

peer reviewed **ARTICLE OF INTEREST****'Zebra spleen': a normal incidental finding**

Joel Harold Bortz MB ChB [Cape Town]; DMRD [London]; FRCR [London] FFRRCS [Ireland]

LSG Imaging, Los Angeles, California, America

ABSTRACT

The term 'zebra spleen' is used in radiology to describe alternating stripes of enhancement of the spleen. Examples of unenhanced and enhanced CT images are presented, in particular those that show a pattern that resemble the stripes on a zebra. This is a normal finding.

Keywords alternating bands, enhancement, intraperitoneal organ, red pulp, white pulp

LAY ABSTRACT

When dye is injected into a person during a computed tomography examination of the abdomen there is a pattern that briefly appears in the spleen that looks like the stripes on a zebra. It is a normal pattern.

INTRODUCTION

Some normal and pathological signs and patterns in radiology resemble animals.^[1] A brief discussion of the spleen and its anatomy and circulation is presented in this paper. The enhancement of a spleen is briefly covered because during a phase following intravenous administration in computed tomography a pattern, which resembles the stripes of a zebra, may be visualised. A range of images of the spleen is presented in this paper.

NORMAL SPLEEN, ANATOMY AND CIRCULATION

The spleen is an intraperitoneal organ situated in the left upper quadrant of the abdomen. It lies posterior and lateral to the stomach, beneath the left hemi-diaphragm and above the splenic flexure of colon.^[2] Figure 1 shows the spleen beneath the hemi-diaphragm on the left. The tail of the

pancreas is close to the splenic hilum.^[2] See Figures 2a to d.

Blood supply to the spleen is via the splenic artery that comes off the celiac axis. It is drained by the splenic vein which unites with the superior mesenteric vein to form the portal vein. Size and weight vary but most adults have a spleen with a length of about 10cms and a weight of about 100 and 150 grams.^[3,4] Its position is maintained by several suspending ligaments including the gastrosplenic, lienorenal and lienosplenic.

The spleen contains two major units: red pulp and white pulp.

- Red pulp is composed of splenic cords and a large volume of venous sinuses. It filters foreign material and old erythrocytes from the blood. In addition it stores and recycles iron as well as erythrocytes and thrombocytes.^[5]

- White pulp is lymphatic tissue located around central arterioles and contains mainly white blood cells (WBC). It is embedded within the vascular meshwork of the red pulp.^[5] It is thus part of the lymphatic system and initiates a response to blood-borne antigens.^[5] Throughout the spleen it is surrounded by red pulp.^[3,6]

UNENHANCED AND ENHANCED CT IMAGING OF THE SPLEEN

The spleen is homogenous on an unenhanced CT image with attenuation values ranging between 40 to 60 Hounsfield units (HU).^[6] Normal spleen and liver are shown in Figure 3. After intravenous (iv) administration of contrast media the spleen enhances in a mottled pattern during the arterial phase and early portal venous phase, while during the venous phase an homogenous enhancement of the spleen is seen. It is believed the ap-



Figure 1. Coronal view shows liver (L) and spleen (S). RK = right kidney. LK = left kidney.



Figure 2a. Axial view: aorta (AO), pancreas (P), tail of pancreas (T), spleen (S), and left kidney (LK).



Figure 2b. Axial view. RK = right kidney. LK = left kidney. AO = aorta. T = tail of pancreas. S = spleen.

pearance is due to differing blood/contrast flow rates between the red pulp which usually enhances earlier and the white pulp which enhances later. A delayed venous phase shows that the spleen has a homogeneous appearance.

In other words the mottled patchy enhancement pattern is caused by variable

flow rates through the spleen and this results in the inhomogeneous enhancement pattern.^[6] The appearance of hypoechoic and hyperechoic bands within the spleen is caused by both the different flow rates of the blood and contrast, and also from the different structural components of the parenchyma and different vascular pathways.^[3]

'ZEBRA' SPLEEN AS SHOWN ON ENHANCED CT SCANS

A 'zebra-striped patterned' spleen may be a completely normal imaging phenomenon and is of no clinical significance.^[7] Despite the large number of CT and MRI studies performed using i.v. contrast, it is a finding not frequently observed.

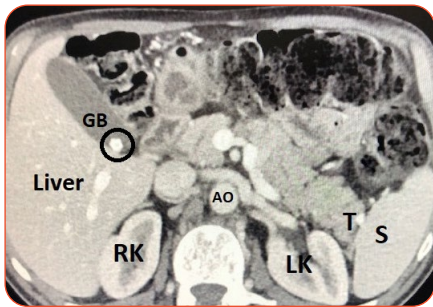


Figure 2c. Axial view showing liver, gallbladder (GB) with a gallstone (black circle), right kidney (RK), left kidney (LK), aorta (AO), tail of pancreas (T), and spleen (S).

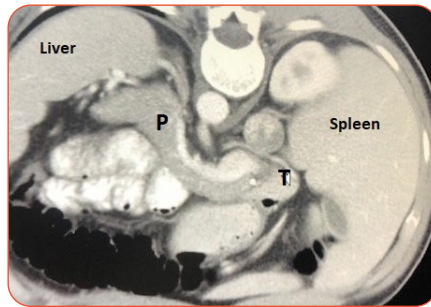


Figure 2d. Prone axial view showing liver, pancreas (P), tail of pancreas (T), and spleen.

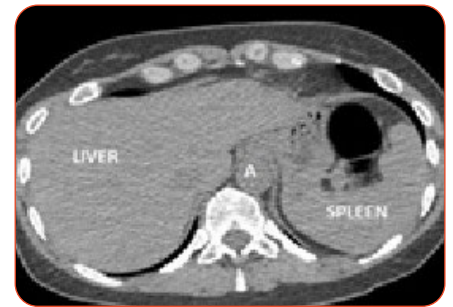


Figure 3. Normal unenhanced study showing almost equal density between liver and spleen. A = aorta.

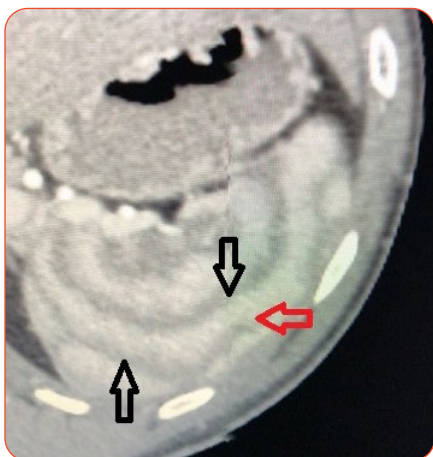


Figure 4a. Axial view showing alternating bands of high (red arrow) and low (black arrows) density simulating the stripes on a zebra.



Figure 4b. Coronal view. Left kidney (LK). Spleen (S) showing alternating bands of high and low density simulating the stripes on a zebra.



Figure 4c. Sagittal view shows spleen (S) with zebra stripes lying posterior to the stomach (red arrow) and above the left kidney (LK).

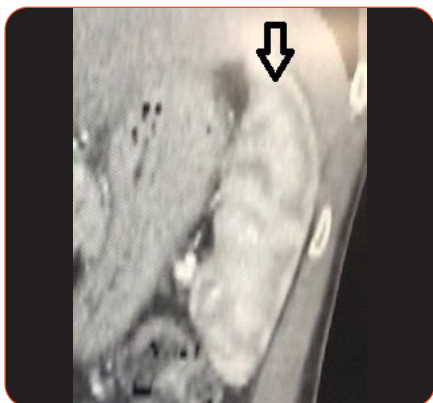


Figure 4d. Sagittal view showing spleen (black arrow) with areas of hypo and hyper-density resembling the stripes of a zebra.



Figure 4e. Axial view showing left nephrectomy and a diffused mottled appearance of the spleen (black arrow) after i.v. administration of contrast media.

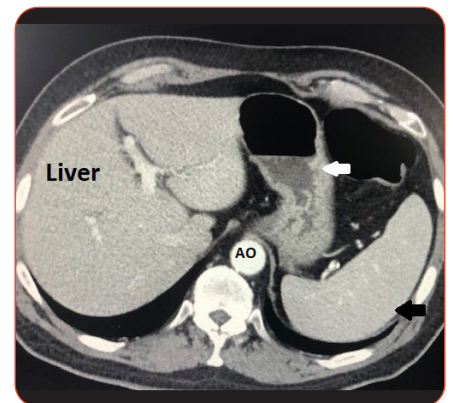


Figure 4f. Axial view of delayed venous phase showing homogeneous splenic enhancement with disappearance of the stripes (black arrow). Stomach (white arrow). Aorta (AO).

Following i.v. administration of contrast there is usually a heterogeneous enhancement of the spleen during the arterial phase. The appearance of alternating stripes of enhancement leads to the spleen taking on the appearance of 'zebra stripes' similar to that seen on a zebra (Figures 4a to e). Figure 4f shows homogeneous spleen enhancement.

KEY POINTS

- A 'zebra' spleen should not be con-

fused with any pathological condition.

- 'Zebra' spleen is a transient normal phenomenon following injection of contrast.

CONCLUSION

Zebra-patterned stripes visualised on contrast enhanced CT images of the spleen are a normal phenomenon. The pattern of 'zebra' stripes appears during the early arterial phase after i.v. administration of

contrast media and then totally disappears during the delayed venous phase.

CONFLICT OF INTEREST

None to declare

ACKNOWLEDGEMENTS

Leonie Munro is thanked for labelling the CT images and editing the paper.

REFERENCES

1. Linhaus Moreira AS, Castro MOE, Grande-Pérez P, Brito J, Ventosa AR, Patricio H et al. Radiology on a trip to the zoo. *ESR*, 2017. [Cited 2020 June 3]. DOI: 10.1594/ecr2017/C-1470
2. Pai A, Gest TR. Spleen anatomy. *Medscape*, 2014. [Cited 2020 June 3]. Available from: <https://emedicine.medscape.com/article/1948863-overview>
3. Urban BA, Fishman EK. Helical CT of the spleen. *AJR*, 1988; 170: 997-1003.
4. Yildiz AE, Ariyurek MO, Karcaaltincaba M. Splenic abnormalities of shape, size, and location: pictorial essay. *The Scientific World J*, 2013 [Cited 2020 June 3]. Available from: <https://www.hindawi.com/journals/tswj/2013/321810/>
5. Kuint RC, Daneman A, Navarro OM, Oates A. Sonographic bands of hyperechogenicity in the spleen in children: zebra spleen. *AJR*, 2016; 207: 648-652.
6. Vancauwenberghe T, Snoeckx A, Vanbeckerevoort D, Dymarkowski S, Vanhoenacker FM. Imaging the spleen: what the clinician needs to know. *Singapore Med J*, 2015; 56(3): 133-144.
7. Giambelluca D. The 'zebra spleen'. *Abdominal Radiology*, 2019; 44:1189-1190. [Cited 2020 June 3]. Available from: <https://doi.org/10.1007/s00261-018-1849-9>