CT PERIPORTAL HALO SIGN IN DOGS-COMPARASION WITH HUMAN MEDICINE

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Abstract

Periportal halo CT sign has been well described in human medicine, being associated with multiple pathological processes (hepatobiliary, congestive heart failure, pyelonephritis, metastases) but also with fluid resuscitation and blunt abdominal trauma. It is supposed to be caused by periportal lymphangiectasia and may be related with primary or secondary liver diseases. The aim of the article is to review and analyse CT findings of periportal halo in dogs and possible relations with systemic diseases and abnormal *liver function* parameters.

Keywords: CT, portal vein, periportal halo, abdominal imaging, dogs.

INTRODUCTION

The main portal vein is formed by the confluence of the cranial and caudal mesenteric veins and the splenic vein, and therefore drains most of the blood from the abdominal organs into the liver (Budras K.D. et al, 2007), cranial mesenteric vein receiving all the jejunal branches (Evans H.E., De Lahunta A. 2013). Caudal to the hepatic entrance, receives the gastroduodenal vein, after draining the pancreaticoduodenal and gastroepiploic veins. The diameter of the portal tributaries becomes enlarged as they approach the main portal vein, and the flow is directed towards the liver.

Computed tomography is used as an advance imaging approach of abdominal pathology due to its excellent morphological resolution and its ability to image many different structures.

For assessment of the abdominal vasculature by computed tomography, a dual phase, low-pitched imaging protocol with good respiration control is used for an appropriate vascular study.

The liver parenchyma shows a homogeneous density in the range of about 60 – 70 HU in dog, values depending on technical settings (kVp, mA, slice width) and the enhancement is intense and homogeneous after contrast medium administration. Contrast resolution is the capacity of a system to accurately represent differences in tissue, physical, and/or biochemical characteristics, which are intrinsically linked to x-ray attenuation (Wisner E.,R., Zwingenberger A.L. 2015). The intrahepatic vasculature includes an arterial supply and double venous system-hepatic and portal veins (Schwartz T., Saunders J. 2011). In dual-phase CT angiography, arterial and venous vessels can be identified (Bertolini G., Prokop M. 2011). The largest hepatic veins are often visible already before contrast administration as hypodense tubular structures, becoming more evident in the arterial and venous phase of contrast administration.

Intrahepatic portal vasculature can be distinguished in CT during the venous phase following the division of the main portal vein into the two main right and left branches (figure 1) which supply the different liver lobes. For a better spatial representation of the hepatic vessels, maximum intensity projection and 3-D reconstructions can be used (Schwartz T., Saunders J. 2011).

On a CT scan, portal vein and collaterals can be seen running toward the periphery, having low density in pre-contrast study and in arterial phase, being highly attenuating in the venous phase.

In both phases, portal lymph nodes, can sometimes be visible to the right and left of portal vein, as normal anatomic structures, with typical CT appearance (Schwartz T., Saunders J. 2011, Wisner E.,R. Zwingenberger A.L. 2015).

Periportal halo sign represents a low attenuation zone seen around the intrahepatic portal veins on contrast-enhanced CT (figure 2). It can be associated with periportal oedema, which is often used as a synonymous term (Lawson T.L. et al, 1993).

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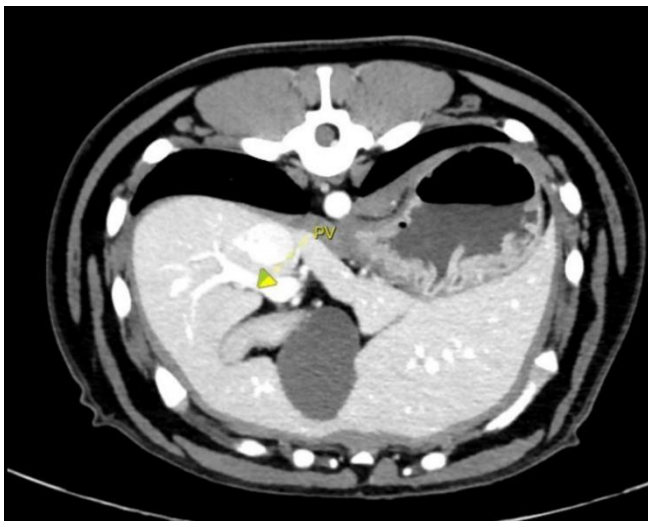

Fig.1. Normal CT appearance of the portal vein at the level of porta hepatis in transverse section (yellow arrow).

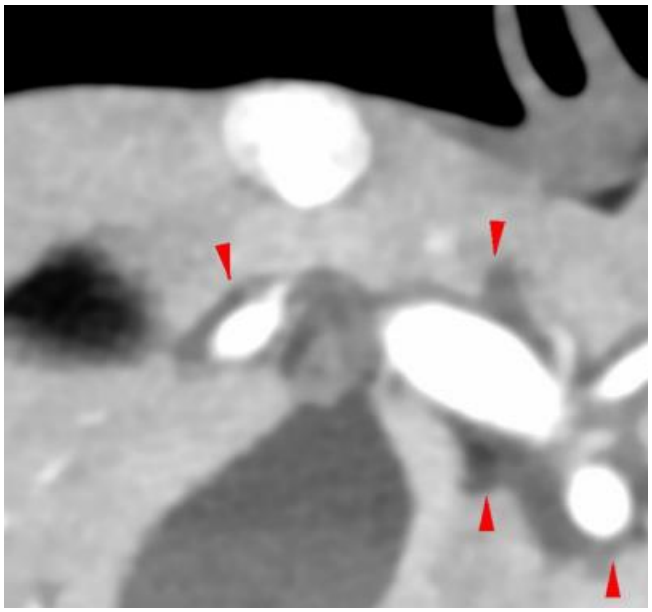
Fig.2. Transverse image of a 4-year-old neuter female diagnosed with lymphadenopathy-hyperplasia.
Periportal hypoattenuating halo in the liver parenchyma on early postcontrast images was noted (red arrows).

MATERIALS AND METHODS

The present study was performed to describe and analyse periportal halo in relation with abdominal pathology in dogs, and possible correlation with changes within liver enzymes in patients positive for periportal halo CT sign.

Consent of using the data in the study was obtain from the owners at the moment of the CT exam.

100 abdominal CT cases have been analysed retrospectively in the St. George's Veterinary Hospital (Wolverhampton, UK) between January 2019 and March 2021. Triphasic abdominal CT (aortic, portal and delayed-venous), with slices between 0.2 and 0.75 mm (SOMATON Scope, 16 slice CT, Siemens, USA), have been performed, results being recorded and analysed. General anaesthesia has been used and intravenous fluids have been administrated pre and post examination. Complete blood work has been done for all the patients included in the study before undergoing CT examination. A positive non-ionic iodinated contrast agent consisting of iohexol (Omnipaque™, GE Healthcare) was administered via an intravenous bolus, according to the literature and a dual phase CT angiography: arterial phase (9-16 s): cranial to caudal and a venous phase (10-35s): caudal to cranial have been completed (10, 16, 21).

Confirmed diagnosis of the cases was represented by 4 cases of pyelonephritis, gastrointestinal changes (congenital, inflammatory-bacterial, parasitic, and viral) including secondary lymphadenopathy-28, primary liver neoplasia and liver metastasis-22, abdominal neoplasia (other organs than liver), including secondary lymphadenopathy-40, 1 case of portosystemic shunt, 5 cases diagnosed with cardiomyopathy and valvular changes, with ages between 4 month and 15 years.

Periportal halo was seen in 11 cases: 2 cases of gastric disease (gastritis and hiatal herniation), 5 cases of lymphadenopathy, 3 cases of neoplasia and 1 case of portosystemic shunt. Lymphadenopathy was seen with all 3 cases of neoplasia and with gastritis.

RESULTS AND DISCUSSION

Periportal haloes may occur around the central portal veins or their peripheral branches and occur on both sides of the portal triads. It is supposed that those halos probably represent fluid or dilated lymphatics in the loose areolar zone around the portal triad structures. Periportal halo is reported as an abnormal imaging sign in human medicine and liver function should be evaluated in search of an underlying aetiology (Lawson T.L. et al, 1993).

In human medicine, periportal halo sign have been associated with abdominal pathology as hepatobiliary disease, particularly viral hepatitis (Zoller T., Stäbler A. 2000) , blunt hepatic trauma, cholangitis, liver transplant, and liver transplant rejection (Takaji R. et al, 2017), lymphadenopathy at the porta hepatis causing lymphatic obstruction and tumours or malignant lymphadenopathy in the porta hepatis, congestive cardiac failure ((Lawson T.L. et al, 1993), kidney disease-acute pyelonephritis (Zissin R. et al, 2006), bone marrow transplantation and was recently described with blunt abdominal trauma and

aggressive fluid resuscitation (Kuhlemann J. et al, 2011).

Periportal oedema (PPE) can be seen in different clinical settings, including in patients following trauma, being reported often on CT scan after major abdominal trauma, without liver injury. However, the underlying mechanisms and clinical significance in trauma patients remain unclear. PPE is seen significantly more often on abdominal CT scans following major traumas (ISS ≥ 16) but is not necessarily associated with liver injury (Kuhlemann J. et al, 2011).

One study showed that periportal low attenuation was a relatively common finding in the portal venous phase of triphasic contrast CT, whereas it was less usual in the arterial or equilibrium phase (Kanazawa S. et al, 1999).

A study on 30 young human patients, associated periportal low attenuation with hepatic trauma, hepatic transplantation, malignancy (undifferentiated hepatoblastoma, juvenile chronic myelogenous leukaemia), and generalized hepatic disorders (acute hepatitis and congenital hepatic fibrosis). In this study, possible mechanisms for development of periportal low attenuation include periportal tracking of blood, obstructive lymphedema, tumour infiltration, perivascular inflammation, or bile duct proliferation. (Siegel M.J., Herman T.E. 1992)

Recent studies described PPE on the hilar and peripheral sides of hepatic metastasis from colorectal cancer may be present but may suggest lymphedema and fibrosis of portal tracts and is not always indicating cancerous infiltration. (Takaji R. et al, 2017)

The most important differential diagnosis of the CT findings in veterinary medicine needs to be made with biliary dilatation, in which the low attenuation is seen on only one side of the portal triads (Schwartz T., Saunders J. 2011). On post-contrast CT, some thin enhancement along the wall is seen mainly where the gallbladder is adjacent to peritoneal fat. Even tough biliary dilatation and periportal halo may coexist, the stripe of periportal low attenuation on one side may be wider than the other.

In the present study, periportal halo CT sign was mostly reported with abdominal neoplasia and lymphadenopathy (figure 3).

Changes within the liver enzymes were noted only for the patient with an underlying portosystemic shunt, most likely being related with the effect of the shunt (figure 4). Rest of the patient's positive for periportal halo had normal liver function.

Compared with human medicine, periportal halo sign was not reported in cases of pyelonephritis, abdominal trauma, congestive cardiac failure, and primary hepatobiliary disease (other than neoplasia).

The hepatic parenchyma was homogeneous, periportal halo being seen mostly in early postcontrast venous phase (figure 5).

The article aims to present possible connection between abdominal and systemic changes with the periportal halo CT sign in dogs and to describe the CT imaging findings. Even human medicine studies described PPE as a sign associated with multiple abdominal and cardiac diseases, in veterinary medicine it is most likely an incidental finding, only a small correlation with lymphadenopathy and tumoral invasion being noted. The disadvantage of this study is that it was performed on a small group of animals, so detailed future studies on a larger number of animals are needed. Also, periportal halo may not be always reported due to the reduced use of the CT scanning in some practices.

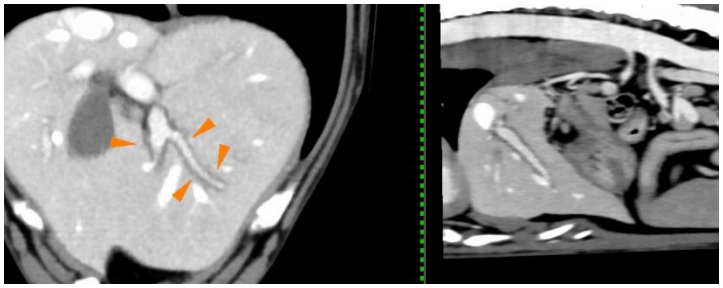

Fig. 3. Transverse and sagittal CT images of an 8-year-old male dog diagnosed with rectal adenocarcinoma. Mildly enlarged liver, with smooth rounded margins, extending caudal to the costal arch. The hepatic parenchyma is homogeneous. Hypoattenuating rim surrounding the intrahepatic portal veins is noted, consistent with periportal halo (orange arrowheads).

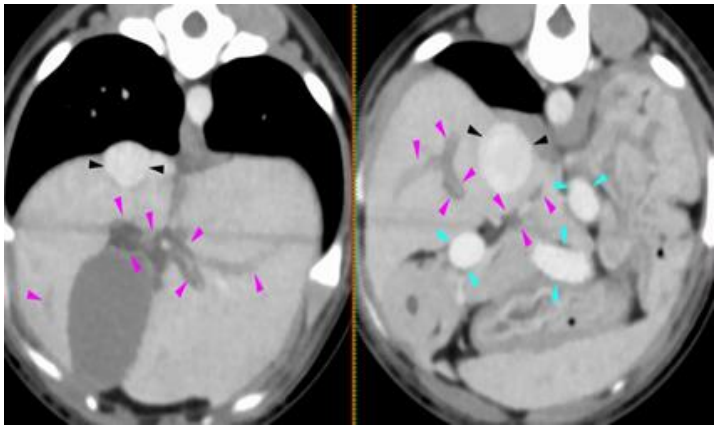

Fig.4. Transverse CT images of a 4-month-old puppy with a congenital extrahepatic right gastrocaval portosystemic shunt.

A tortuous vessel (cyan arrowheads) arising from the portal vein at the level of the junction

between the gastroduodenal and pancreaticoduodenal veins and running along the lesser curvature of the stomach have been seen. After a sinuous trajectory, it enters at the left aspect of the caudal vena cava (black arrowheads). A halo of fluid attenuation was visible, surrounding the visible intrahepatic portal branches as well as the region of the other intrahepatic portal branches (magenta arrowheads)

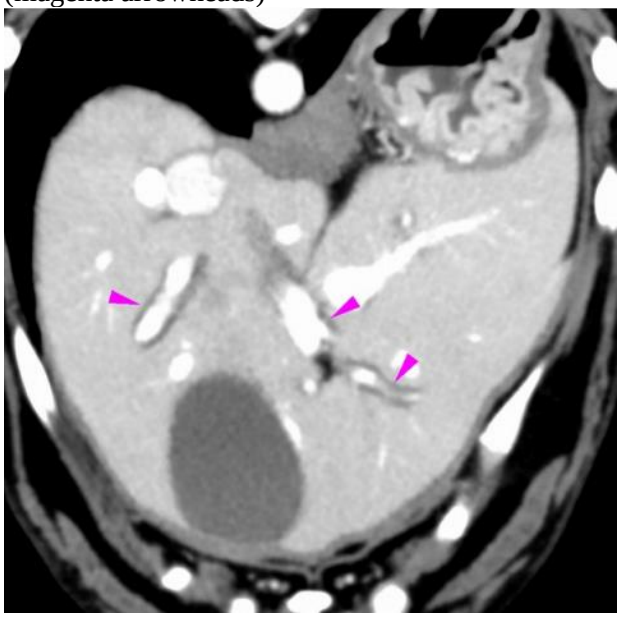

Fig.5 Transverse post contract CT scan of an 8-year-old neuter female with non-conclusive CT findings. Mildly enlarged liver with a normal portal vascularisation. A 1-1.5mm hypoattenuating halo around the intrahepatic portal vasculature is represented by the pink arrows.

CONCLUSIONS

Even though the periportal halo has been described in many studies in human medicine, being associated with many pathological processes, in veterinary medicine it is most likely incidental sign.

No correlation between changes of the hepatic parameters have been found in patients with periportal halo, exception being represented by the patient with portosystemic shunt.

Lymphadenopathy was commonly associated with CT findings of periportal halo in the present study, supporting the presence of fluid or dilated lymphatics around the portal branches described in human medicine literature. Furthermore, as previous described, this can be due to obstructive lymphedema, tumour infiltration and perivascular inflammation. In all the cases with periportal halo, hepatomegaly was noted, with smooth rounded margins. In the future, attention should also be directed toward the lymphatic system in patients with periportal halo.

For a better evaluation of the periportal halo and possible connections between systemic pathology, more detailed studies on a larger group of animals would be beneficial.

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