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CASE REPORT

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Atypically located accessory splenic hemangiosarcoma in a Dog: Diagnostic value of triple-phase computed tomography

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Abstract

A 10-year-old Cocker spaniel presented with lethargy. Triple-phase computed tomography was obtained with a contrast test bolus at the level of porta hepatis, which revealed a right lower abdominal mass. The mass was not connected to other abdominal organs; however, a linear structure was observed connecting the splenic hilum to the mass, which was suspected to be the feeding vessel. The arterial phase image was obtained again with a contrast bolus at the level of the celiac artery. A prominent contrast-enhanced feeding artery originating from the splenic artery to the mass was observed. Histopathology confirmed an accessory splenic hemangiosarcoma.

KEYWORDS
canine, ectopic spleen, feeding vessel, test bolus, tumour origin, splenic tumour

1 | INTRODUCTION

Given that the major of the accessory spleens are located at the splenic hilum, the presence of a mass in this location may be an indicator of an accessory spleen (Rossi et al., 2010). However, an accessory spleen can be located anywhere in the abdomen; moreover, one can be found in atypical locations. For example, humans may have accessory spleens in the pancreas, pelvis, stomach, mesentery and greater omentum (Bertolini, 2017; Cowles & Lazar, 2007; Yang et al., 2017). Therefore, even if the mass is located far from the spleen, it may be an accessory splenic mass, so determining tumour origin is important. This case report describes the computed tomography (CT) angiography feature of an accessory splenic hemangiosarcoma located in the right caudal abdomen in a dog and the usefulness of CT angiography for determining accessory splenic origin.

2 | CASE PRESENTATION

A 10-year-old neutered male Cocker spaniel presented for evaluation of lethargy. On presentation, there were no abnormalities in physical examination (body temperature = 38.8°C, heart rate = 150 times per minute, respiratory rate = 42 times per minute and blood pressure = 130 mmHg). A complete blood count revealed anaemia (Hct 14.4%; reference range, 37.3%–61.7%), leucocytosis (26.15 K/μL; reference range, 5.05–16.76 K/μL), and thrombocytopenia (60 K/μL; reference range 148–484 K/μL). Blood chemistry and urinalysis results were unremarkable.

Thoracic radiographs were normal. Abdominal radiography revealed decreased serosal detail with abdominal distension; ultrasound-guided paracentesis was performed, and 1500 mL of ascites was drained. The ascites were haemorrhagic exudates (haematocrit: 14.6%). On

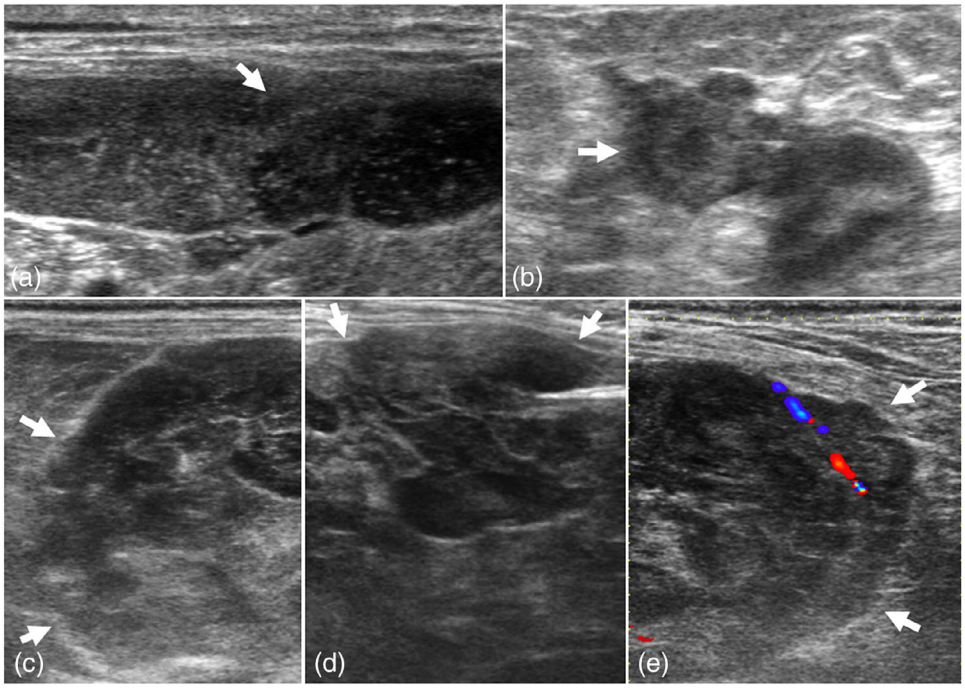

FIGURE 1 Ultrasound images. (a) The splenic parenchyma had heterogeneously hypoechoic nodules (arrow). (b) Small, heterogeneously hypoechoic nodule (8×9 mm^2) in the left abdomen (arrow). The nodule had an indistinct margin and surrounding fatty oedema. Multiple nodules with similar shapes were observed throughout the abdomen (c–e). Cranial (c), middle (d) and caudal (e) portion of the right caudal abdominal mass (arrows). The mass had a heterogeneous parenchyma with multiple hypoechoic areas. The margin was partially indistinct and the mass was not connected to adjacent organs. It was difficult to measure the size of the mass due to its large size. On colour-Doppler, a small blood signal was found on the margin (e).

cytology, a number of erythrocytes were found in the background, and tumour cells or bacteria were not identified.

Abdominal ultrasound (10-MHz linear transducer, Prosound α7, Hitachi Aloka Medical) revealed the following three major lesions, except for the remaining small volume of echogenic ascites: (1) splenic nodules, (2) large right caudal abdominal mass and (3) numerous mesenteric nodules. In the splenic parenchyma, heterogeneously hypoechoic nodules (maximum 2.0×1.4 cm^2) distorting the splenic border were observed (Figure 1a). The splenic nodules did not show blood signal on colour-Doppler. A large and heterogeneously heteroechoic mass with a partially indistinct margin was observed in the right caudal abdomen, cranial to the bladder (Figure 1c–e). The mass was so large that it was difficult to assess its size on ultrasound. On colour-Doppler, blood flow signals are observed in the margins of the mass. There were several indistinct hypoechoic areas without blood signals in the mass, but it was difficult to differentiate between a cavitary lesion and hypoechoic tissue parenchyma. There was no distinct connection between the mass and other adjacent organs. Various sized (maximum 1.4×1.4 cm^2), rounded or lobulated shaped heterogeneously hypoechoic nodules with mild perilesional fat oedema were observed throughout the mesentery (Figure 1b). Based on ultrasound, the large caudal abdominal mass was suspected to originate from the mesentery or metastasized from the splenic nodules; the splenic nodules were considered primary splenic lesions or metastasis of the caudal abdominal mass. Moreover, multiple mesenteric nodules led to the suspicion of mesenteric or lymph node metastasis.

Triple-phase CT was performed to identify the mass origin. General anaesthesia was induced via intramuscular injection of zolazepam hydrochloride–tiletamine hydrochloride (Zoletil, Virbac) at 0.75 mL/kg and medetomidine (Domitor, Orion Corporation) at 0.03 mg/kg. After intubation, isoflurane (Terrell, Piramal Critical Care, 1%–2%) and oxygen (1 L/min) were used to maintain anaesthesia. CT scans were obtained with the dog in sternal recumbency using a 16-row multidetector CT (Siemens Emotion 16, Siemens) with the following settings: slice thickness, 1 mm; pitch, 0.8; rotation time, 600 ms; tube voltage, 120 kV; and tube current, 120 mA. A breath-hold technique was performed by inducing apnoea with manual hyperventilation.

After pre-contrast thoracic and abdominal CT, a test bolus scan was performed at the porta hepatis level with the administration of 0.5 mL/kg of iohexol (Omnipaque 300, GE Healthcare) IV at 3 mL/s. Based on a time-to-attenuation curve, arterial phase scan delay was determined as aortic arrival time, and venous phase scan delay was determined as the time to peak enhancement of the portal vein. Scan delay for the delayed phase was set at 2 min. After obtaining triple-phase abdominal imaging, post-contrast thoracic images were obtained. Triple-phase CT was performed after injecting 2 mL/kg iohexol IV at 3 mL/s. All CT images were reconstructed with 1-mm thickness using a mediastinum kernel with a window width of 400 Hounsfield units (HU) and window level of 40 HU. All images

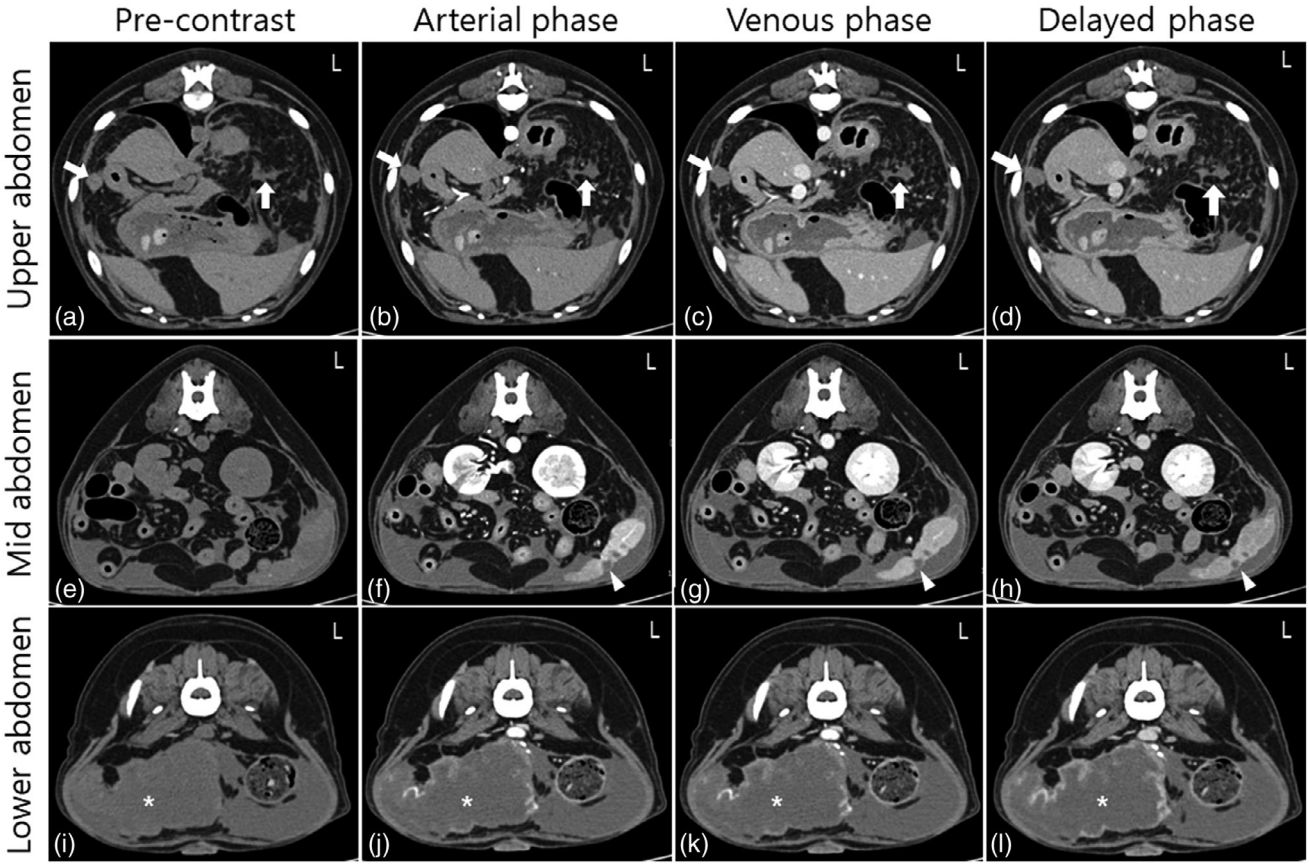

FIGURE 2 Pre-contrast (a, e, i), arterial phase (b, f, j), venous phase (c, g, k) and delayed phase (d, h, l) computed tomography images. Multiple nodules (arrow) with fat stranding signs were found in the entire abdomen. Multiple small cystic nodules (arrowhead) were found in the splenic parenchyma. A large soft tissue mass without connection to the adjacent organs was located at the right caudal abdomen (asterisk).

were interpreted using a picture archiving and communicating system (INFINITT PACS, INFINITT Healthcare).

On thoracic CT, there were no remarkable findings except for sternal lymph node enlargement. Soft tissue attenuating (59 HU) multiple nodules (maximum diameter: 13 mm) with smooth margins were observed throughout the abdomen (Figure 2a–d). The nodules did not show remarkable contrast enhancement in arterial, portal and delayed phases (60–63 HU). Furthermore, multiple small cystic nodules (maximum diameter: 19 mm) without contrast enhancement (30 HU at pre- and post-contrast) were observed throughout the splenic parenchyma (Figure 2e–h). A large, amorphous and mildly inhomogeneous soft tissue mass was observed in the right caudal abdomen ($88.3 \times 46.7 \times 76.4\ mm^3$) (Figure 2i–l). The mass was located between the urinary bladder and intestines, and due to the mass effect, the urinary bladder was compressed and displaced to the left. Peripheral contrast enhancement was observed, but the parenchyma of the mass did not reveal any enhancement (25 HU in both pre- and post-contrast phases). No connection was identified between the mass and other organs. A linear structure connecting the splenic hilum to the right caudal abdominal mass was observed on arterial and venous phase images, and it was considered to be the feeding vessel of the mass; however, the structure was difficult to evaluate owing to indistinct contrast enhancement (Figure 3a).

A second CT scan was obtained to evaluate the linear structure that was considered to be a vessel feeding the mass 3 days after the first CT. A test bolus scan was performed at the celiac artery for clear visualization of the splenic artery. Based on the time-to-attenuation curve, the arterial phase scan delay was determined as aortic arrival time. Arterial phase CT scan was obtained using the same settings as the first CT scan, and reconstructed images were obtained, including maximum intensity projection images. The second arterial phase CT revealed that the feeding artery originated from the splenic artery and extended into the right caudal abdominal mass (Figure 3b,c). Thus, the mass was suspected to originate from the accessory spleen, but migration of ruptured splenic mass or neovascularized mesenteric masses was not ruled out. Mesenteric metastasis was suspected due to fat stranding sign, ascites and multiple mesenteric nodules throughout the abdominal cavity.

The owner declined further diagnostic testing and treatment, and the patient died 1 week after the CT with persistent lethargy and anaemia; with owner permission, necropsy was performed (Figure 4). Grossly, the spleen had multiple masses on the surface, but no rupture was evident. In the right caudal abdomen, a blood-filled mass connected to the splenic hilum via a feeding vessel was found (Figure 4a). The mass was located cranial to the urinary bladder and surrounded by mesenteric fat. Additionally, multiple nodules existed throughout

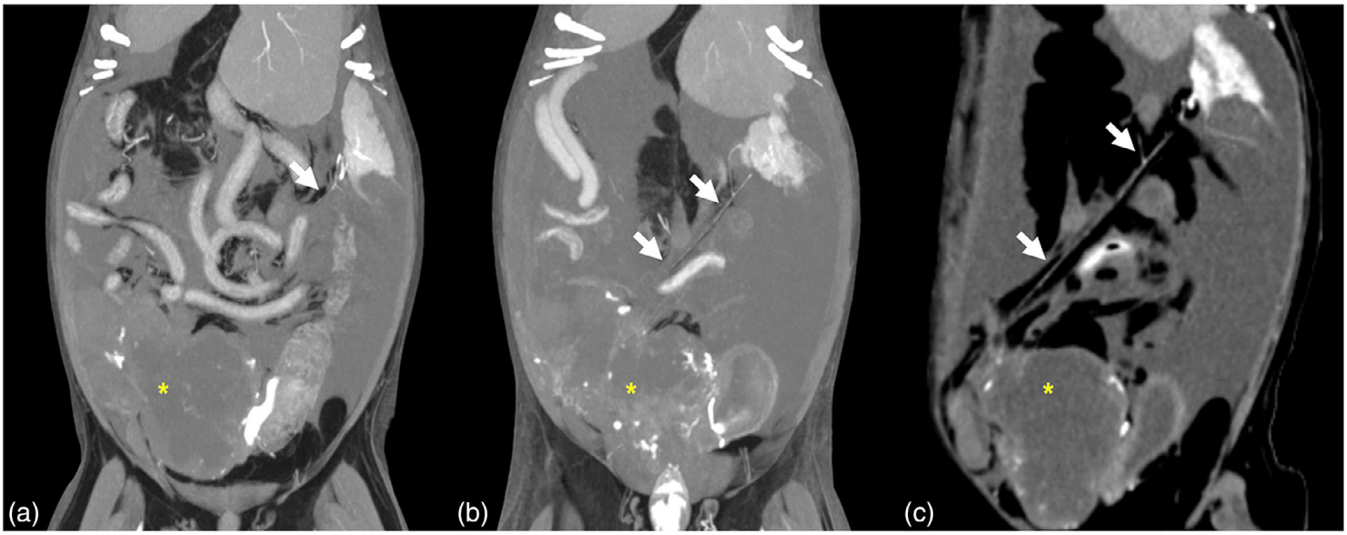

FIGURE 3 Maximum intensity dorsal plane soft tissue window arterial phase images of the first (a) and second (b) computed tomography (CT), and oblique dorsal plane image of the second CT (c). In the first CT, a linear structure (arrow) considered to be connecting the splenic hilum and right caudal abdominal mass (asterisk) revealed indistinct contrast enhancement (a). The second CT scan clearly showed the feeding artery (arrow) originating from the splenic artery to the mass (asterisk) and the connection between the vessel and the mass was confirmed (b and c).

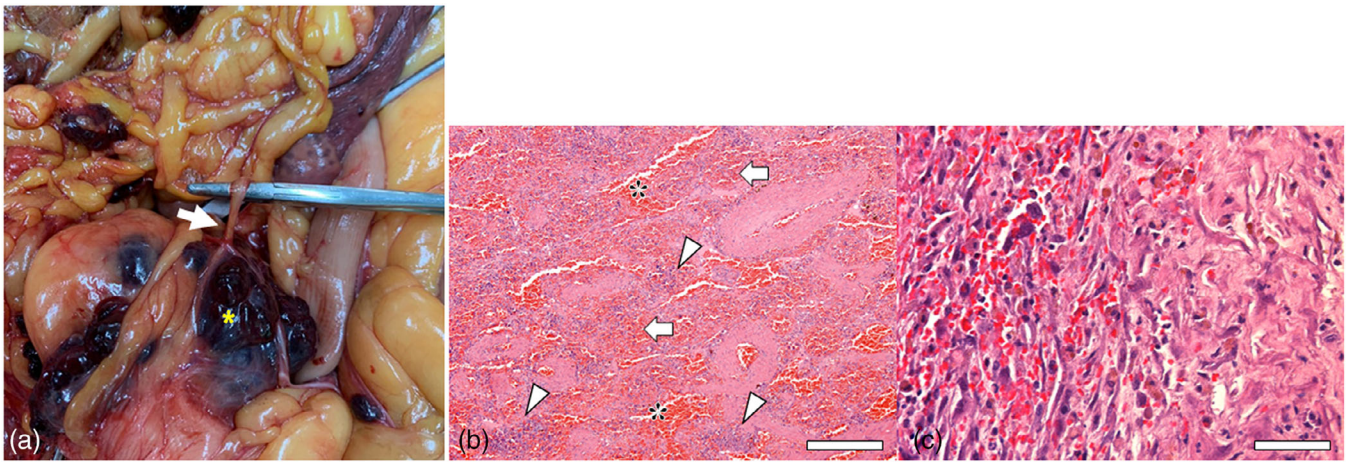

FIGURE 4 Gross findings (a) and histopathologic findings (b and c) of the accessory splenic tumour: (a) a small feeding vessel (arrow) connecting the right caudal abdominal mass (asterisk) to the spleen; (b) the accessory spleen had the architecture of the ordinary spleen with white (arrowhead) and red pulp (arrow), showing patch-form haemorrhages (asterisk) and moderate congestion (50×, bar = 400 μm); (c) neoplastic endothelial cells were highly pleomorphic and showed a capillary-like growth pattern of newly formed vessels, where erythrocytes were present in the cavities (200×, bar = 100 μm).

the abdominal wall, omentum and mesentery. The spleen, right caudal abdominal mass and some nodules in the abdominal wall were sampled, and a histopathological examination was performed. Haematoxylin and eosin stain revealed that the blood-filled mass contained components of a normal spleen, namely trabeculae, white pulp and red pulp, indicating an accessory spleen nourished by the spleen. However, the general architecture was markedly distorted due to severe congestion and haemorrhage (Figure 4b) and complete replacement by tumorous lesions (Figure 4c). The neoplastic cells had a capillary-like growth pattern of newly formed vessels, where erythrocytes were present in the cavities. Some tumour cells formed small acinar or anastomosing lumens, roughly divided by connective tissue. Neoplastic endothelial cells were highly invasive and pleomorphic with round to polyhedral cells with moderate eosinophilic cytoplasm and a vacuolated nucleus, usually without a distinct nucleolus. They exhibited severe anisocytosis and anisokaryosis, and numerous mitotic figures were found throughout the lesion. In the spleen and abdominal wall nodules, the same type of tumour cells were identified, leading to a diagnosis of splenic hemangiosarcoma and accessory splenic hemangiosarcoma with sarcomatosis.

3 | DISCUSSION

An accessory spleen can theoretically occur anywhere, but there are not many reports of them in dogs other than at the splenic hilum. To the author's knowledge, this is the first report of accessory splenic hemangiosarcoma that occurred in the caudal abdominal mesentery diagnosed by CT. In the present case, the accessory splenic origin could be determined by visualizing the feeding vessels from the spleen via CT angiography. Moreover, the utilization of test bolus scanning for the celiac artery facilitated a distinct visualization of the splenic artery in this case.

It is difficult to determine tumour origin if there is no connection between masses and other abdominal organs, as seen in the present case. Thus, determining the feeding vessel of the mass is important to evaluate the tumour origin. In this case, feeding vessels were evaluated using test bolus triple-phase CT scans twice. For obtaining the second CT scan, test bolus scanning was performed at the celiac artery level, allowing contrast enhancement of the feeding vessels of the mass branched from the splenic artery. These results suggested that the scan delay for a dynamic CT should be adjusted for the vessels to be evaluated. Therefore, test bolus scanning or bolus tracking should be performed at the vessel of interest (Cassel et al., 2013; Lee et al., 2019).

Most accessory spleens in humans are supplied by the splenic artery (Mortelë et al., 2004). Thus, identifying feeding vessels using triple-phase CT is a diagnostic criterion for an accessory spleen (Cowles & Lazar, 2007). However, some accessory spleens are supplied by the left gastroepiploic artery in humans, as confirmed by triple-phase CT in a previous study (Ota et al., 2016). To the best of our knowledge, there are no reports of accessory spleens supplied by the left gastroepiploic artery in dogs, but if a mass is supplied by this artery and has no connection to other abdominal organs, an accessory spleen can be considered a differential diagnosis.

In the present case, the feeding vessels from the spleen identified through CT were useful in determining the accessory spleen origin. However, connectivity to the splenic artery does not always mean accessory spleen, because collateral angiogenesis can occur from the splenic artery along with the tumour other than the accessory spleen (Kim et al., 2005). In previous human studies, splenic arteries were found to supply liver and pancreatic tumours (Moon et al., 2015). However, in dogs, no mesenteric tumours have been reported to be supplied by the splenic artery, and therefore, the right caudal abdominal mass connected to the spleen in the present case was primarily considered to be an accessory splenic tumour. Given that mesenteric tumours generally receive a supply of mesenteric blood vessels (Ichikawa et al., 2017), if a tumour within the mesentery receives a supply from splenic arteries, an accessory spleen may be suspected.

Ectopic splenic tissue may arise from splenosis, which is often associated with trauma or surgery. Compared to the accessory spleen, which contains histologically normal splenic tissue and receives blood supply from the splenic artery, splenosis features variable microscopic architectures and is supplied by adjacent tissues (Mohammadi et al., 2016; Yildiz et al., 2013). These characteristics allow for some differentiation of splenosis through CT angiography. In the present case, as the caudal abdominal mass had splenic tissues and it was confirmed through CT that blood flow was supplied from the splenic artery, an atypical accessory spleen was considered more likely than splenosis.

4 | CONCLUSION

In conclusion, this was a rare case because hemangiosarcoma developed in an accessory spleen located in the caudal abdomen and not in the typical location of splenic hilum. Identifying the feeding artery originating from the splenic artery using triple-phase CT may be a critical role in diagnosing atypically located accessory splenic tumours.

AUTHOR CONTRIBUTIONS

Conceptualization; formal analysis; investigation; methodology; validation; visualization; writing—original draft: Dain Yun. *Conceptualization; data curation; resources; supervision; writing—review and editing*: Jihye Choi and Kyoung-Oh Cho. *Data curation; investigation; resources; writing—original draft; writing — review and editing*: Yeong-Bin Baek. *Conceptualization; supervision; validation; visualization; writing—review and editing*: Kija Lee. *Conceptualization; funding acquisition; project administration; supervision; writing—review and editing*: Sang-Kwon Lee.

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CONFLICT OF INTEREST STATEMENT

No conflicts of interest have been declared.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author.

ETHICS STATEMENT

The owner consented to the use of the information.

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