Ultrasonographic Thicknesses of Ruminal and Abdominal Wall in High Yielding Holstein Dairy Cows

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Abstract: Ultrasonography has been used as a non invasive method for examination of gastrointestinal tract of cattle. Rumen status and rumen health are importance in high producing dairy herds. In this study the normal values of abdominal and ruminal wall thickness in mid lactation cows were measured and abnormal cases were evaluated with ultrasonography. On ultrasonogram, ruminal wall in all of the cases were constituted by two layers but in some cases such as fluid accumulation or ascite were imaged as three layers. The mean ± standard deviation of abdominal and ruminal wall thickness (two layers) were 17.31 ± 3.08 and 8.01 ± 1.36 milimeters respectively. So, ultrasonographic investigation of left abdomen and their values of the thicknesses could be a part of rumen health evaluation in dairy herds but more researchs should be done for this matter in high producing dairy herds.
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Key words*:* Ultrasonography; Dairy cow; abdominal wall; Ruminal wall; Thickness.

1. Introduction

Ultrasonography is a non-invasive method for examination of body organs in domestic animal (Schroder and Staaufenbiel 2006; Braun 2009; Vaughan 2009). It has been used for investigating of diseases and disorders of gastrointestinal tract of cows (Tschuor and Clauss 2008; Braun 2003; Braun 2009). In cattle and especially in high yielding dairy cows diseases of rumen are importance. Rumen diseases such as carbohydrate engorgement, simple indigestion and rumen parakeratosis and rumenitis are most common (Radostits et al., 2006; Garry 2009; Grunberg and Constable 2009; Kersting et al., 2009). Thickening of the ruminal wall may be seen in cases of rumenitis or secondary to ruminotomy or ruminal trocarization. Abscesses between ruminal and abdominal wall in the left flank region and echogenic strands of fibrin in association with abscesses may be found in ultrasonography examination. Localized or generalized peritonitis may also occur secondary to abscessation (Braun 2009; Vaughan 2009).

The ultrasonographic examination is performed on none sedated, standing cattle by using a 3.5 to 5 MHz linear or convex transducer and ultrasonographic gel. The rumen is visualized in the left flank. The ruminal wall appears echogenic. In the dorsal part of the rumen reverberation artifacts are seen parallel to the ruminal wall. The ingesta in the middle part of the rumen are imaged as echogenic with gaseous inclusion. The fluid in the ventral part is hypoechogenic (Radostits et al., 2006; Tschuor et al., 2008; Braun 2003; Braun 2009). However to our knowledge, ruminal wall thicknesses have not been reported in high yielding dairy cows with ultrasonography. This study was undertaken to assess normal ruminal and abdominal wall thicknesses because of a few researchs about ruminal ultrasonography especially in high yielding dairy cows.

2. Materials and Methods

The study was carried out on 10 commercial dairy herds located in Tehran and Alborz provinces of Iran. 126 healthy Holstein dairy cows in 60-150 days in milk (DIM) were randomly selected. An area in the ventral left flank below the midline and 20 centimeter (cm) posterior to the last ribs was shaved

(30cm by 30cm) and washed. Ultrasonographic investigation of the area of interest was done using a 5 MHz linear probe (Agroscan, ECM, Angouleme, France). Transmission gel was applied to the transducer. The transducer was placed at a point in the ventral left flank 15-20 cm posterior to the last rib on the top of the horizontal line level of the patella. The abdominal wall layers (skin, muscles) and ruminal wall were measured by ultrasonography. Ultrasonographically, the ruminal wall was constituted by three layers which include (from mucosa to serosa); first; a thick hyperechoic layer that was situated adjacent to the ingesta of rumen, second; a thin hypoechoic layer that was situated laterally to the previous layer and the last layer was a thin hyperechoic layer that in most of the cases was attached to the outer (Fig.1). Due to the inconsistency of visualization of the last layer of the ruminal wall, ruminal wall thickness was determined measuring the first two layers. The ultrasonographic images were stored electronically.

3. Results

A total of 126 cows were included in this study. The skin was seen hypoecho and the fascia was imaged as a narrow hyperechoic line. The muscle layers were visualized with mixed echo. The two layers of ruminal wall were imaged as a thick hyperechoic and a thin hypoechoic line. The mean ± standard deviations of the abdominal wall and hyper and hypo and total layers of ruminal wall are recapitulated in table 1. The maximum thicknesses of abdominal wall and hyperechoic layer, hypoechoic layer and total layer of ruminal wall were 24.4 mm, 9.8 mm, 3.6 mm, 12.6 mm respectively. The minimum thicknesses of abdominal wall and hyperechoic layer, hypoechoic layer and total layer of ruminal wall were 10.2 mm, 3.8 mm, 1.2 mm, 5.6 mm respectively. There were some abnormal findings on ultrasonograms of some cows such as hyper echogenicity in peritoneal cavity that were excluded from this study (Fig.2).

Table 1: The mean and standard deviation of lactation, days in milk, abdominal wall and ruminal wall thickness (mm) of left abdomen with ultrasonography.

Parameters	Mean Values [a,b]
Lac	3.48 ± 1.74
DIM	99.31 ± 27.81
Abdominal wall	17.31 ± 3.08
Ruminal wall (hyperechoic layer)	5.82 ± 1.10
Ruminal wall (hypoechoic layer)	2.18 ± 0.56
Ruminal wall (hyper + hypo)	8.01 ± 1.36

[a,b] Data are expressed as the means ± SD
Lac = Lactation
DIM = days in milk

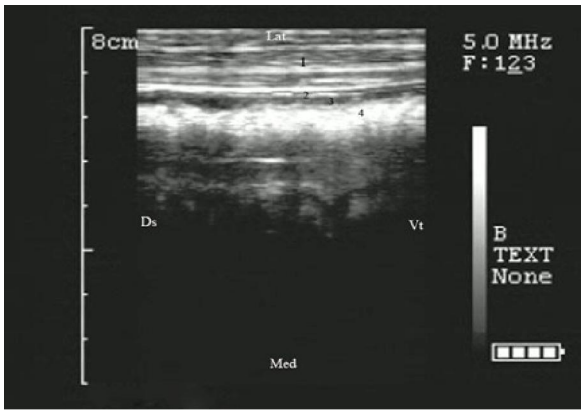

Figure 1: Ultrasonogram of left ventral abdomen and ruminal wall with three layers. Ventral abdominal wall (1), thin hyperechoic layer of ruminal wall (2), hypoechoic layer of ruminal wall (3), wider hyperechoic layer of ruminal wall (4). Ds, dorsal; Vt, ventral; Lat, lateral; Med, medial.

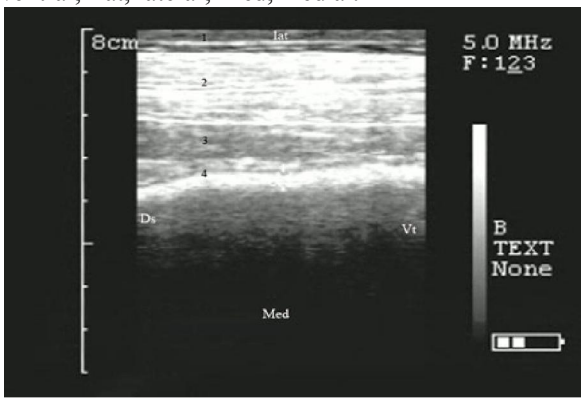

Figure 2: Hyper echogenicity in peritoneal cavity of left ventral abdomen in dairy cow. Skin (1), muscle layers (2), peritoneal cavity with hyper echogenicity (3), ruminal wall (4). Ds, dorsal; Vt, ventral; Lat, lateral; Med, medial

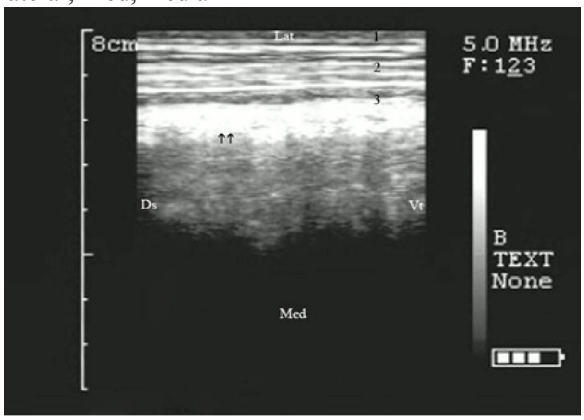

Figure 3: Ultrasonogram ruminal wall with edema in mucosal layer (black arrows) of left ventral abdomen in dairy cow in mid lactation. Skin (1), muscle layer (2), ruminal wall (3). Ds, dorsal; Vt, ventral; Lat, lateral; Med, medial.

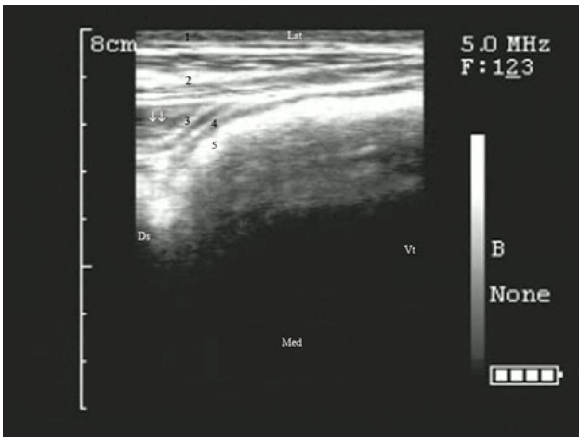

Figure 4: Ultrasonogram of fluid accumulation (white arrows) in left ventral abdomen and ruminal wall with three layers. Skin (1), muscle layer (2), omentum (3),thin hyper and hypo echoic of ruminal wall (4), wider hyperechoic of ruminal wall (5). Ds, dorsal; Vt, ventral; Lat, lateral; Med, medial.

4. Discussion

In this study the thicknesses of abdominal and ruminal wall (two layers) was measured. Braun et al (2011) have measured the thickness of abdominal wall in cows. The abdominal wall thicknesses of their study had a range between 28 to 34 mm while in the present study this range was between 10.2 to 24.4 mm. It seems that differences have originated from the different site of ultrasonographic examination and the large number of cows in our study than other study. The ruminal contents in present study were not visualized in all of the cases as described by others authors (Braun 2003, 2009, Tschuor and clauss 2008). In this study the ultrasonographic differences between the fibre mat and the fluid phase were imaged in some cases. Tschuor et al (2008) showed these differences in two of 3 Swiss braunvieh cows but Imran et al (2011) could not detect these differences in their study. Although in the study of Tschuor et al (2008) the dorsal rumen of the cannulated animal was partially evacuated while in the Imran ´s study they performed non invasive procedure. Braun et al (2011) showed these differences in all of the 30 Sannen goats in their study and have measured these layers separately. It has been suggested that in domestic cattle, the fibre mat is mostly not limited to the lower region of the dorsal rumen, and reaches deep into the ventral rumen (Kovacs et al., 1997; Ahvenjarvi et al., 2001; Hummel et al., 2008b; Tschuor et al., 2008). In this study, ruminal wall thickness were measured and the range of two layers were between 5.6 to 12.6 mm. Imran et al (2011) have measured ruminal wall. The range of the thickness of rumial wall in their study was between 3 to 4.8 mm. These differences between two studies may due to the breed of the cows and the stage of lactation but it should be considered that the layer of tunica mucosa of ruminal wall probably was measured by Imran et al. while in our study two layers were measured or may be due to higher thickness of ruminal wall in high yielding dairy cows in the present study. It is reported that different layers of ruminal wall is not distinguishable itself (Tschuor and Clauss 2008; Imran et al., 2011) but in the present study two layers of ruminal wall (hyperechoic layer and hypoechoic layer in accordance with tunica mucosa and tunica muscularis) were visible in all of the cases and in cases of fluid accumulation and edema in tunica mucosa three layers were more visible (Fig.1, Fig.3 and Fig.4). Braun (2009) showed a three layers of reticular wall in cases of ascite with ultrasonography and stated that different layers of the reticular wall usually cannot be imaged, but in cattle with ascites, the tunica serosa of the reticulum appears as a narrow echogenic line, the tunica muscularis is seen as a hypoechogenic line and the tunica mucosa is seen as a wider echogenic line. Imran et al. (2011) had similar results about omasum. In conclusion, we can speculate that the layers of ruminal wall in high yielding dairy cows could be differentiated at least as two layers. It seems that determination of the ruminal wall thickness could be a part of ruminal examination and evaluation of rumen health in dairy herds but more researchs for this matter should be done . Also, determination of normal thickness of abdominal wall and differentiate it from abnormal thickness could be helpful in interpretation and prognosis of some complicated cases such as peritonitis to reach the reliable descision.

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