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## Foreign body-induced changes in the reticular contraction pattern of sheep observed with M-mode ultrasonography

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### Abstract

In the pre-experimental period of a clinical trial, an apparently clinically healthy sheep fitted with ruminal and abomasal cannulas showed changes in the reticular contraction pattern visualized in M-mode ultrasonogram. Radiographic examination revealed a blunt metal screw in its reticulum. By the time change in the reticular motility through the ultrasound examination was detected, the animal had still not expressed any behavioral changes. A description of the clinical case, follow-up of the findings and laboratory data, like white blood cell count, serum pepsinogen and fibrinogen concentrations, were presented. The foreign body was removed through the ruminal cannula and reticular contraction tended to normal. An association of the contraction pattern with measured clinical data was possible, leading to the conclusion that use of M-mode ultrasonography has a potential application in similar clinical situations.

**Keywords:** Blunt object, M-mode curve, Reticulum, Ruminant.

### Introduction

Ultrasonography has been considered an excellent diagnostic tool to investigate disorders of the pre-stomachs, abomasum and intestines of ruminants. Indeed, this technique is non-invasive, has no known side effect, provides images in real time and does not require sedation (Braun, 2009).

This technique has been used successfully to evaluate the rumen, reticulum, omasum, abomasum and some portions of intestines, providing important information to clinicians, avoiding the need of invasive diagnostic procedures (Streeter and Step, 2007; Braun *et al.*, 2011; Braun *et al.*, 2013a,b).

Despite its potential and possibilities, there is limited literature available and the references found used only B-mode (Streeter and Step, 2007; Braun *et al.*, 2011; Braun *et al.*, 2013a,b). No records on utilization of pre-stomachs ultrasound in adult sheep were found (SCOPUS, PUBMED, GOOGLE SCHOLAR, researched on March of 2015). In Brazil, there is scant reference to ruminant gastrointestinal ultrasound and no specific publication on ultrasound of pre-stomach was identified. One of the authors, in his 25 years of activity in local market, registered only sporadic use of gastrointestinal ultrasound in ruminants, most of which in academic environment.

A detailed analysis of the movement of the reticulum is necessary to obtain significant information, and B-mode ultrasound can be used to observe the frequency and amplitude of the reticular phase contraction as well as its speed and the duration of the organ relaxation

(Streeter and Step, 2007; Braun, 2009). In M-mode, the behavior of a reading line during a certain period is represented, and temporal changes can be observed in the generated graph. In our experience, the biphasic curve obtained in M-mode representing the reticular contraction facilitates its evaluation; standardization is easier and the measured points of dynamic aspects of reticular contraction are precisely shown.

### Case Details

The technique using M-mode ultrasonography was standardized in an effort to design a study in which the reticular motility of sheep that received ranitidine intravenously would be evaluated (Morgado *et al.*, 2014). For this experiment all sheep had ruminal and abomasal cannulas. The animals were examined while standing, held by a halter with no additional mechanical or chemical restraint. Hair was clipped at a small area (2×3 cm), caudal and adjacent to the sternum. Scanning was performed with 3.5-5.0 MHz probe, adjusted to 15 cm of depth. Scan head was positioned caudal and adjacent to the xiphoid cartilage in the medial plane and scan beam directed cranially (max 30°) (Fig. 1), applying slight pressure until capturing a representative image. The images obtained were printed on thermal paper through a Sony UP701 video printer.

During the standardization of the technique, a constant pattern of reticular contraction curves was observed. The reticular contraction waves viewed by M-mode ultrasonography of the animal in question were particularly well defined and had the standard biphasic pattern (Fig. 2) (Akester and Titchen, 1969;

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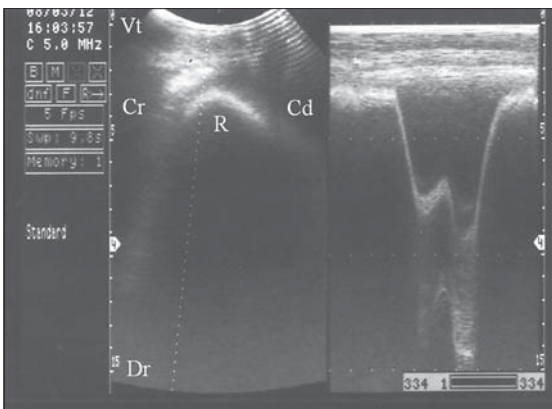
Streeter and Step, 2007; Braun, 2009; Kandeel *et al.*, 2009) and triphasic pattern (Braun and Rauch, 2008) during rumination. Suddenly, lower amplitude in both contraction phases and longer return time to the starting position were observed in comparison with their previous examinations (Fig. 3).

The B-mode ultrasonogram showed minor signs of a little quantity of fibrin and low amount of totally anechoic content around the reticulum, which were interpreted as signs of non-specific inflammation. Clinically, only bruxism and mild dehydration were noted.

The initial suspicion was abomasal problems resulting from the cannula surgery that occurred one month prior to the change in M-mode pattern, so the animal was forwarded to the diagnostic imaging section and was examined by contrasted radiographic exam with the administration of 50 ml of barium sulfate through the abomasal cannula (day 0). The images were obtained



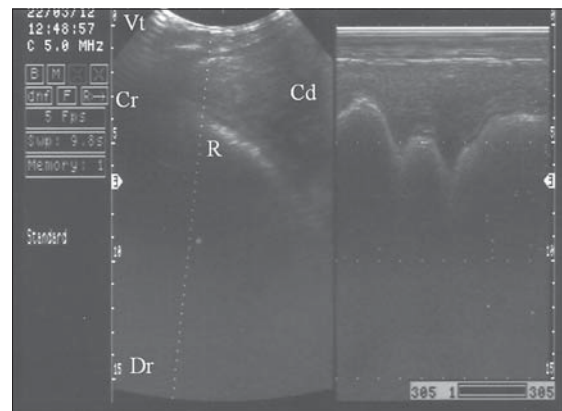
**Fig. 1.** Scanning was performed with the probe positioned caudal and adjacent to the xiphoid cartilage in the medial plane and directed cranially (max 30°).



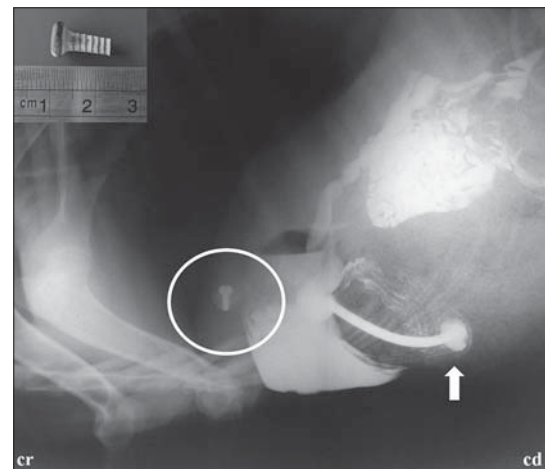
**Fig. 2.** B-mode (left) and M-mode (right) ultrasonographic images of the normal biphasic pattern of reticular contraction in a cannulated sheep before swallowing a foreign body. (Cr = Cranial; Cd = Caudal; Vt = Ventral abdominal wall; Dr = Dorsal abdominal wall; R = Reticulum).

with the animal in standing position, with the current technique (KV 60, MAS 3.2) and right-left lateral projection.

The radiographic examination revealed the presence of a blunt screw in the animal's reticulum (Fig. 4). No sign of reticular commitment was identified. Because the animal was fitted with a ruminal cannula, it was possible to remove the gastric contents and to retrieve the blunt screw in the reticulum by direct palpation. During the process, no adherence to the mucosa was noted. As the ruminal content had an acid smell, healthy contents were replaced via the ruminal cannula. After these procedures, the animal was more active and showed appetite.



**Fig. 3.** B-mode (left) and M-mode (right) ultrasonographic images of an abnormal biphasic pattern of reticular contraction of the same animal shown in Fig. 2. (Cr = Cranial; Cd = Caudal; Vt = Ventral abdominal wall; Dr = Dorsal abdominal wall; R = Reticulum).



**Fig. 4.** Radiographic image revealing the presence of blunt screw in the reticulum of a sheep (circle). The left small image shows the size of the screw removed from the animal. Animal was standing, right-left lateral projection. The circle shows the screw in the reticulum; the white arrow points the abomasal cannula. (Cr = Cranial; Cd = Caudal).

A non-steroidal anti-inflammatory drug (2.2 mg/kg of flunixin meglumine) was administered intravenously for three consecutive days, and preventive antibiotic therapy with penicillin (40,000 IU of benzathine penicillin/kg of body weight) was administered intramuscularly for five days (day 0 to 6).

Daily blood samples were collected before, during and after treatment to determine the blood count (automatic hematological counter, ABC Vet, ABX, Gurnee, Illinois, USA), differential leukocyte count (evaluation of a blood smear by microscopy), and serum fibrinogen (Schalm *et al.*, 1981) and pepsinogen (Paynter, 1992) concentrations.

On day 1, the animal showed leukocytosis ( $14.9 \times 10^9$  leukocytes/L) with neutrophilia ( $12.5 \times 10^9$  neutrophils/L) (Fig. 5). These findings in addition to the B-mode ultrasonography images confirmed a mild inflammatory process. The serum total protein was 88 g/L, and the cell volume was normal.

On subsequent days, the leukocyte count returned to the normal range for sheep, with a neutrophil: lymphocyte rate close to ideal for small ruminants (Byers and Kramer, 2010). Serum pepsinogen (Fig. 6) has increased on day 0 (8.89 IU/L), reflecting changes in the gastrointestinal tract, and returned to normal values on day 1 (Mesarić, 2005). The fibrinogen concentration has increased on day 2 (Byers and Kramer, 2010) (Fig. 6).

After the removal of the screw, the animal showed occasional kyphosis but all other clinical parameters were normal; it presented an appetite and the rumen was filled. Although the animal had mild dehydration, the PCV was within normal range and the total protein values were close to normal.

From day 1 to the last ultrasonographic examination (day 4), M-mode sonography revealed a biphasic pattern of reticular contraction, with a longer return time in comparison with their previous examinations (Fig. 7).

### Discussion

Radiography is the gold standard for identifying metallic foreign bodies in the forestomach of small ruminants. The gas content in the gastric compartments is a physical barrier for the use of ultrasound and an obstacle for the detection of foreign bodies by ultrasonography. M-mode ultrasonography, however, identified the effects of the presence of a foreign body on reticular motility by representing a contraction curve, thereby enabling measurement. In this sheep, changes in the pattern of reticulum contraction were observed even before clinical manifestations were noted, showing the potential of ultrasonography. M-mode ultrasonography can be an important tool to monitor reticular contraction, including the possibility of diagnostic support in foreign body ingestion.

### Conflict of interest

The authors declare that there is no conflict of interest.

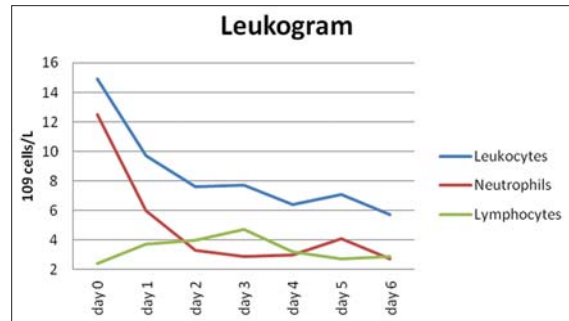


Fig. 5. Leukogram changes of the sheep from the day of diagnosis of a foreign body up to the six subsequent days.

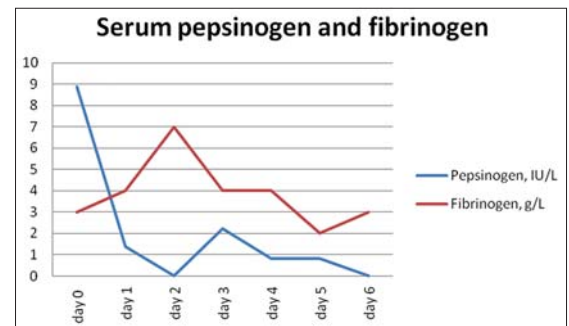


Fig. 6. Serum pepsinogen and fibrinogen changes of the sheep from the day of diagnosis of a foreign body up to the six subsequent days.

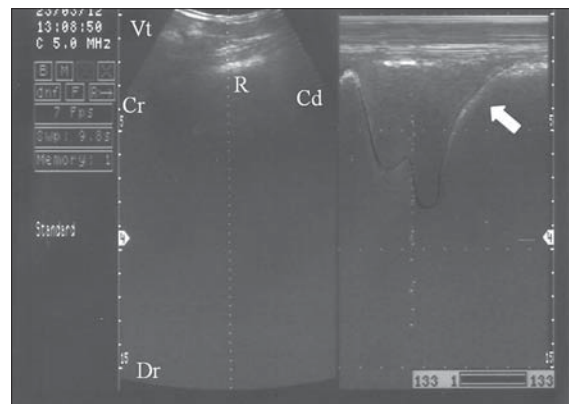


Fig. 7. B-mode (left) and M-mode (right) ultrasonographic images of the biphasic curve of reticular contraction in a cannulated sheep four days after foreign body removal showing a longer return time to the starting position (arrow). (Cr = Cranial; Cd = Caudal; Vt = Ventral abdominal wall; Dr = Dorsal abdominal wall; R = Reticulum).

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