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SUBTOTAL PERICARDIECTOMY FOR TREATMENT OF CONSTRICTIVE EFFUSIVE PERICARDITIS IN A LLAMA CRIA

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ABSTRACT

A 2 month old llama cria was evaluated for lethargy and intermittent fever. A physical examination revealed a holosystolic murmur (3/6) over the tricuspid valve area and an enlarged umbilicus suggestive of an abscess. An echocardiography revealed severe enlargement of the atriums, ventricular hyperkinesia and mild increase of the pericardial fluid mainly organised as fibrin. A diagnosis of constrictive effusive pericarditis was made. To increase the ventricular segmental fraction, a subtotal pericardiectomy was suggested. After resection of the 5th rib, a left thoracotomy was performed to expose the heart. 60% of the pericardium was then removed. The cria recovered uneventfully from the surgery. Seven days after the surgery a control echocardiography was performed. No more effusion was surrounding the heart. However, the cria showed signs of cardiac failure (enlarge vessels, abdominal effusion). Two weeks after the pericardiectomy, the cria gained weight and was clinically normal, hence was discharged from the hospital. A laparotomy was performed to remove umbilical abscess. At follow up, the owner reported that the cria died suddenly without showing any signs of lethargy. In conclusion, this case demonstrates that a pericardiectomy can be performed in llama cria from a left thoracotomy.

Key words: Cria, llama, pericarditis, pericardiectomy, umbilical abscess.

Cardio-vascular diseases are uncommon in llamas. Congenital heart defect, mainly ventricular septal defect, is the most common cardiac abnormality in neonates. Llama crias are born agamaglobulinemic and insufficient colostrum intake results in failure of passive transfer predisposing to a greater risk of developing septicaemia. Which may lead to a variety of complication including septic arthritis, osteomyelitis, meningitis, endocarditis and pericarditis. The later complications are rare and surgical management of pericarditis has not been reported in llamas. The objective of this report is to describe the surgical approach and technique to perform a pericardiectomy in a llama cria.

Case report

A two month old female llama cria, weighing 30 kg was born in a muddy area of the pasture and was an unthrifty or "poor doer" since soon after birth but was presented because of a 10 days history of lethargy. Those signs were associated with spikes of fever (>39.0° C). Multiple antibiotics (Florfenicol, Penicillin, and Enrofloxacin) and anti-inflammatory drug (Flunixine meglumine) were used unsuccessfully to control the fever. Upon her arrival at the hospital, the cria was bright and alert and had a slightly increased rectal temperature (39.4° C). Cardiac auscultation revealed a holosystolic heart murmur (3/6) with the point of maximal intensity over the heart base close to the tricuspid valve area. Haematology tests revealed an increased white blood cell count (40.8 x10^9/l reference range: 7.4-19.9 x10^9/l) with a severe neutrophilia (35.9 x10^9/l reference range: 3.5-13.7 x10^9/l), regenerative anaemia (PCV=21% reference range 24-40, RBC=9.4x10^{12}/l reference range 8.8-16.1 x10^{12}/l, 126 nucleated red blood cells/100 WBCs) and hypoproteinemia (5.1 G/dL reference range 5.6-7.2 g/dL). A routine serum biochemistry profile was within normal limits. Later during the day, the cria showed clinical signs of weakness characterised by the inability to stand upright. The cria was still conscious of her surroundings, but not responsive to external stimuli. A blood culture (10 ml sample from the jugular vein) was performed and an 18 gauge indwelling catheter was placed in the jugular vein to allow use of Na-ceftiofur 2.2 mg/Kg IV BID [Naxcel, Pharmacia & Upjohn, Research Triangle Park, North Carolina, US] and Flunixine meglumine 1 mg/Kg IV BID [Banamine, Shering-Plough, Union, New-

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Jersey, US]. The day after admission, an abdominal ultrasound revealed the presence of an enlarged liver and spleen and the presence of an umbilical abscess (7 mm in diameter). The abscess was aspirated and submitted for microbial culture. Thoracic radiographs with the animal in lateral recumbency revealed increased alveolar and interstitial densities suggestive of a mild bronchopneumonia without evidence of intrathoracic or mediastinal abscess. In addition, biatrial enlargement, pulmonary vein dilatation, and caudal vena cava engorgement suggestive of increased preload and equivocal congestive heart failure were noted. A complete echocardiographic study including two dimensional (2D), M-mode and Doppler examinations from both side of the heart revealed several abnormal findings. There was severe left and right atrial enlargement (left and right atrial end-systolic septal-to-free wall dimensions 7.14 cm and 6.47 cm, respectively). The left and right ventricular systolic and diastolic dimensions as well as wall thickness were unremarkable, and left ventricular segmental shortening fraction was 54%, indicating ventricular hyperkinesia. The heart was surrounded by a small amount of fluid mainly organised in a hyperechoic, fibrinous appearing tissue that involved the epicardial surface of the ventricles and both left and right atrium (Fig 1). A left-to-right shunting atrial septal defect was also detected (peak velocity at atrial systole 1.8 m/s), indicative of a left-to-right atrial pressure difference of 13 mm Hg (Fig 2). Filling of the left ventricle ended abruptly in early diastole and was associated with visible, not commonly seen wall vibrations. The transmitral early and late filling flow velocity waves were fused (peak velocity 1.55 m/s) with a short deceleration time (24 ms) suggestive of increased left ventricular filling pressure. There was increased respiratory variation of pulmonary vein flow velocities, a common sign of restrictive left ventricular physiology in people (Fig 3) (Ducharme *et al,* 1992). Colour and spectral Doppler showed mild to moderate regurgitation of the tricuspid and the mitral valves with regurgitant jets located centrally. Peak tricuspid regurgitant velocity was 3.48 m/s suggestive of mild pulmonary hypertension (estimated pulmonary artery pressure > 48 mm Hg). A tentative diagnosis of constrictive pericardial disease, most likely due to constrictive pericarditis was made. The prognosis for this condition was considered grave. An exploratory thoracotomy with a subtotal pericardiectomy was recommended. In the mean time, the results of the blood culture revealed *Pseudomonas* species and the culture of the umbilical abscess revealed lactose negative *E coli*. Gentamicin (5 mg/kg IV SID for five days) [Gentocin, Schering-Plough, Union, New-Jersey, US] was added to her treatment schedule based on the microbial susceptibility testing.

The cria was induced for general anaesthesia with a "double drip" solution made of Guaifenesin (5%) [Guaifenesin, Vedco, St-Joseph, Montana, US] and Ketamine (1 mg/ml) [Ketaset, Fort Dodge Animal Health, Division of Wyeth, Fort Dodge, Iowa, US] given to effect. An oro-tracheal tube was placed and anaesthesia maintained with Isoflurane gas (2.0%) [Isoflo, Abbott Laboratories, North Chicago, Illinois, US]. The animal was ventilated with a mechanical ventilator throughout the surgery. The animal was placed in right lateral recumbency and the left thoracic wall was shaved and aseptically prepared. Using a number 10 scalpel blade, a skin incision of 12 cm was made over the 5th rib. The subcutaneous tissues were bluntly dissected to expose the periosteum of the 5th rib. The periosteum was incised longitudinally along the rib and elevated with a periosteal elevator. Exposure of the thoracic cavity was poor; therefore, 5 cm of the rib was excised using an OB wire. A Finochietto rib spreader was used to further expose the thoracic cavity. Approximately 50 ml of serosanguinous fluid with fibrin was present within the pericardial sac. The pericardium was incised and a sample of the pleural effusion was obtained for cytology and bacteriology. A T-shaped incision ventral to the phrenic nerve was made and approximately 60% of the pericardium was removed (Fig 4). The pericardium was submitted for histopathologic examination. Exploration of the thoracic cavity was made and showed no other abnormality. The pleural cavity was flushed with sodium chloride solution. A 12 French chest tube was placed into the thoracic cavity. The drain was introduced by a skin incision at the level of the 10th intercostal space and passed under the skin to the 7th intercostal space where it entered the thoracic cavity. A Heimlich valve was placed at the end of the drain and suction was applied to allow proper drainage of the cavity. The thorax was closed in routine fashion. The first layer included the pleural serosa and the periosteum of the 5th rib and was closed in a simple continuous pattern with 0 Polydioxanone [PDS II, Ethicon inc, Johson and Johnson co, Somerville, New-Jersey, US]. The second layer included the intercostal muscle and the subcutaneous tissue and was closed in a simple continuous pattern with 2.0 Polyglactin 910 [Vicryl, Ethicon inc, Johson and Johnson co, Somerville, New-Jersey, US]. The skin was closed appositionally with skin staples. All remaining free air within the left hemithorax was removed using

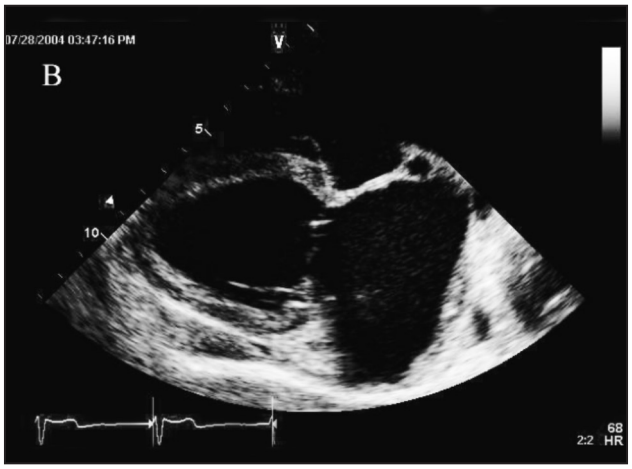

Fig 1-A. Right parasternal long-axis view (systolic frame) demonstrating left atrial enlargement, an atrial septal defect (dotted arrow), and increased thickness and abnormal content (soft tissue opacities and fluid filled pockets) of the pericardium next to the left ventricular posterior wall (solid arrows).

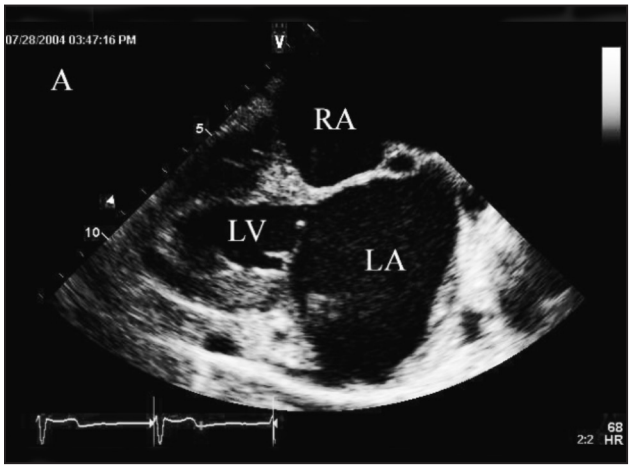

Fig 1-B. Systolic frame. RA, right atrium; LA, left atrium; LV, left ventricle.

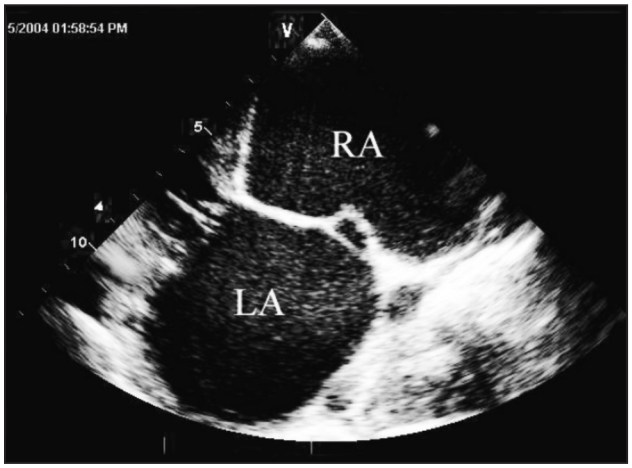

Fig 2. Right parasternal long-axis view demonstrating biatrial enlargement. RA, right atrium; LA, left atrium.

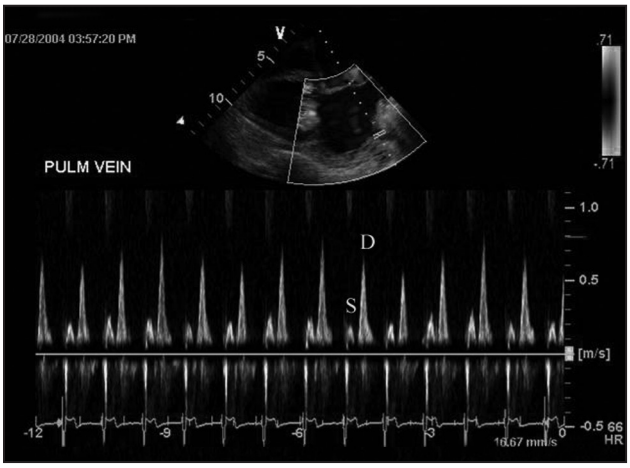

Fig 3. Right parasternal long-axis view demonstrating exaggerated respiratory variation of Doppler pulmonary vein flow suggestive of restrictive physiology of left ventricular filling. Notice the abrupt cessation of diastolic pulmonary vein flow most commonly associated with increased left ventricular filling pressure. S, systolic flow wave; D, diastolic flow wave.

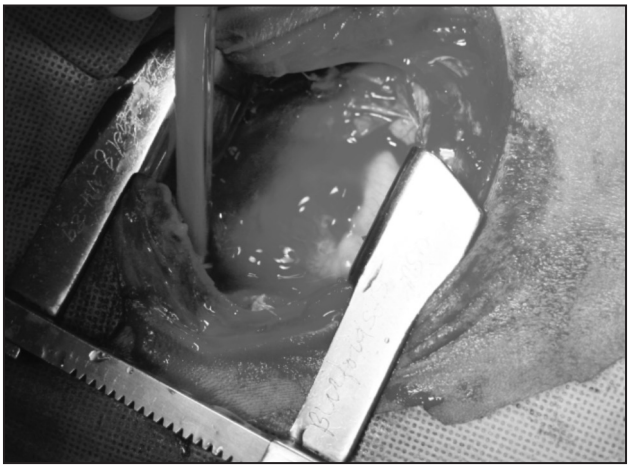

Fig 4. Pericardium and heart expose after a 5th rib resection from a left side approach.

suction applied via the thoracic drain tube. Morphine (0.2 mg/Kg) [Morphine, Baxter, Baxter Healthcare Corporation, Deerfield, Illinois, US] was given IV and 1 ml of lidocaine [Lidocaine 2%, Butler Co, Phoenix Scientific, St-Joseph, Montana, US] was injected at the extremities of the sectioned 5th rib to provide postoperative pain relief.

The animal remained stable throughout the procedure. Anaesthesia and extubation were uneventful. No signs of respiratory distress or discomfort were noted. The chest tube drained pleural and pericardial effusions at a slow rate (i.e. < 1 drop per 2 seconds) for the first day. On the second day, the Heimlich valve was obstructed with fibrin and was replaced. At that time, 120 ml of serosanguinous fluid was drained with a syringe.

On the third day, no drainage was noted and no fluid could be aspirated from the tube. The tube was then removed. The cria's appetite returned to normal within 24 hours after thoracotomy and pericardial resection. No signs of lethargy were noted, and rectal temperature remained normal. The cytology result of the pericardial fluid sample showed an increase in the white blood cells (7,000 cells/µl) with a predominance of degenerate neutrophils (84%) consistent with a suppurative inflammation. No bacteria were found in the sample and microbial cultures were negative at that time. Gross pathology of the excised pericardium showed diffuse thickening (several millimetres in some areas). Histology of various sections revealed a multifocal oedema with congestion of the capillaries associated with neutrophil margination. A presumptive diagnosis of acute pericarditis was made. The pericardium from another cria of the same age euthanised for a reason non-related to heart failure or to a septic process was submitted for comparison of anatomic and histologic features. The normal cria's pericardium was thin (70 to 100 µm) and consisted of layers of mesothelial cells, collagen, fibrovascular stroma, and adipocytes. There was no evidence of interstital oedema or polymorphonuclear cell invasion. A CBC 5 days after the beginning of the Gentamicin treatment revealed a marked reduction of the WBC count (22.2 $x10^9$/l).

An echocardiogram performed 7 days after pericardiectomy showed similar findings compared to the study done prior to surgery. However, pericardial effusion was absent. The umbilical abscess was also re-evaluated. The diameter of the umbilical vein was larger (20 mm in diameter). Some free fluid was noticed in the abdomen. A laparotomy was performed to remove the umbilical abscess. The animal was bright, alert, had normal rectal temperature and had been gaining weight before the procedure. During the surgery a marked decrease in blood pressure occurred (mean systemic blood pressure= 30 mm Hg, heart rate= 20 bpm). The animal responded to reduction of anaesthetic gas concentration and administration of epinephrine (1 ml/45 kg IV) [Epinephrine 1:1000, Vedco, St-Joseph, Montana, US]. The surgical procedure was completed and infected umbilical structures were removed successfully. The animal returned to her normal attitude over a period of two days. Five days after removal of the umbilical abscess, the cria was bright, alert and maintaining weight. No febrile episodes were observed. The cria was discharged to the owner with instructions to continue medical therapy (Na-ceftiofur 2.2 mg/kg BID SQ for 5 days). At follow up, the owner reported that the cria died 10 days after laparotomy without showing any signs of lethargy. No necropsy was performed.

Discussion

Pericardial diseases associated with pericardial effusion are rarely reported in llamas. In dogs and horses, causes of pericardial effusion are divided in two major categories: neoplastic and non-neoplastic effusion. A pericardiectomy is recommended if the effusion is drained unsuccessfully. In dogs, several approaches can be used successfully to remove the pericardium. In horses, a limited number of pericardiectomies have been reported (Forbes *et al*, 2001). In cattle, the most common cause of pericardial effusion is traumatic reticulopericarditis (Grisneaux and Fecteau, 2002). With septic pericarditis, prognosis is poor but some success has been observed after pericardiostomy (Guard, 2002; Hardy *et al*, 1992 and Jackson *et al*, 1999). In most of these cases, thick caseous purulent exudates are present in the pericardium and need to be removed manually. The pericardium is then attached to the chest wall for post-operative lavage the wound is allowed to heal by second intention. In our llama, the effusion was associated with non-neoplasic disease. The pericarditis was most likely a dissemination of umbilical vein infection and septicaemia. In neonates, septicaemia is often associated with infection of the umbilicus, the respiratory tract or the gastrointestinal tract especially after poor colostrum intake. The cria described herein had no clinical signs of respiratory or gastrointestinal disease. Failure of passive immune transfer from colostrum increases risk of septicaemia. An epidemiologic study on morbidity and mortality of llama and alpaca crias reported that failure of passive immune transfer was common and that umbilical disease was present in 16.2% of the cases (Kerstetter *et al*, 1997).

Failure to culture bacteria from the pericardial fluid obtained at surgery was thought to have been associated with the prior use of antibiotics. Pseudomonas bacteria discovered with the blood culture may have been a contaminant, a nosocomial bacterium, or a true septicaemic bacterium. The cria's fever and the WBC count (22.2 $x10^9$/l reference range: 7.4-19.9$x10^9$/l) decreased clinically after the introduction of the gentamicin in her daily treatment.

Several techniques for pericardiectomy have been described in other species. In dogs, thoracoscopic partial pericardiectomy was reported to have a favourable success rate (Mejburg *et al*, 1995). In humans and dogs, balloon pericardiotomy

was used in cases of recurrent pericardial effusion (Ring, 1995; Sharpe *et al,* 2000). This technique creates a window in the pericardium to allow drainage of fluids into the pleural cavity from where it can be reabsorbed. Balloon pericardiotomy is also used to disrupt the adhesions between the epicardium and the pericardium that may develop secondary to open heart surgery. This technique offers a less invasive and less expensive alternative to the other techniques but may not be appropriate for septic conditions or pure constrictive or constrictive-effusive pericarditis. Commonly, pericardiectomy is done via left or right sided thoracotomy or by median sternotomy. Median sternotomy is considered when total pericardiectomy is required. In dogs, the long term survival was similar for either surgical approach (Sidley *et al,* 2002). In our case, the left approach with 5^{th} rib resection was chosen because of the llama's thoracic anatomy and the surgical team's experience. The left lung is small in llamas and has a large cardiac notch that provides an excellent access to the heart. The thoracotomy and the pericardectomy were performed quickly (45 minutes), easily and without intra or post-operative complications. Unfortunately, antibiotic treatment failed to cure umbilical infection necessitating a second surgery to remove the umbilical vein abscess.

The cause of death of this cria is undetermined. It is thought to be associated with acute myocardial failure, malignant ventricular arrhythmia, or myocardial infarction. However, this case demonstrates that thoracotomy and pericardiectomy can be performed on llama crias. Left side thoracotomy using 5^{th} rib resection is a viable method to gain adequate access to the thorax.

References

Ducharme NG, Fubini SL, Rebhun WC and Beck KA (1992). Thoracotomy in adult dairy cattle: 14 cases (1979-1991). Journal of American Veterinary Medical Association 200:86-90.

Forbes TJ, Horenstein MS and Vincent JA (2001). Balloon pericardiotomy for reccurent pericardial effusions following fontan revision. Pediatric Cardiology 22:527-529.

Grisneaux MS and Fecteau G (2002). Pericardiostomie chez une Holstein de 2 ans ½. Point Vet 32 (213):68-72.

Guard C (2002). Traumatic reticuloperitonitis. In: Smith BP. Large Animal Internal Medicine. 3rd Ed. St-Louis: Mosby. pp 747-748.

Hardy J, Robertson JT and Reed SM (1992). Constrictive pericarditis in a mare: attempted treatment by partial pericardiectomy. Equine Veterinary Journal 24:151-154.

Jackson J, Richter KP and Launer DP (1999). Thoracoscopic partial pericardiectomy in 13 dogs. Journal of Veterinary Internal Medicine 13:529-533.

Kerstetter KK, Krahwinkel DJ, Millis DL and Hahn K (1997). Pericardiectomy in dogs: 22 cases (1978-1994). Journal of American Veterinary Medical Association 211:736-739.

Mejburg HWJ, Visser CA, Bredee JJ and Westerhof PW (1995). Clinical relevance of Doppler pulmonary venous flow characteristics in constrictive pericarditis. European Heart Journal 16:506-513.

Rings M (1995). Surgical treatment of pleuritis and pericarditis. Veterinary Clinic of North America and Food Animal Practice 11(1):177-182.

Sharpe M, Wittum T and Anderson DE (2000). An epidemiological study of morbidity and mortality in neonatal llamas and alpacas. Procedings, Camelid Medicine, Surgery, and Reproduction Short Course, Columbus, Ohio, March.

Sidley JA, Atkins CE, Keene BW and DeFrancesco TC (2002). Perctaneous balloon Pericardiotomy as a treatment for recurrent pericardial effusion in 6 dogs. Journal of Veterinary Internal Medicine 16:541-546.