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## **Ascites secondary to compression of the caudal vena cava by liver abscesses in a cow**

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1 Ascites secondary to compression of the caudal vena cava by liver  
2 abscesses in a cow

3

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## 11 **Abstract**

### 12 Background

13 Ascites due to thrombosis of the caudal vena cava is relatively seldom in cattle. To our knowledge,  
14 there have been no reports of ascites secondary to compression of the caudal vena cava by liver  
15 abscesses. This case report describes the findings in a 3.7-year-old Brown Swiss cow with this  
16 disease.

### 17 Case presentation

18 The cow had a distended, pear-shaped abdomen. Ultrasonography of the abdomen showed a massive  
19 accumulation of hypoechoic fluid and dilatation of the caudal vena cava. A tentative diagnosis of  
20 thrombosis of the caudal vena cava was made, and because of a poor prognosis, the cow was  
21 slaughtered. Incision of the abdominal wall released approximately 100 litres of yellow, clear, non-  
22 malodorous fluid from the peritoneal cavity. The liver was markedly enlarged, and two abscesses,  
23 approximately 10 cm in diameter, were situated immediately adjacent to the caudal vena cava causing  
24 compression of the vein. **No microbiology culture was done.** The final diagnosis was ascites  
25 secondary to compression of the caudal vena cava by two liver abscesses **and secondary hepatic**  
26 **fibrosis.**

### 27 Conclusions

28 This report suggests that compression of the caudal vena cava by liver abscesses should be included  
29 in the list of differential diagnosis of conditions associated with ascites and dilatation of the caudal  
30 vena in cattle.

31 Keywords: Cattle, ascites, liver abscess, caudal vena cava, compression

## 32 **Background**

33 Ascites is excessive accumulation of fluid in the peritoneal cavity. The ascites fluid can be  
34 characterised as inflammatory, non-inflammatory, chylous, urine-like, haemorrhagic or bilious [1]. In

35 cattle, ascites fluid is usually non-inflammatory and associated with vascular congestion due to  
36 chronic right-sided heart failure, a mediastinal mass, chronic liver or kidney disease, ileus of the small  
37 intestines, enteropathies, peritoneal tumours or thrombosis of the caudal vena cava [1]. There are  
38 several reports on ascites associated with thrombosis of the caudal vena cava in cattle [2-5], but to the  
39 authors' knowledge, there are no reports on ascites secondary to compression of this vein. This case  
40 report describes the clinical, ultrasonographic and pathological findings in a 3.7-year-old Brown  
41 Swiss cow, which was five months pregnant and had ascites secondary to compression of the caudal  
42 vena cava by liver abscesses.

## 43 Case presentation

44 For several days before referral to our clinic, the cow had a marked decrease in appetite and faecal  
45 output and progressive distension of the abdomen. On admission, the cow was in poor general health,  
46 had a marked decrease in appetite and a pear-shaped abdomen (Fig. 1). The rectal temperature was  
47 38.5 °C, the heart rate 68 bpm and the respiratory rate 28 breaths per min. Rumen motility was  
48 severely decreased, the rumen was relatively full and there was no distinct layering of rumen contents.  
49 Tests for reticular foreign bodies and swinging ~~and auscultation~~ and percussion ~~and~~ auscultation on  
50 both sides of the abdomen were negative. Intestinal motility was markedly decreased, and the cow  
51 passed small amounts of dark, watery, malodorous faeces. The results of a urine test strip (Combur<sup>9</sup>-  
52 Test, Roche, Basel) were unremarkable. An increased volume of peritoneal fluid was suspected based  
53 on sloshing felt during transrectal palpation.

54 The results of haematological and serum biochemical analyses showed haemoconcentration  
55 (~~haematocrit 38 %, reference interval 33—36 %~~), increase in  $\gamma$ -GT activity (~~56 U/l, reference interval~~  
56 ~~15—25 U/l~~), azotaemia (~~urea 7.7 mmol/l, reference interval 3.5—6.5 mmol/l~~), hypocalcaemia  
57 (~~calcium 2.1 mmol/l, reference interval 2.3—2.6 mmol/l~~) and metabolic acidosis (Table 1) (~~venous~~

58 ~~blood pH 7.36, bicarbonate 21.1 mmol/l, base excess -3.1 mmol/l; reference interval blood pH 7.40–~~  
59 ~~7.50, bicarbonate 20–30 mmol/l, base excess -2 to +2 mmol/l).~~

60 **Transcutaneous ultrasonography was performed using a 5.0 MHz convex transducer. It showed a**  
61 **massive amount of hypoechoic fluid in the peritoneal cavity, and the reticulum (Fig. 2), intestines**  
62 **(Fig. 3) and liver (Fig. 4) were displaced dorsally by the ascites fluid. The liver parenchyma appeared**  
63 **heterogeneous and hyperdense on ultrasonograms because of congestion. The caudal vena cava was**  
64 **circular and dilated in cross-section (Fig. 5) and did not have a normal triangular shape [6]. The**  
65 **gallbladder wall was thicker than normal because of oedema (Fig. 4). Ultrasound-guided**  
66 **abdominocentesis yielded yellow, clear, non-malodorous fluid with a specific gravity of 1.034**  
67 **(reference interval < 1.015), a protein concentration of 46 g/l (reference interval < 30 g/l), urea**  
68 **concentration of 7.5 mmol/l (reference interval similar to that of blood) and creatinine concentration**  
69 **of 94.3 µmol/l (reference interval similar to that of blood). Cytological evaluation of the abdominal**  
70 **fluid showed a few erythrocytes, leukocytes and macrophages, and was classified as a modified**  
71 **transudate. Based on all the findings, a tentative diagnosis of non-inflammatory ascites secondary to**  
72 **thrombosis of the caudal vena cava was made. The cow was slaughtered because of a poor prognosis,**  
73 **and a postmortem examination was carried out. Approximately 100 litres of clear, non-malodorous**  
74 **fluid escaped from the abdomen when the abdominal wall was incised (Fig. 6). The liver was**  
75 **markedly increased in size and firmer than normal and had a bumpy surface. Two abscesses with a**  
76 **diameter of approximately 10 cm were located immediately adjacent to the caudal vena cava and**  
77 **compressed it (Fig. 7, 8). There was no thrombus in the caudal vena cava (Fig. 9). **Histopathology of****  
78 **the liver parenchyma revealed a diffuse fibrosis, which was especially severe around the centrolobular**  
79 **veins and was often forming fibrous bridges between the periportal spaces (bridging fibrosis).**  
80 **Hepatocytes and hepatic lobules were severely atrophic and midzonal sinusoids were heavily**  
81 **congested and dilated (severe hepatic chronic congestion). Portal tracts were characterized by severe**  
82 **bile duct proliferation and multiplication of arterioles. Several vessel walls were moderately thickend**

83 **and centrolobular vein.** The final diagnosis was ascites attributable to compression of the caudal vena  
84 cava by two liver abscesses **and secondary hepatic fibrosis.**

85 The causes of ascites and the diagnostic work-up of cattle with ascites were recently described in  
86 detail [1]. Ultrasonography, abdominocentesis and examination of peritoneal fluid are critical  
87 components for determining the aetiology of the problem. Inflammatory and non-inflammatory  
88 conditions can be differentiated by peritoneal fluid analysis. Uroperitoneum is diagnosed when the  
89 creatinine concentration of peritoneal fluid is higher than that of serum, and an increased  
90 concentration of bilirubin in peritoneal fluid usually indicates bile peritonitis. Rupture of a tumour or  
91 blood vessel results in haemorrhagic peritoneal fluid, and peritoneal fluid that appears milky and has a  
92 high lymphocyte count may indicate chyloabdomen. The most important finding in this case study,  
93 other than the massive accumulation of peritoneal fluid, was the change in shape of the caudal vena  
94 cava in cross-section. The caudal vena cava normally appears triangular in cross-section [6], but  
95 becomes oval to circular with congestion of the vein. Changes in the shape of the vein are of greater  
96 diagnostic importance than an increase in the diameter of the vein [7]. Congestion of the caudal vena  
97 cava occurs with right-sided heart failure and with obstruction or compression of the vein. In cattle  
98 with right-sided heart failure, there is also congestion of the jugular veins, which did not occur in the  
99 present case. Our tentative diagnosis of thrombosis of the caudal vena cava appeared to be the most  
100 plausible cause because it occurs relatively often in cattle [2-4,7-9]. However, in these cases, a  
101 thrombus can rarely be seen via ultrasonography [8-10] because most are located in the part of the  
102 caudal vena cava that is obscured by the lungs. An outstanding yet time-consuming method for  
103 identifying a thrombus in the caudal vena cava is intraabdominal ultrasonography of the vein through  
104 a right-flank laparotomy [11]. Our tentative diagnosis was proved incorrect during postmortem  
105 examination, which revealed compression of the caudal vena cava by two liver abscesses.

106 Unfortunately, ultrasonography could not be used to visualize the abscesses because they were located  
107 in a part of the liver obscured by the lungs. It is highly likely that a correct diagnosis would have been

108 possible using intraabdominal ultrasonography [11]. The liver abscesses were immediately adjacent to  
109 the caudal vena cava and thus led to compression and subsequent congestion of the vein. Liver  
110 abscesses are the most common cause of thrombosis of the caudal vena cava in cattle [12-18] and,  
111 similar to our case, are situated immediately adjacent to the vein. However, liver abscesses usually  
112 rupture into the caudal vena cava and form a fibrinous thrombus attached to the intima, which  
113 partially or completely obstructs the lumen of the vein. This did not occur in our case.

114 Severe ascites usually is a sequel to increased hydrostatic and decreased oncotic pressure. In the case  
115 described in this report, increased hydrostatic pressure in the caudal vena cava was caused by an  
116 abscess that compressed the vein and impaired blood flow to the heart, and the decreased oncotic  
117 pressure was the result of liver fibrosis caused by congestion.

## 118 **Conclusion**

119 In conclusion, the change in the cross-sectional shape of the caudal vena cava from triangular to  
120 circular or oval on ultrasonography and the features found through the necropsy suggest that the  
121 ascites was caused by compression performed by the abscess and the secondary hepatic fibrosis.

122 ~~A change in the cross-sectional shape of the caudal vena cava from triangular to circular or oval on~~  
123 ~~ultrasonograms is abnormal in cattle. In such cases, right-sided heart failure, thrombosis of the caudal~~  
124 ~~vena cava and compression of the caudal vena cava by an abscess must be part of the differential~~  
125 ~~diagnosis.~~

## 126 **Competing interests**

127 The authors declare that they have no competing interests.

## 128 **Author's contributions**

129 UB prepared the manuscript and supervised the clinical and ultrasonographic examination, MS and  
130 SS examined the heifer, postmortem examination was performed by MH. All authors have read and  
131 approved the manuscript.

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## 179 Figure legends

180 **Figure 1 - Pear-shaped abdomen in a cow with ascites.** Photo showing a pear-shaped abdomen  
181 in a Brown-Swiss cow with ascites due to compression of the caudal vena cava by two liver  
182 abscesses.

183 **Figure 2 - Ultrasonogram of the reticular region.** Ultrasonogram of the reticular region of a cow  
184 with ascites due to compression of the caudal vena cava by two liver abscesses, imaged from the  
185 sternal part of the ventral abdomen. The reticulum is displaced dorsally by anechoic ascites fluid. 1  
186 Ventral abdominal wall, 2 Musculophrenic vein, 3 Diaphragm, 4 Ascites fluid, 5 Reticulum, 6 Anterior  
187 dorsal blind sac of the rumen, Cr Cranial, Cd Caudal.

188 **Figure 3 - Ultrasonogram of ascites.** Ultrasonogram of ascites in a cow with compression of the  
189 caudal vena cava by two liver abscesses, imaged from the right flank. Loops of small intestines are  
190 displaced dorsally by anechoic ascites fluid. 1 Lateral abdominal wall, 2 Extraomental ascites fluid, 3  
191 Greater omentum, 4 Intraomental ascites fluid, 5 Small intestines, Ds Dorsal, Vt Ventral.

192 **Figure 4 - Ultrasonogram of the liver and gallbladder.** Ultrasonogram of the liver and gallbladder  
193 of a cow with ascites due to compression of the caudal vena cava by two liver abscesses, imaged  
194 from the 10th intercostal space on the right side. The liver and the gallbladder are displaced from  
195 the abdominal wall by anechoic ascites fluid. The wall of the gallbladder **appears thicker than normal**  
196 **is thickened** because of oedema (congestion). 1 Lateral abdominal wall, 2 Ascites fluid, 3 Liver, 4  
197 Gallbladder, Ds Dorsal, Vt Ventral.

198 **Figure 5 - Ultrasonogram of the caudal vena cava.** Ultrasonogram of the caudal vena cava in a  
199 cow with compression of the caudal vena cava by two liver abscesses, imaged from the 11th  
200 intercostal space on the right side. The caudal vena cava, which normally is triangular in cross-  
201 section, is round because of congestion and dilation. 1 Lateral abdominal wall, 2 Liver, 3 Hepatic  
202 vein, 4 Caudal vena cava, 5 Right hepatic vein, Ds Dorsal, Vt Ventral.

203 **Figure 6 - Yellow ascites fluid escapes from the peritoneal cavity.** A large volume of yellow  
204 ascites fluid escapes from the peritoneal cavity after incision of the abdominal wall during

205 postmortem examination of a Brown-Swiss cow with compression of the caudal vena cava by two  
206 liver abscesses.

207 **Figure 7 - Liver with two abscesses.** The diaphragmatic fascia of the liver of a Brown-Swiss cow  
208 with two abscesses (arrows) in the upper margin of the liver and immediately adjacent to the caudal  
209 vena cava. The liver is whitish-grey and enlarged because of congestion of the caudal vena cava.

210 **Figure 8 - Pus oozes from an incised liver abscess.** Yellow viscous pus (arrow) oozes from an  
211 incised liver abscess that was compressing the caudal vena cava in a Brown-Swiss cow.

212 **Figure 9 - Opened caudal vena.** The caudal vena cava (arrow) of a Brown-Swiss cow with  
213 compression of the vein by two liver abscesses. The incised and opened caudal vena cava has no  
214 macroscopic abnormalities, such as a thrombus.

215 Table 1: Selected haematological and biochemical results and venous blood gas analysis in a cow  
216 with ascites secondary to compression of the caudal vena cava by liver abscesses

Variable	Cow	Normal range
Haematocrit (%)	38	33 – 36
$\gamma$ -GT (U/l)	56	15 – 25
Urea (mmol/l)	7.7	3.5 – 6.5
Calcium (mmol/l)	2.1	2.3 – 2.6
Venous blood pH	7.36	7.40 – 7.50
Bicarbonate (mmol/l)	21.1	20 – 30
Base excess (mmol/l)	-3.1	-2 to +2

217