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NOTE

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Antemortem diagnosis of external iliac arterial thromboembolism in a calf using contrast-enhanced computed tomography: a case report

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ABSTRACT. A 28-day-old Holstein calf with astasia (i.e., right hind limb flaccid paralysis) was referred to Large Animal Veterinary Educational Center. Thoracic radiographs showed an alveolar pattern and air bronchograms indicating pneumonia, whereas skeletal radiography showed muscle atrophy of the right hind limb but no abnormalities in the coxofemoral and stifle joints. Contrast-enhanced computed tomography revealed the pulmonary abscess in the right cranial pulmonary lobe and a thrombus (5 × 5 × 20 mm) in the right external iliac artery distal to the bifurcation of the abdominal aorta. These findings were confirmed via pathological examination. *Streptococcus bovis/equinus* complex colonies were isolated from the thrombus and pulmonary abscess. Thus, the pulmonary abscess was considered the infectious source of the thromboembolism in the right external iliac artery. Arterial thromboembolism should be included in the differential diagnoses in calves with astasia but without radiographic skeletal abnormalities.

KEYWORDS: calf, contrast-enhanced computed tomography, external iliac artery, muscular atrophy, thromboembolism

Thromboembolism is a life-threatening disease that has been reported in various animals. In humans, pulmonary artery thromboembolism is fatal and is often associated with atrial fibrillation [10]. In cats, aortic thromboembolism is a well-known vascular disorder associated with hypertrophic cardiomyopathy [8]. In dogs, heartworm disease is the most common cause of pulmonary artery thromboembolism, which is a result of arterial occlusion caused by an embolism from a dying worm [12]. Despite the low prevalence of aortic thrombus, it can occasionally be encountered in small animal practice [5]. However, very few reports of arterial thromboembolism have been available in calves, most of which are based on necropsy findings [1, 4, 9], although the previously reported clinical use of ultrasonography could contribute to the antemortem diagnosis of this disease [3]. This study reports the external iliac arterial thromboembolism diagnosed antemortem using contrast-enhanced computed tomography (CT) in a Holstein calf with astasia.

A 28-day-old female Holstein calf weighing 44 kg with an acute onset history of astasia was referred to the Large Animal Veterinary Educational Center at Azabu University, Sagamihara, Japan. On first admission, the calf showed tachypnea and right hind limb flaccid paralysis with femoral muscle atrophy. Neurological examination of the cerebrum revealed a normal level of consciousness. The patellar tendon reflex in the right hind limb and deep pain sensation were slightly decreased. However, severe muscle weakness was observed in the right hind limb, which suggested musculoskeletal disorder. The rectal temperature, heart, and respiratory rates were 38.9°C, 108 beats/min, and 58 breaths/min, respectively. Hematological examination revealed decreased levels of erythrocytes (447 × 10^4/μL; reference range: 511–760 × 10^4/μL), hemoglobin (6.0 g/dL; reference range: 8.5–12.2 g/dL), and hematocrit (20%; reference range: 22–33%) [11]. Blood chemistry analyses displayed decreased serum total protein (5.7 g/dL; reference range: 6.7–7.46 g/dL) and chloride (96.3 mmol/L; reference range: 97–111 mmol/L) and elevated glucose (84 mg/dL; reference range: 45–75 mg/dL), lactate dehydrogenase (1,978 IU/L; reference range: 697–1,445 IU/L), and inorganic phosphorus (6.6 mg/dL; reference range: 5.6–6.5 mg/dL) [11]. Although blood examination suggested anemia and hypoproteinemia, the abnormal values of blood chemistry analyses were mild.

The thorax and hind limb radiographs were taken, and images were acquired using a computed radiography unit (Regius Sigma, Konica Minolta, Tokyo, Japan). The thoracic radiographs revealed an alveolar pattern and air bronchograms, indicating pneumonia

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(Fig. 1). However, skeletal radiography showed right femoral muscle atrophy, with no abnormalities observed in either the coxofemoral or stifle joints.

Contrast-enhanced CT was performed using the 80-row multi-detector row helical CT unit (Aquilion Prime SP/SPREAD, Canon, Ohtawara, Japan) in the prone position under deep sedation via intravenous administration of xylazine (1.3 mg/kg, Xylazine INJ. 2%, Fujita Pharm, Tokyo, Japan). The imaging parameters were as follows: tube voltage, 135 kV; tube current, 250 mA; scanning slice thickness, 1.0 mm; and reconstructed bone, lungs, and soft-tissue algorithms. A contrast agent (iopamidol, 370 mgI/mL, lopamiron injection, Bayer, Osaka, Japan) was injected into the jugular vein at a dose of 2.0 mL/kg for 30 sec, and images were obtained immediately after the injection and at the second phase consecutively. Three-dimensional CT images were generated using Global illumination software (Vitrea, Canon Medical). In the lungs, air bronchograms were observed in the right cranial (Fig. 2A), right medial, and left caudal lobes. A gas in the ring-enhancement mass (34 × 35 mm), indicating abscesses with gas, was depicted in the right cranial pulmonary lobe (Fig. 2B, 2C). No enlargement of the sternal and hilar lymph nodes was detected.

The shape of the trunk at the sacro-lumbar section exhibited asymmetry, suggesting atrophy of the right gluteal and femoral muscles, and diffuse fluid-attenuation areas, edema-like changes were present in the right limb in the pre-contrast image (Fig. 3A). In the post-contrast images, arterial vessels were depicted in the first phase, whereas a contrast defect indicating thrombus was detected in the right external iliac artery distal to the bifurcation of the abdominal aorta (Fig. 3B, 3C) [12]. This defect was 5 × 5 × 20 mm in size and had a CT value of 48 HU. As a contrast agent was delivered to the distal vessel of the thrombus, this thrombus did not cause complete occlusion. However, the thrombus led to a partial occlusion, resulting in ischemic muscle atrophy and edema-like changes.

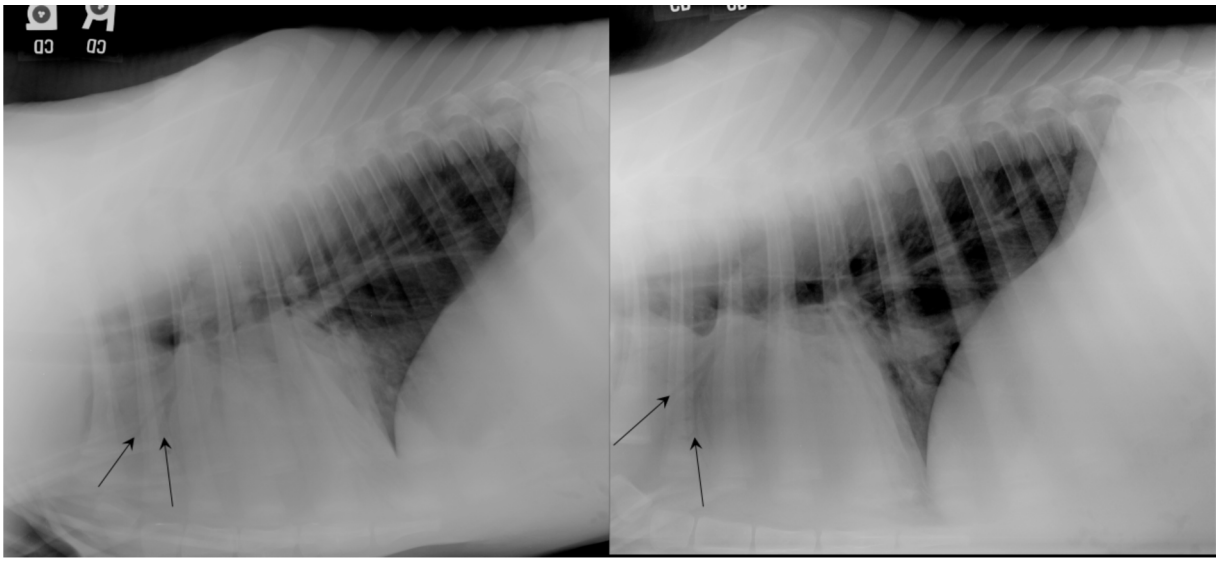

Fig. 1. Right lateral (left) and left lateral thorax radiographs. The thoracic radiographs showed an alveolar pattern and air bronchograms in the cranial lobes (arrows).

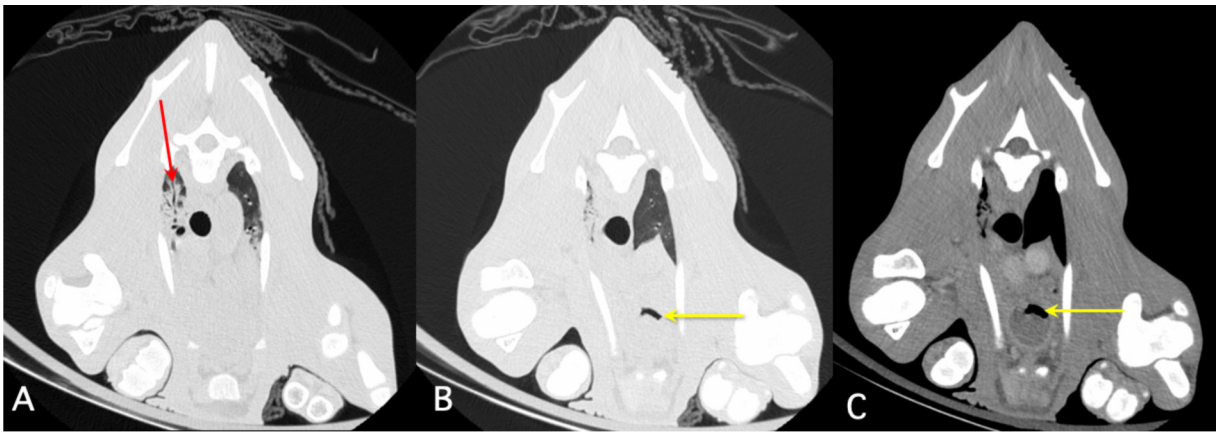

Fig. 2. Pre-contrast computed tomography (CT) image with a lung window (**A**, **B**), and post-contrast image with a soft-tissue window (**C**). Air bronchograms were depicted in the right cranial lobe (red arrow, A). A gas in the ring-enhancement mass (C, 34 × 35 mm), was observed in the right cranial lobe. The yellow arrows show a gas in the mass.

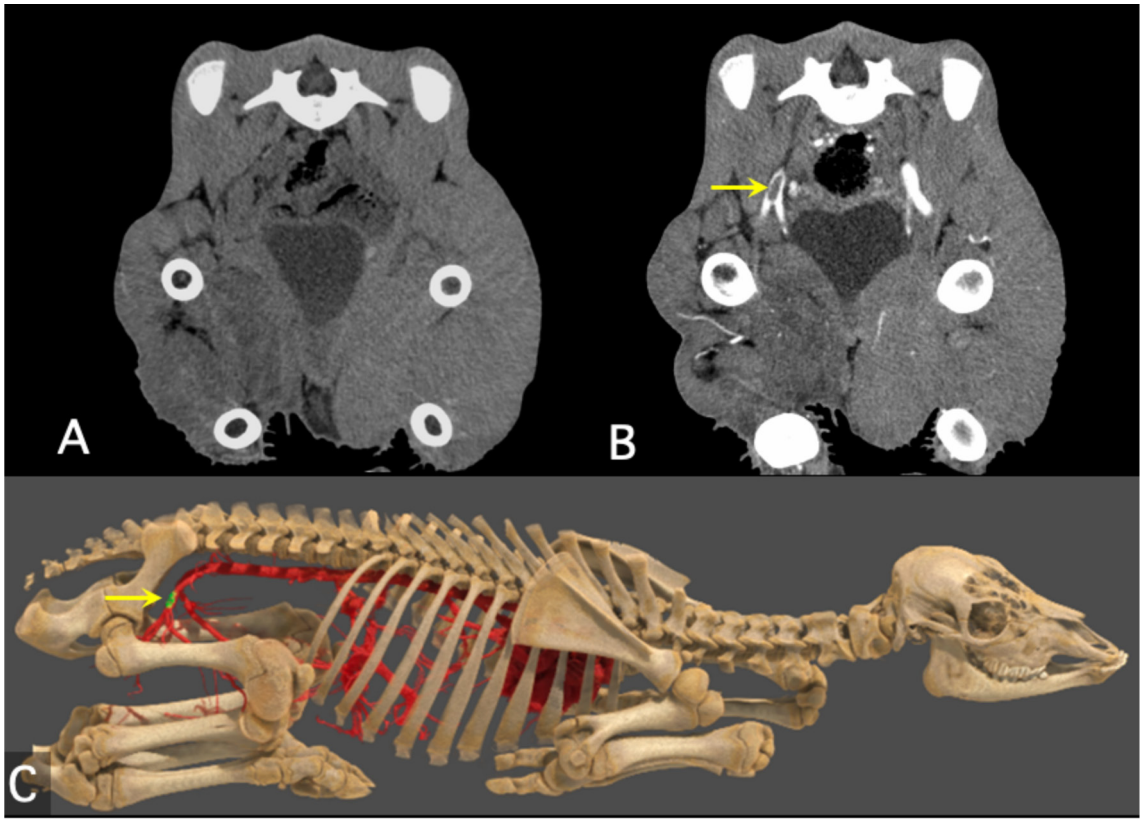

Fig. 3. The pre- and post-contrast CT image and three-dimensional (3D) image. In the pre-contrast image, the shape of the trunk at the sacro-lumbar section exhibited asymmetry, suggesting atrophy of the right gluteal and femoral muscles, and diffuse fluid-attenuation areas were present in the right hind limb (**A**). In post-contrast images, arterial vessels were depicted in the first phase, whereas a contrast defect, indicating thrombosis in the external iliac artery, was detected in contrast-enhanced CT (yellow arrow, **B**). The lesion was also visualized in 3D-CT (yellow arrow, **C**).

Following contrast-enhanced CT, ultrasound examination was performed using an ultrasonographic machine (MyLabOneVet, Esaote S.p.A, Genoa, Italy) with a linear transducer frequency of 6 MHz to confirm the presence of the lesion; however, no thrombus in the iliac artery was detected.

The present case was considered to have a poor prognosis based on its clinical condition and CT findings. Therefore, a pathological examination was performed after euthanasia under deep anesthesia by intravenous injection of xylazine (0.2 mg/kg) and ketamine (2.0 mg/kg, Ketamine INJ. 5%, Fujita Pharm, Tokyo, Japan) according to the protocol approved by the Animal Care and User Committee (230327-2). Macroscopic findings revealed a yellow ocher thrombus (21 × 6 mm) in the right external iliac artery, descending 2.5–5.5 cm from the bifurcation of the abdominal aorta, which is consistent with the contrast-enhanced CT findings. A portion of the thrombus contained pus and elastic fibers with a rough surface within the blood vessel (Fig. 4A). Histopathological examination of the thrombus revealed neutrophilic infiltration, and Gram staining showed a small number of Gram-positive streptococci (Fig. 4B). Additionally, extensive coagulative necrosis was observed in the right biceps femoris, semitendinosus, and semimembranosus muscles. Abscesses were found in the right cranial and right middle lobes (Fig. 4C). No abnormal findings were noted in the other organs, including the umbilical cord and heart. Hematoxylin–eosin staining of the lung revealed multiple abscesses covered with connective tissue. Gram staining showed Gram-positive streptococci in the pus (Fig. 4D).

The samples were collected aseptically from the thrombus found in the external iliac artery and pulmonary abscess. The obtained thrombus and pus from the pulmonary abscess were inoculated on a blood agar medium and cultured aerobically and anaerobically at 37°C. *Streptococcus bovis/equinus* complex was isolated from the thrombus and pulmonary abscess. Therefore, bacteria in the pulmonary abscess were considered to have passed through the left heart from the pulmonary vein and formed a thrombus in the external iliac artery.

Reports have shown that ultrasonography [3] and conventional radiographic angiography [9] can be used to diagnose external iliac artery thromboembolism. Although ultrasonography can be performed easily, the observable area of the lesion site is limited, and the examiner's skill greatly affects the diagnostic quality, as we have experienced. Conventional radiographic angiography requires surgical exposure of the artery and indwelling catheter, a complicated and invasive procedure to animals. Meanwhile, contrast-enhanced CT has the advantage of being able to examine a calf's whole body in cases wherein the calf can fit into the gantry, thus making the detection of a wide range of thrombus formation sites possible. The current case was characterized by asymmetric muscular atrophy of the hind

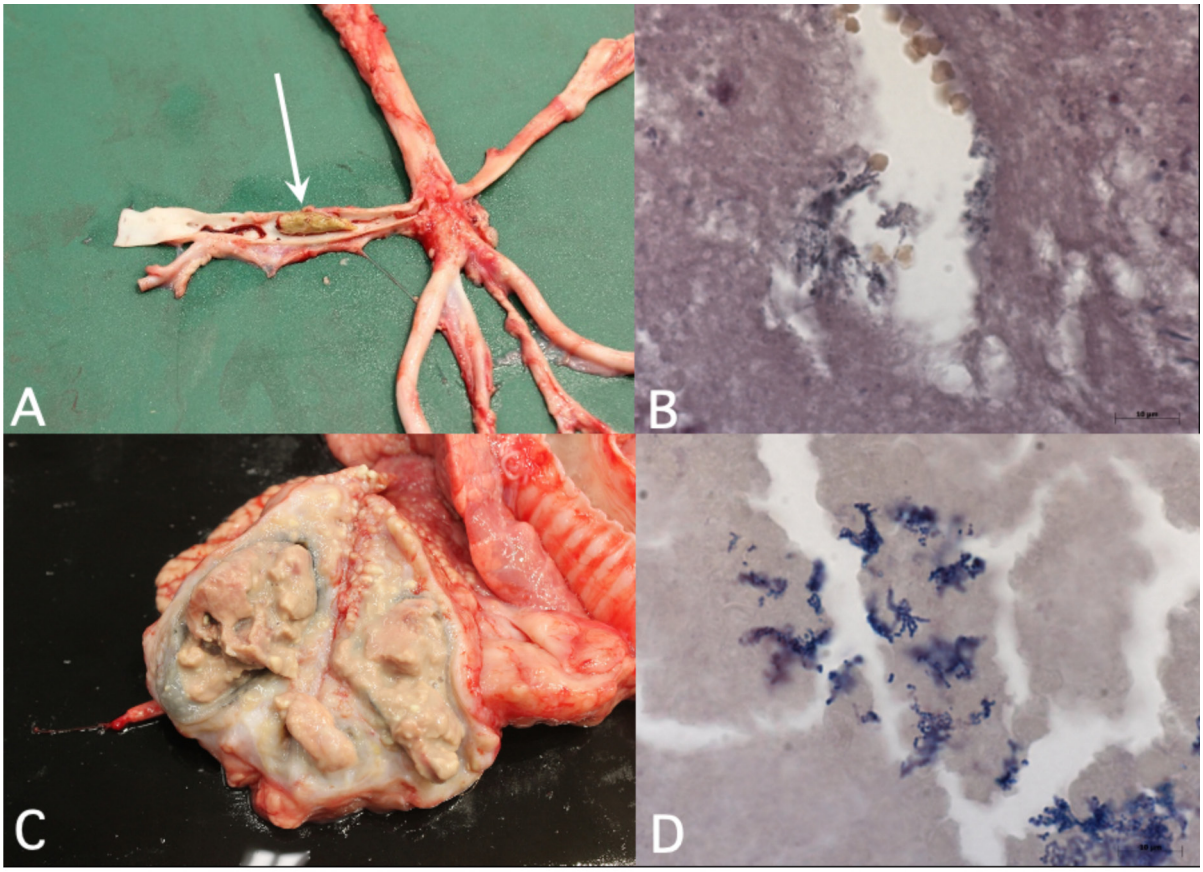

Fig. 4. Pathological findings. The right external iliac artery descending about 5.5 cm from the bifurcation of the abdominal aorta was dilated, and an ocher thrombus was found inside (white arrow, **A**). Hematoxylin–eosin (HE) staining of the thrombus showed neutrophilic infiltration, and Gram staining showed a small number of Gram-positive streptococci (**B**). The abscess was found in the right cranial lobes (**C**). HE staining of the lungs revealed multiple abscesses covered with connective tissue, and Gram staining showed Gram-positive streptococci in the pus (**D**).

limb despite the lack of radiographic skeletal abnormalities. Contrast-enhanced CT revealed a thrombus in the external iliac artery, which can affect ischemic muscle atrophy. Conventional radiography was unable to diagnose arterial lesions and pulmonary abscess in this calf due to the superimposition of the trunk; however, cross-sectional CT provided images of the contrast defect associated with thrombosis and the ring-enhancement pulmonary abscess with gas. Although CT is rarely used, it is being used increasingly in secondary care facilities, such as universities, for detailed examination of pathological conditions [6]. A study has also suggested the utility of contrast-enhanced CT given its ability to detect various abscesses such as a ring-enhancement abscess in the lungs and brain of cattle [7].

Anraku [1] reported that the increase in aspartate aminotransferase, lactate dehydrogenase, and creatinine phosphokinase levels was a strong indicator of aortic thromboembolism. These changes were due to muscle damage. The present case showed increased level of lactate dehydrogenase; however, the levels of aspartate aminotransferase and creatinine phosphokinase were within normal range. Aspartate aminotransferase and creatine kinase are blood biomarkers for myocardial infarction that reflect muscle ischemia-induced damage. However, these markers have a short lifespan. Creatine kinase values, return to normal levels within 48–72 hr after a sudden increase [2]. Therefore, in this case, we speculate that enough time had passed after muscle damage caused by blood flow of the external iliac artery to allow for aspartate aminotransferase and creatine kinase levels in blood to return to normal levels. In this specific case, blood analysis did not provide evidence of aortic thromboembolism.

In small animal practice, arterial thrombosis therapy using medications, such as acetylsalicylic acid, enoxaparin, heparin, and interventional thrombolytic therapy or surgery have been reported [5]. Although no standard treatment has been established for this disease in cattle, early clinical diagnostics using contrast-enhanced CT can enable early selection and reduction of economic losses.

In conclusion, contrast-enhanced CT was useful for the antemortem diagnosis of external iliac artery thromboembolism in a calf. We propose that arterial thromboembolism should be included in the differential diagnoses in calves with astasia but without radiographic skeletal abnormalities.

CONFLICTS OF INTEREST. The authors declare no conflicts of interest.

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