FOOD/FARMED ANIMALS

Laser ablation and management of a retropharyngeal abscess caused by Corynebacterium pseudotuberculosis in a ram

Adam Copeland,1 Amanda Speckels,1 Paul Merkatoris,2 Ryan M Breuer, Jennifer A Schleining,2 Joseph Smith

SUMMARY
A one-year-old crossbred ram presented for acute respiratory distress. Initial diagnostics revealed compression of the pharynx by a spherical, avascular mass. The ram was initially managed with a tracheostomy, antimicrobials and non-steroidal anti-inflammatories. Advanced imaging confirmed a pharyngeal abscess which was managed via endoscopic-guided laser procedure. While synergistic haemolysin inhibition (SHI) testing was negative, Corynebacterium pseudotuberculosis was cultured from the exudate, indicating a false negative result by the SHI test and the potential for a lack of reliability of this test in sheep with internal abscession. Clinicians should be aware of the utility of diagnostic imaging as well as the use of endoscope-guided laser procedures in areas where traditional surgical approaches are challenging, such as the upper airway of sheep.

BACKGROUND
Corynebacterium pseudotuberculosis, the causative agent of caseous lymphadenitis (CLA), is a pathogen of worldwide economic concern. Aside from carcass condemnation, CLA can profoundly decrease average daily gain and fibre quality of small ruminants. Once in the lymphatics, internal or external lymph node abscessation may occur. In severe cases, C pseudotuberculosis may simultaneously affect both superficial and deep nodes, with the preascapular, submandibular and parotid lymph nodes of small ruminants being the most commonly affected.1 However, similar infections have been reported in people, horses, camels and alpacas.2-4

Although facilitated drainage of superficial abscesses by lancing and lavage can resolve cutaneous masses, proper exudate disposal is essential for pathogen containment, especially since C pseudotuberculosis can survive in soil for at least eight months.5 It is generally recommended to isolate affected animals until all draining lesions have resolved to mitigate exposure to unaffected animals. Other treatment techniques for external abscesses include en bloc removal under general anaesthesia or intralesional inoculation with tulathromycin.6 Clinical resolution of external abscessation is achievable; however, treatment of internal lesions can be challenging and unrewarding, as evidenced by a 40 per cent mortality in equine patients with disseminated disease.7 Although abattoir surveillance studies report a 34 per cent infection prevalence,8 prognostication of similar CLA infections among small ruminants is challenging due to a lack of reporting in literature. Even still, approximately 17 per cent of affected small ruminants succumb to CLA as a result of abscess-induced respiratory dysfunction.9 Nonetheless, antibiotics and anti-inflammatories have become the mainstay of therapy for affected equine patients, with clinical resolution reported between 36 and 97 days of treatment.7 9

Although CLA commonly affects small ruminants, literature on treatment and prognosis for retropharyngeal abscesses caused by CLA in sheep is sparse. The case presented herein describes a novel surgical and medical management approach to C pseudotuberculosis infection in an uncommon anatomical location in a ram.

CASE PRESENTATION
A one-year-old, 125-kg crossbred ram was examined on-farm by a veterinary college food animal ambulatory service on emergency for tachypnoea and acute respiratory distress. The animal had been individually housed within a barn and was last evaluated by the owner during morning feeding of a commercial sheep diet, six hours before veterinary examination.

Initial vital parameters included a 39.7°C rectal temperature, a heart rate of 120 beats per minute and a respiratory rate of 160 breaths per minute. No abnormal lung sounds were auscultated; however, breaths were shallow and auscultation of the larynx revealed severe stridor. Ocular mucous membranes were pink and synonymous with a FAMACHA score of 1.

After suspecting an upper airway obstruction, the ram was referred to the university hospital for further evaluation. A temporary tracheostomy tube was not available for placement before transportation. Instead, the ram received 0.2 mg/kg butorphanol (Torbugesic; Zoetis) intravenously before shipment to decrease total body oxygen consumption and provide mild sedation for the distressed animal.

On presentation to the university food animal teaching hospital, the ram was in profound respiratory distress. Mucous membranes remained pink.
and tacky, with a capillary refill time of two seconds. The rectal temperature had risen to 40.2°C, while the heart rate decreased to 80 beats per minute. Respirations remained unaltered at 170 breaths per minute, and cardiopulmonary auscultation remained static. All palpable lymph nodes were symmetrical and normal; ruminal fill and succussion were within normal limits.

**INVESTIGATIONS**

Initial complete blood count results indicated a leucocytosis of 14.68 x 10^3/µl (reference range (RR): 4.0–12.0 x 10^3/µl) with a mature neutrophilia of 8.73 x 10^3/µl (RR: 0.7–6.0 x 10^3/µl) and mild hyperfibrinogenaemia of 600 mg/dl (RR: 100–500 mg/dl), consistent with an infectious or inflammatory process. Venous blood gas analysis revealed a moderate respiratory alkalosis and mild metabolic acidosis (pH 7.58; pCO₂ 21.3 mmHg; HCO₃⁻ 20.4 mEq/l). However, aerobic contamination during ruminal fill and succussion was within normal limits.

Venous blood gas analysis revealed a moderate respiratory alkalosis and mild metabolic acidosis (pH 7.58; pCO₂ 21.3 mmHg; HCO₃⁻ 20.4 mEq/l). However, aerobic contamination during sample handling was suspected due to elevated venous pO₂ (145.9 mmHg). Serum biochemistry values were clinically unremarkable.

Lateral cervical radiographic projections revealed tracheal discontinuity and near-complete pharyngeal obstruction due to a large, smoothly marginated soft tissue mass approximately 7.5 cm x 3.7 cm (figure 1). Adjacent cervical osseous and soft tissue structures were normal; thoracic radiographs were also normal. On confirmation of an upper respiratory obstruction, a temporary tracheostomy was performed to stabilise the patient. Approximately 5 ml of 1 per cent lidocaine (Lidocaine HCl 2%; Vet One) provided sufficient local anaesthesia to allow a 3-cm ventral midline skin incision along the cranial one-third of the neck. The paired sternohyoideus and sternothyroideus muscles and fascial tissue were bluntly dissected to facilitate a circumferential incision in the annular ligament between the eighth and ninth tracheal rings encompassing approximately one-third of the tracheal diameter. To facilitate tube replacement, stay sutures were individually placed around the eighth and ninth cartilage rings; manual traction was applied on the stay sutures to widen the tracheal opening to allow tube replacement. After establishing airway patency, the pleural surface and thoracic cavity were assessed as normal with ultrasonography.

Although not currently validated for ovine species, a synergistic haemolysin inhibition (SHI) test was performed to differentiate CLA abscess from other differential diagnoses. Current equine reference ranges suggested the 1:8 titre reported in this case was negative for CLA.

Since the ram stabilised after temporary tracheostomy placement, further imaging for in situ visualisation and surgical planning was deferred until the third day of hospitalisation when a full technical support staff could be present. A cervical CT study with contrast was performed under general anaesthesia in left lateral recumbency from the caudal nasal cavity through to cervical spinal region of C4. Imaging was performed before and after administration of intravenous iohexol. The image shows that the left retropharyngeal lymph node was severely enlarged and causing obliteration of the normal gas column of the pharynx. This enlargement has a thick, contrast-enhancing rim and a more fluid attenuating centre with striations of stippled mineral. The vessels did not course through the mass, but multiple vessels, including the carotid artery, coursed around the mass. A second left-sided enlarged lymph node was present as well between the mass and the jugular vein. The right retropharyngeal lymph node was normal. There was also stippling mineralisation at the centre of the lymph node, indicating a chronic pathogenesis. At this time chronic abscess of the left retropharyngeal lymph node and reactivity of an adjacent lymph node was diagnosed and was most consistent with caseous lymphadenitis secondary to Corynebacterium pseudotuberculosis infection.
Figure 3  The red arrow points to a thick rim of the lymph node that is enhanced with contrast. This hyperattenuation indicates that the vessels were not coursing through the lymph node, but around the lymph node. The lack of hyperattenuation within the lesion provides support for a retropharyngeal lymph node abscess and less for a neoplastic mass.

Figure 4  Nasopharyngeal endoscopy image. A large space-occupying lesion was observed in the pharyngeal region, obstructing the airway.

After 13 days of medical management for undulating respiratory distress and pyrexia, the patient underwent surgical intervention via nasopharyngeal endoscopy. Intravenous administration of 0.002 mg/kg acepromazine (Acepromazine; Vet One) and 0.48 mg/kg morphine (Morphine Sulfate; Hikma Pharmaceuticals) provided satisfactory sedation before induction with 2 mg/kg lidocaine, 0.5 mg/kg ketamine (Ketaset; Zoetis) and 1.35 mg/kg propofol (Propofol 1%; Hospira). Once intubated with a 10-mm endotracheal tube through the tracheostomy site, the patient was placed in right lateral recumbency. The neck was elevated with the rostral portion of the head oriented downward to allow drainage of abscess contents through the nasal and oral cavities. The pharyngeal region was noted to be markedly swollen (figure 4). The enlarged retropharyngeal lymph node was visualised with a 1-metre flexible endoscope through the right nasal passage. A 600-micron bare diode laser, with energy output of 12 W, was passed through the endoscope instrument chamber to create multiple punctate incisions in the rostroventral surface of the abscess. Then, malleable laparoscopic grasping forceps were used to connect the punctate lesions through blunt dissection and ruptured the capsule, allowing copious amounts of caseous material to enter the nasal cavity. After collecting a sample for culture, a 10-mm Tom Cat catheter was used to lavage the area with saline until all visible debris exited the nostrils through gravity-assisted drainage and a Poole suction set. Anaesthetic recovery was smooth and uneventful.

Culture and antimicrobial susceptibility testing confirmed florfenicol-susceptible *C. pseudotuberculosis*. Therefore, the original antibiotic regimen was continued at the initial dose and interval for a total of seven doses over 28 days. Additional antimicrobial options listed on the antimicrobial susceptibility report were ampicillin, cefotiofur, chlorotetracycline, clindamycin, enrofloxacin, florfenicol, gentamicin, neomycin, oxytetracycline, sulfadimethoxine, tiamulin and trimethoprim/sulphamethoxazole.
OUTCOME AND FOLLOW-UP
Once the airway was deemed stable and patent, the tracheostomy tube was removed six days after surgery to facilitate tracheostomy site healing. General health and appetite of the patient remained within acceptable parameters for the duration of hospitalisation. The ram was discharged 24 days after presentation when cervical radiographs confirmed airway patency and resolution of the retropharyngeal abscess (figure 5). On-farm recommendations included pen confinement in a well-ventilated barn, administration of the final florfenicol dose, 1 mg/kg meloxicam every 48 hours for four doses and sexual rest until the tracheostomy site completely healed.

The owner declared full recovery and successful breeding seasons during the telephone follow-ups at 8 and 17 months after discharge. No further CLA lesions or deleterious effects from the surgical procedures were identifiable by the owner. Subsequent cases of CLA have not been diagnosed on-farm.

DISCUSSION
*C. pseudotuberculosis* is thought to spread via insect vectors, or direct contact with exudate or contaminated equipment. Although the environmental longevity of *C. pseudotuberculosis* in natural conditions is uncertain, it remained detectable throughout an eight-month study. Additionally, sandy or rocky earth and the presence of faecal debris promoted the bacteria’s environmental survivability. In vitro studies comparing the sensitivity of *C. pseudotuberculosis* to common veterinary disinfectants, including iodine, chlorhexidine, chlorine and quaternary ammonia, determined 0.625 per cent or greater concentration of a chlorhexidine solution was a superior disinfectant as it determined 0.625 per cent or greater concentration of a chlorhexidine solution was a superior disinfectant as it inhibited 100 per cent of bacterial growth. Common fomites of CLA in small ruminant operations include shearing equipment, milking machines and lambing pens. Therefore, minimising skin abrasions during processing and disinfecting equipment with chlorhexidine between animals may reduce herd prevalence.

Other preventive methods aim to reduce stocking density, head butting and the introduction of subclinical carriers to the herd.

Another technique for disease prevention is immune modulation through vaccination. The efficacy of phospholipase D (PLD) toxoids, *C. pseudotuberculosis* bacterins or combination products in ruminant species has been extensively investigated around the world. In 2006, work done by Fontaine and others suggested a bacterin–toxoid combination vaccine could effectively prevent the spread of infection from experimental inoculations of *C. pseudotuberculosis* in sheep. Similar protection was demonstrated in a small ovine study using multiple biovars for vaccination and experimental inoculation. Injection site reactions were the most commonly reported adverse event across all studies. Despite experimental success, CLA vaccination protocols can be challenging to implement due to legal constraints, vaccine availability or disease prevalence among severely infected animal populations. One should always consider herd CLA prevalence and eradication goals of the owner when recommending vaccination, prevention and treatment protocols as producer compliance can be rate-limiting.

To the authors’ knowledge, this is the first reported surgical laser treatment of a retropharyngeal abscess caused by *C. pseudotuberculosis* in a ram. The novel approach of laser ablation through the right nasal passage with a flexible endoscope adds another treatment modality to small ruminant clinicians when treating peripharyngeal abscesses. Laser surgical techniques have been described and compared in equine literature for treatment of various upper airway procedures, including ventriculocordectomy and epiglottic entrapment correction. However, use of this surgical modality is scarce to non-existent in ruminant surgery literature. Previously described surgical treatments of CLA abscesses in small ruminants include lance and drain, intrathoracic tulathromycin infusion, or en bloc removal of affected lymph nodes under general anaesthesia.

As demonstrated in this case, CLA can manifest in any lymphatic tissue and cause a variety of clinical signs. Moreover, abattoir surveillance studies have reported a natural carcase prevalence of 1.3–15.66 per cent with lymphatic, liver, lung, large intestine, kidney and oesophageal tissue involvement. As a result, economic loss from growth performance, reproductive inefficiency, wool yields and carcase condemnation can be expected regardless of abscess location.

*C. pseudotuberculosis* is subdivided into biotypes equi and ovis, named after the respective species in which they predominately infect, based on their ability to reduce nitrate to nitrite. Interestingly, biovar equi can perform this reduction reaction, while biovar ovis cannot. Nonetheless, all *C. pseudotuberculosis* isolates produce a PLD toxin, which is the foundation for the SHI test. The SHI test measures the highest serum dilution that will inhibit haemolysis of sensitised bovine red blood cells when combined with known concentrations of *C. pseudotuberculosis* PLD toxin. The diagnostic value of this test for the detection of *C. pseudotuberculosis* abscesses varies with species, dissemination of disease and chronicity of infection. It has not been validated in sheep but may have utility promise as a diagnostic tool in small ruminant infections. In one study, sensitivity and specificity of the SHI test in sheep are reported as high as 100 per cent and 90 per cent, respectively. However, titre results should always be analysed in conjunction with clinical signs as the aforementioned study additionally reported a 61 per cent specificity when evaluating a different cohort. While the original SHI tests considered a titre exceeding 1:4 as positive, validated equine titre thresholds are published as follows: titres of 1:512 or greater indicate active infection; 1:16

Figure 5 Lateral projection radiographs were repeated before discharge to monitor regression of the lanced abscess. The soft tissue convexity is still present but moderately decreased in size from the presenting radiographs (figure 1). The gas column of the pharynx is much larger, indicating more space for air to pass from the upper respiratory tract to the lower respiratory tract. The red arrow indicates an area of increased soft tissue opacity due to the healing site of the tracheostomy tube placement.
or lower is negative; and results between 1:16 and 1:128 are infection suspects. To further complicate test interpretation, external abscesses have been associated with decreased SHI test accuracy, possibly due to acute infection, rapid abscess maturation or immunoglobulin consumption throughout the disease process. As evidenced by this case, clinicians should interpret SHI test results from sheep with caution, as false negative results are possible.

In addition to the SHI test, other antemortem modalities of CLA detection have been investigated, including microagglutination assays, immunodiffusion tests, dot blots, western blots, complement fixation, indirect haemagglutination inhibition and various ELISAs. Of these, the double-antibody sandwich ELISA developed by ter Laak and others in 1992, as the source of infection. Investigators suspected contaminated hay correctly identified a subclinical retropharyngeal abscess as part of a flock evaluation. In one eradication pilot study, this type of ELISA programme. In one eradication pilot study, this type of ELISA correctly identified a subclinical retropharyngeal abscess as part of a flock evaluation. Investigators suspected contaminated hay as the source of infection.

To the authors’ knowledge, no study has evaluated the efficacy of topical diclofenac in sheep. Nonetheless, diclofenac has been used to treat inflammatory conditions in both people and other animal species through non-selective COX (cyclooxygenase) inhibition and reduction of both PGE2 (Prostaglandin E2) and interleukin-6. Although uncommonly reported in animals, common adverse reactions of topical diclofenac in people are dryness, rash and pruritus at the application site. Caution should be used in patients at an increased risk for gastrointestinal ulceration, as nausea and ulcers have also been reported after a single application. Adverse reactions were not seen in this ram. It must be noted that use of diclofenac in sheep is an extra-label drug use and must be prescribed by a veterinarian. The prescribing veterinarian is responsible for contacting the appropriate governing body (eg, Food Animal Residue Avoidance Databank in the USA) for guidance on an appropriate drug withdrawal period after each use in food-producing animals.

Oclusion of the respiratory tract by a blood clot on day 9 presents a complication that clinicians should be aware of when managing animals with tracheostomies. While not commonly reported, these clots can lead to lethal consequences. A recent report described death in a reindeer due to complete endotracheal tube occlusion with a blood clot. Clients should be aware of this potential complication when considering long-term management of small ruminants with airway obstructions.

The ram in this case received extra-label, extended use of the antimicrobial florfenicol. While monitored frequently for adverse effects, none was noted with respect to anaemia. Bone marrow hypoplasia secondary to florfenicol toxicity has been reported in a gazelle administered 10 times the labelled cattle dose of this product, indicating that anaemia may be a potential complication of extended exposure to florfenicol in ruminant species.

In conclusion, the pharyngeal lymph node abscess and the secondary airway obstruction observed in this case were diagnosed via radiography, CT and endoscopy. Before hospitalisation and endoscopy-guided surgical laser ablation, the occluded airway was managed with an emergency tracheostomy placement. Although the SHI test was negative, culture of the abscess contents indicated the presence of C pseudotuberculosis. The ram was additionally managed with florfenicol and non-steroidal anti-inflammatories and discharged with no complications observed at least 17 months postdischarge. Clinicians should be aware of the utility of advanced imaging and endoscope-guided laser surgery of the upper airway for management of C pseudotuberculosis abscesses in the pharyngeal region in sheep.

Learning points
- As evidenced by the present case, the synergistic haemolysis inhibition test may not be a reliable diagnostic tool for detecting internal caseous lymphadenitis abscesses in small ruminants.
- Retropharyngeal abscesses can be successfully drained into the nasal passage by passing a 1-metre flexible endoscope and 600-micron bare diode laser through the nostril under general anaesthesia.
- Diclofenac can be considered as a management tool for dermal swellings in sheep.

Contributors AC, AS, PM, RMB, JCS and JSS all contributed to case management and manuscript construction.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests None declared.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement All data relevant to the study are included in the article.

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ORCID iDs Ryan M Breuer https://orcid.org/0000-0001-9439-102X
Joseph Smith https://orcid.org/0000-0002-4288-2262

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