



NOTE

Theriogenology

Transrectal ultrasonography and blood lactate measurement: a combined diagnostic approach for severe uterine torsion in dairy cattle

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ABSTRACT. In this study, we aimed to elucidate the utility of transrectal ultrasonography (TRUS) and blood lactate concentration (bLac) measurement to diagnose cows with severe uterine torsion. We investigated the association of TRUS and bLac measurement with macroscopic findings on laparotomy for severe uterine torsion in nine cows. We found that an increased ultrasonographic cross-sectional thickness (15–25 mm) and multiple hypoechogenic areas corresponded to macroscopic vascular compromise in the uterus on laparotomy. In addition, bLac was elevated (≥ 5.0 mmol/l) in cows showing uterine necrosis on laparotomy. A combined diagnostic approach with TRUS and bLac measurement enables assessment of the uterine vascular status and has utility for selecting the treatment option (including laparotomy) and predicting the outcomes.

KEY WORDS: dairy cattle, diagnosis, lactate, ultrasonography, uterine torsion

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The prognosis of uterine torsion in dairy cattle is influenced by the duration of the torsion, degree of severity, and extent of vascular compromise in the uterine tissues [1, 2, 4, 11]. Laparotomy may be required for correction of the torsion and extraction of the fetus [3]. Therefore, establishing therapeutic guidelines is important for predicting the outcomes and ascertaining the severity in cases of uterine torsion. However, it is difficult to assess torsion severity and uterine vascular status from rectal and vaginal examinations. Other examination methods are needed to assess severity, and these should include assessment of vascular compromise.

In cases of severe uterine torsion, vascular compromise results in thickening of the uterus, congestive edema, bloody ascites, and uterine necrosis [3, 6, 8, 9]. Transrectal ultrasonography (TRUS) is used for the diagnosis of uterine and ovarian disorders in bovine medicine and is considered to be suitable for the diagnostic examination of uterine lesions. Blood lactate concentration (bLac) is an indicator of torsion-induced uterine necrosis and poor prognosis [5]. A dual approach, using TRUS and bLac measurement, may enable prompt assessment of the uterine vascular status.

In this study, we aimed to clarify the utility of TRUS and bLac measurement to diagnose cows with severe uterine torsion. We targeted cows with severe uterine torsion to investigate the association between uterine vascular status and the outcomes in cows and calves and the association between ultrasonographic uterine cross-sectional thickness and bLac and macroscopic findings on laparotomy.

The subjects were 33 Holstein dairy cows reared in Nemuro, Hokkaido, Japan from 2014 to 2016. Each cow had severe uterine torsion and underwent laparotomy after rolling and/or hindlimb elevation failed to correct the torsion. Cows were suspected with severe uterine torsion when the fetus was not palpable in the vaginal or rectal examination. Laparotomy was performed with the conventional method via an incision in the right flank while the cow was in lateral recumbency. We investigated associations between the uterine vascular status and survival rates in cows on post-laparotomy day 30 and in calves at birth. Subjects were

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classified into no compromise, compromise, and necrosis groups based on the uterine vascular status. The no compromise group had no uterine thickening and/or edema on laparotomy. The compromise group had macroscopic increase in the ascites volume and uterine thickening and/or edema on laparotomy. The necrosis group had bloody ascites, dark purple discoloration of the uterus, and/or uterine thrombus formation. The compromise group showed signs of recovery in the blood flow, such as return to normal coloration with correction of uterine torsion, even when findings suggestive of necrosis were present. Obtained data were analyzed with the chi-square test.

Additionally, nine cows underwent TRUS and bLac measurement in the initial examination, and we investigated the associations between these results and the macroscopic findings on laparotomy. A 7.5-MHz portable ultrasound device equipped with a linear probe (Tringa Linear VET; Esaote Europe B.V., The Netherlands) was used for ultrasonography. The probe was inserted in the rectum to visualize the uterus and examine the cross-sectional thickness (in the thinnest part of the visualized range) and lesions visible on ultrasonography. Blood samples were obtained from the coccygeal vein before correction of the torsion, placed in heparinized tubes, and analyzed for bLac using a portable lactate analyzer (Lactate Pro2, Arkray KDK, Kyoto, Japan).

Of the 33 subjects diagnosed with severe uterine torsion, 29 underwent laparotomy. [Table 1](#) presents the uterine vascular status and cow and calf survival rates. Calves delivered from cows with vascular compromise tended to show poor viability. Cows with necrotized uterine vascular status showed significantly poor survival on post-laparotomy day 30.

A total of nine cows underwent TRUS, bLac measurement, and observation on laparotomy; [Table 2](#) presents the relevant results. Ultrasonography revealed a cross-sectional thickness of 10 mm and uniformly clear images in the three cows with no vascular compromise (Cases 1, 2, and 3; [Fig. 1](#)). These three cows showed bLac <5.0 mmol/l. Ultrasonography revealed increased uterine cross-sectional thickness (15–25 mm) and multiple hypoechogenic areas in the compromise and necrosis groups (Cases 4–9; [Fig. 2](#)). Three cows in the necrosis group had bLac levels ≥5.0 mmol/l (the exception was Case 8). Intraoperative ultrasonography of a gravid uterine horn with uterine necrosis (Case 9) revealed similar images to those obtained on TRUS ([Fig. 3](#)).

In this study, cows with uterine necrosis had lower post-laparotomy survival rates. However, because of lack of precise diagnostic criteria for the uterine vascular status, in many cases, the condition is first detected on laparotomy, with findings of uterine necrosis and rupture [3, 8]. Therefore, early detection of uterine vascular compromise and necrosis would be useful for predicting outcomes and selecting treatment options.

In cows with uterine torsion ≥360°, vascular compromise develops within the uterus, broad ligament, and mesovarium, which results in edematous swelling of the uterine wall [3, 7, 9]. Further aggravation of the torsion causes fetal death, thickening of the uterus, and uterine necrosis in protracted cases [10]. A cow with similarly severe uterine torsion showed thickening of the uterine wall, congestion, edema, necrosis, and thrombus on necropsy and histopathology [9]. Accordingly, we assumed that increased cross-sectional thickness (≥15 mm) and multiple hypoechogenic areas represent ultrasonographic signs of vascular compromise and that multiple hypoechogenic areas represent an ultrasonographic sign of congestive edema.

We previously reported suspected uterine necrosis in cows with bLac ≥5.0 mmol/l and poor prognosis for cows with bLac ≥6.5 mmol/l [5]. In the present study, bLac was elevated in three of the four cows (Cases 6, 7, and 9) with uterine necrosis. Thus, TRUS and bLac measurement may be useful to assess the uterine vascular status.

Table 1. Cow and calf survival rates after laparotomy for uterine torsion (%)

Uterine vascular status	Cow	Calf
No compromise	90.9 ^{a)} (10/11)	27.3 (3/11)
Compromise	60.0 (3/5)	0 (0/5)
Necrosis	15.4 ^{b)} (2/13)	0 (0/13)

Significantly different a) vs. b) ($P < 0.01$).

Table 2. Macroscopic findings on laparotomy, ultrasonography, and blood lactate (bLac) in nine cows with severe uterine torsion

Uterine vascular status	Case No.	Ultrasonography		bLac (mmol/l)	Outcome	
		Cross-sectional thickness of the uterus (mm)	Multiple hypoechogenic areas		Cow	Calf
No compromise	1	10	-	2.3	Survived	Viable
	2	10	-	4.2	Survived	Viable
	3	10	-	2.8	Survived	Died
Compromise	4	20	+	2.3	Survived	Died
	5	25	+	1.2	Survived	Died
Necrosis	6	15	+	5.0	Euthanized	Died
	7	25	+	5.5	Euthanized	Died
	8	25	+	1.8	Euthanized	Died
	9	25	+	23.4	Died	Died

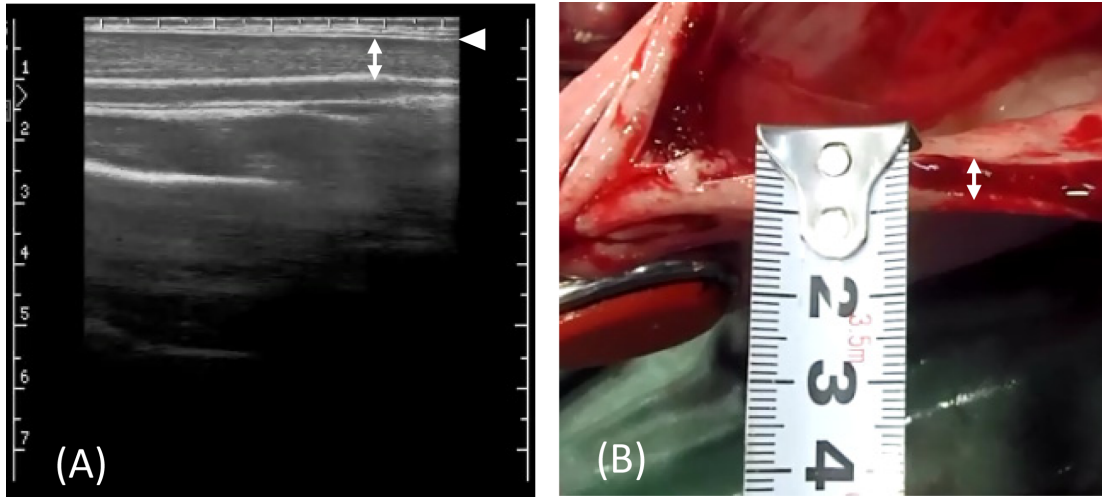


Fig. 1. Ultrasonography (A) and macroscopic findings on laparotomy (B) in Case 2. Arrow: Cross-sectional thickness. Arrowhead: Rectal wall.

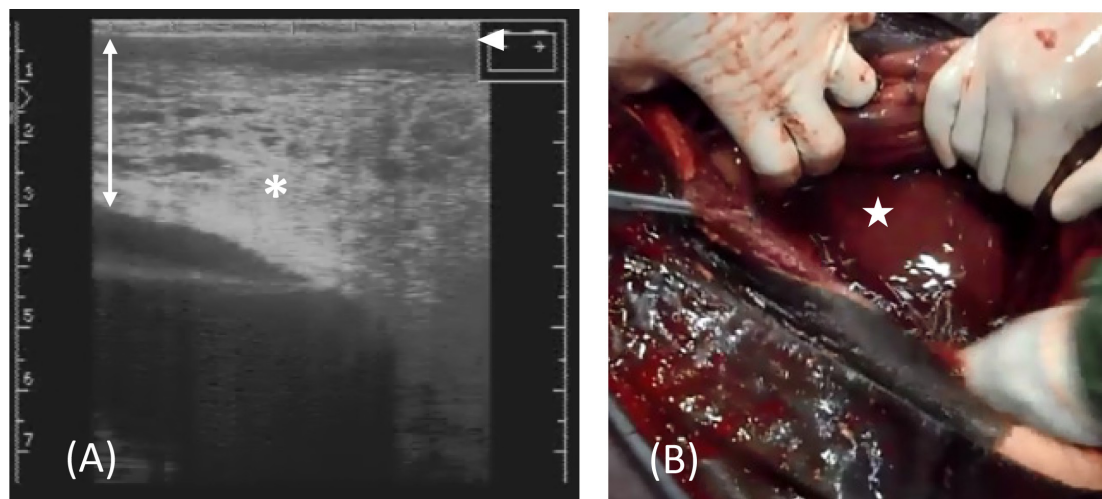


Fig. 2. Ultrasonography (A) and macroscopic findings on laparotomy (B) in Case 8. A: Increased cross-sectional thickening of the uterus and multiple hypoechoic areas (*). Arrow: Cross-sectional thickness. Arrowhead: Rectal wall. B: Dark purple discoloration and bloody ascites (☆).

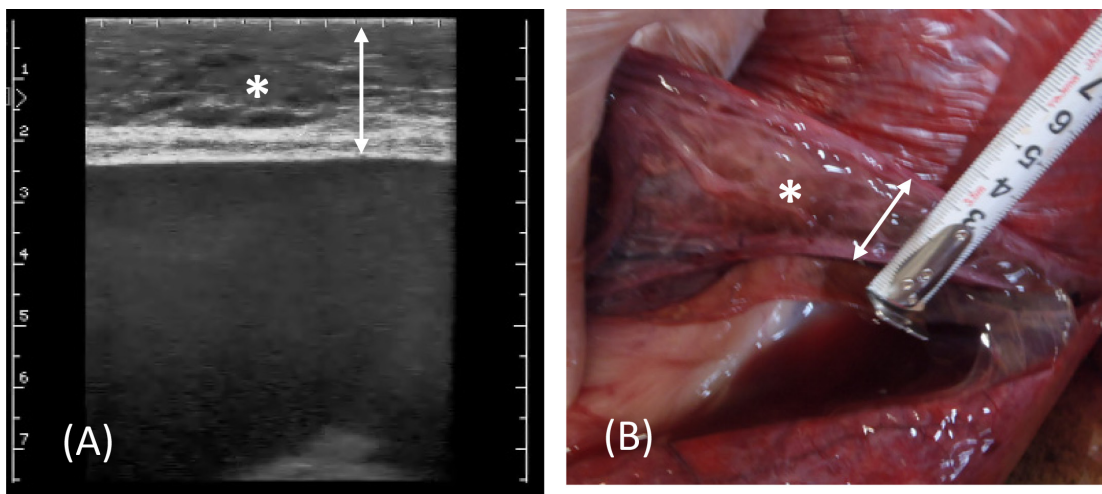


Fig. 3. Ultrasonography (A) and macroscopic findings (B) in Case 9. A: Increased cross-sectional thickness of the uterus and multiple hypoechoic areas (*). Arrow: Cross-sectional thickness. B: Congestive edema in the uterus (*). Arrow: Increased cross-sectional thickness of the uterus.

Although TRUS does not enable visualization of the entire gravid uterus, direct ultrasonography of the extirpated uterus from one cow (Case 9) showed images similar to those obtained by TRUS. Accordingly, we assumed that visualization of the area detectable on rectal examination enables the diagnosis.

In cases of bovine uterine torsion, veterinarians make a treatment plan after a comprehensive assessment, encompassing the stage of gestation, torsion severity, and maternal, uterine, and fetal conditions, but there is no diagnostic gold standard for all cases [3]. In cases of severe uterine torsion, the uterus becomes fragile, raising the risk of rupture of the organ or its major blood vessels [3]. In such cases, correction of the torsion requires great care. TRUS may reveal signs of vascular compromise, such as thickened uterine cross-section and hypoechoic areas, in cows with severe uterine torsion, and such findings necessitate early laparotomy. Determinations need to be selected carefully, considering that hysterectomy [10] is indicated when elevation in bLac is noted in addition to ultrasonographic abnormalities.

When deciding on laparotomy, veterinarians attach great importance to fetal viability; however, they have difficulty palpating the fetus *per vaginam* when the birth canal is completely closed, as is typical in severe cases. We found low fetal survival rates in cases of severe torsion, which is consistent with a similar report on fetal death resulting from persistent vascular compromise [10]. Accordingly, TRUS assessments of the uterine vascular status in cows may allow prediction of outcomes for the fetus simultaneously.

Based on the results of this study, we suggest that TRUS in cases of severe uterine torsion enables assessment of vascular compromise. In severe cases, when the fetus cannot be palpated, the predicted outcomes for the calf and cow can vary depending on the uterine vascular status. Accordingly, we assumed that a combined diagnostic approach with TRUS and bLac measurement has utility for selecting the treatment option (including laparotomy) and predicting the outcomes.

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