. The findings of the neurological examination were within normal limits and the dog was able to ambulate although it had a 4/10 hindlimb lameness bilaterally, which was attributed to the severe bilateral stifle disease.

The drain was removed four days after placement and the dog was discharged after a further 24 hours hospitalisation with instructions to the owners to administer sucralfate\(^a\) (0.04 mg/kg po tid), ranitidine\(^g\) (2 mg/kg po bid), firocoxib (227 mg po sid), tramadol\(^h\) (2 mg/kg po tid), and clavulanic acid/potentiated amoxicillin\(^i\) (20 mg/kg po bid) four weeks.

Six weeks after completing the administration of antibiotic medication, the dog was re-examined. With the exception of a 2/10 bilateral hindlimb lameness presumed due to bilateral stifle orthopaedic disease, the dog was found to be clinically normal. Magnetic resonance imaging of the pelvic limbs was repeated to assess residual changes prior to potential surgery for cruciate disease. The signs of myositis, fascial plane inflammation, and fluid filled cavities in the right thigh had resolved (\(\star\)Figure 4A and B). Culture of synovial fluid from both stiﬂes was performed to rule out...

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\(\star\)Figure 3 Post-contrast fat-suppressed T1-weighted images of both thighs at the level of the distal third of both femurs. A) Taken from the same level as \(\star\)Figure 2B. There is extensive enhancement (arrows) of the lateral and caudal subcutis (cellulitis) and deep fascia between the biceps femoris (BF) and adductor (Add) muscles. Abscesses within the caudodistal (black asterisk) and proximomedial (white asterisk) enhance peripherally. The popliteal lymph node (P) is enlarged. B) Taken further distally, between the biceps femoris and the lateral head of the gastrocnemius muscle. Note that the caudodistal abscess (black asterisk) is enlarged. G = lateral head of gastrocnemius. C) Localiser for parts A and B.

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\(^a\) Antepsin: Chugai Pharma Europe Ltd., London, UK
\(^b\) Zantac: GlaxoSmithKlein, Philadelphia, PA, USA
\(^c\) Zantac: GlaxoSmithKlein, Philadelphia, PA, USA
\(^d\) Tramadol Hydrochloride: Tillomed, Cambridge-shire, UK
\(^e\) Noroclav: Norbrook, Corby, UK
joint sepsis and these did not yield any growth.

The dog was re-examined nine months following the initial episode and no further signs of necrotizing fasciitis were apparent.

Discussion

Necrotizing fasciitis is diagnosed by clinical suspicion, signs of severe pain, bacterial culture, and importantly, a lack of resistance of normally-adherent fascia to blunt dissection (5). Necrotizing fasciitis primarily involves superficial fascia, subcutaneous fat and deep fascia. According to the classification by Giuliano, extremity lesions are usually monomicrobial and involve skin flora, as in the current case (3). Necrotizing fasciitis of the extremities in humans is most often secondary to trauma or may develop at the site of a scratch or even in seemingly intact skin (6). Similarly, there were not any wounds apparent in this case, even after complete clipping of the coat, although wounds may have been missed and penetrating injuries may have a small entry wound. The most common isolate in necrotizing fasciitis in the dog is the commensal group G streptococcus (7).

In man, plain radiography, computer tomography, ultrasonography, and MRI have been used to aid in diagnosis of necrotizing fasciitis (8-12). Magnetic resonance imaging has been demonstrated to be reliable in the differentiation between necrotizing fasciitis which requires immediate surgical intervention and cellulitis which can be treated medically (4, 11). At present, definitive diagnosis of necrotizing fasciitis is made only at surgery when extensive undermining of the surrounding tissues is discovered, with the fascial plane lacking resistance to a blunt instrument as seen in the current case with a Poole suction tip (4). On MRI, cellulitis is seen as subcutaneous thickening with fluid collections on T2-weighted images, contrast enhancement of subcutaneous tissue or superficial fascia or some combination of these signs (4). For the diagnosis of necrotizing fasciitis, MRI reveals additional involvement of deep fascia with large fluid collections, thickening, and enhancement after contrast administration, as seen in the current case. It has been concluded that MRI appears to be the method of choice to differentiate necrotizing fasciitis from cellulitis (4).

In the current case, ultrasonography was useful for identification of large subcutaneous pockets within the lateral and medial aspects of the affected limb. Magnetic resonance imaging was able to better define the extent and complex appearance of these pockets and to ensure that additional cavities were not overlooked using ultrasound. Gas introduced during drain placement could have affected image quality and assessment of the changes but was not a feature in this case. Magnetic resonance imaging was performed after placement of the drains, which may have influenced the appearance of the changes on MRI by reducing the size of the cavities and limiting assessment of communication between these areas. However, it is accepted that initiation of therapy or management is usually necessary as the condition is rapidly-progressive and may be fatal. For completeness, MRI would have also been performed both before and after drain placement, but this was difficult to justify financially in this client-owned patient case. The findings of the post-drainage MRI therefore influenced the decision not to proceed with more invasive surgical intervention. The smaller pocket was not drained because of its small size and the rapid clinical improvement.

Follow-up MRI allowed complete resolution of muscle condition to be documented before any potential surgical correction of cruciate disease requiring surgical implants.

Treatment of necrotizing fasciitis is surgical, involving early debridement of all necrotic tissue and provision of drainage, usually via extensive fasciectomy (2). Because of the potential for rapid disease progression, the medical human literature recommends extensive surgery, with excision of as much as 45% of the entire patient surface area (2). This protocol is currently recommended in veterinary medicine, requi-
ring extremely intensive, costly and prolonged postoperative care, and sometimes necessitating amputation (13). In the case described here, the abscess identified on ultrasonography was largely confined to a single cavity, which was considered amenable to drainage via a minimally-invasive technique. The success of this drainage was confirmed by MRI. The authors propose that this was the case because the abscess was superficial and a deeper abscess may not be amenable to minimally-invasive drain placement. Ultrasound provided a cost-effective, quick, non-invasive method of identifying fluid cavities, provided an idea of cavity depth and allowed postoperative monitoring.

Intense physical therapy, including hot packing, massage and passive range-of-motion exercises, may have contributed to increased blood flow and lymphatic drainage of the affected area. Unfortunately, pressure within the right thigh musculature was not objectively measured in this case. It is possible to speculate that some element of necrosis in similar cases may be the result of elevated compartmental pressure, rather than solely secondary to bacterial activity. The rapid fasciotomy and drain placement in this case may have relieved this component of the disease process. It is only possible to speculate as to the causes of the initial signs of neurological deficits. The dog may have been non-ambulatory because of the inability to move the hindlimbs secondary to the massive soft tissue swelling and pain, or there may have been true nerve impairment or damage secondary to a compartment syndrome or pressure from the abscess.

Minimally invasive management may offer the benefit of reduced hospitalization (five days) compared with other reports, which is particularly important in young dogs where prolonged institutional care may cause behavioural problems which may lead to euthanasia (13).

However, these cases in young dogs involved subperiosteal abscesses and we have no evidence that this minimally invasive technique will be successful in subperiosteal lesions (13). Potential complications that may have been encountered using this approach could have included neuropraxia, particularly of the sciatic nerve, and vascular damage. In order to minimize these risks, the stab incision into the abscess cavity was made under ultrasonographic guidance and blunt techniques using a sheathed Poole suction tip were used within the cavity. If neurological trauma had been caused by this technique, postoperative assessment and confirmation of damage would have been challenging because of our inability to achieve a complete neurological examination.

**Conclusion**

A novel method of minimally-invasive treatment for acute necrotizing fasciitis in a dog is presented, using ultrasound-guided fasciotomy, lavage, and drain placement. Additionally, MRI was used immediately following drain placement to validate the minimally invasive management strategy and again at 10 weeks thereafter to document resolution of fascial changes. The information provided may be useful in selected cases of necrotizing fasciitis for which minimally invasive management is appropriate and this technique may significantly reduce the length of hospitalisation and treatment cost.

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**Conflict of interest**

None declared.

**References**