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Radiographic findings in sheep with abomasal phytobezoariasis

S.M. Hashemiasl[1], S. Azizi[1], D. Torkamani[2]

[1]Faculty of Veterinary Medicine, Urmia University, Urmia, Iran
[2]Private Section Practitioner, Urmia, Iran

ABSTRACT: The purpose of this study was to characterise the radiographic appearance of abomasal phytobezoars in sheep as well as to evaluate the utility of abdominal radiography to identify them. Twenty-seven fat-tailed Herrick sheep with a clinical suspicion of abomasal impaction were examined radiographically. Abdominal survey radiographs in right lateral recumbency were taken. Abomasal phytobezoars (AP) were seen in abdominal survey radiographs in 25/27 sheep (92%). Their radiographic survey appearance was round-to-oval masses with radiopaque margins and radiopacity similar to the ingesta centrally. An additional gastrographic barium study was performed in six of the sheep, followed by exploratory laparotomy where phytobezoars were removed through abomasotomy. The optimal time to visualise the APs was 48 h post-contrast. A significant correlation was noted between phytobezoars size in radiology and surgery (r = 0.651, P < 0.001). Use of the barium study can improve the phytobezoar-ingesta contrast and visibility of the phytobezoars. Plain radiography with sheep positioned in right lateral recumbency is a useful supplementary technique which can be used to evaluate abomasal phytobezoariasis. This study shows that radiography is a suitable diagnostic method for detecting the presence of, but not the number of, abomasal phytobezoars in sheep.

Keywords: phytobezoar; abomasography; radiography; barium; abomasum; abomasotomy

Phytobezoars can occur in sheep ingesting large quantities of poor quality fibrous feeds or plants covered in fine hair (Radostits et al. 2007). A velvety form of abomasal phytobezoar occurs in goats and sheep in the arid regions of southern Africa and causes significant economic loss (Bath et al. 1992a; Bath et al. 1992b). Phytobezoars can cause abomasal impaction in sheep, and affected sheep may have decreased appetite, anorexia, weight loss, decreased faecal production, apparent depression, lethargy, severe sickness, and can even die (Gogoi et al. 1976; Bath and Bergh 1979; Kline et al. 1983; Radostits et al. 2007; Anderson 2009). Treatment typically consists of surgical removal through abomasotomy (Hofmeyr 1986).

In our clinical experience, abomasal phytobezoars impaction is an important endemic disease of sheep in Urmia, Iran and is associated with relatively high morbidity and mortality. The annual prevalence of sheep abomasal phytobezoariasis was determined to be 1.95% (Azizi et al. 2010). Ingestion of large quantities of unprocessed poor-quality chicken pea (*Cicer arietinum*) straw in the season when animals are kept indoors (November to April) is believed to be a predisposing factor for phytobezoar formation in the abomasum (personal communications). If present, the abomasal phytobezoars can often be palpated just behind the xiphoid cartilage in goats and sheep (Bath et al. 2005).

Diagnostic imaging of the gastrointestinal tract, particularly the abomasum in affected sheep may be useful to confirm the presence of phytobezoars. Radiography and ultrasonography have been suggested as useful techniques for diagnosis of bezoars in the rumen or abomasum of calves, sheep and goats (Anderson 2009), and ultrasonography was used for detection of a duodenal phytobezoar in a ram (Sargison et al. 1995). Radiography and ultrasonography have also been used for detection of duodenal trichophytobezoar in New World camelids (Sullivan et al. 2005).

We are unaware of studies evaluating the radiographic findings of abomasal phytobezoariasis in

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sheep. Our hypothesis was that using radiographic methods can help to diagnose AP. Thus, our purpose was to determine whether abdominal survey and contrast radiography can be used to diagnose abomasal phytobezoars and if such were discovered to describe the radiographic findings.

MATERIAL AND METHODS

Animals. The study used 27 sheep with abomasal phytobezoariasis, which were referred to the veterinary hospital, University of Urmia, between November 20, 2008 and April 31, 2009. There were four rams and 23 ewes, ranging in age from three to six years and weighing between 45 to 60 kg from 10 flocks with endemic phytobezoariasis. A tentative diagnosis of abomasal phytobezoariasis was based on clinical findings and confirmed by exploratory abomasotomy. Two healthy sheep from two of the same herds without any clinical signs of the disease were used as controls.

Clinical examination. Before radiographic examination, the sheep were examined clinically (Radostits et al. 2007; Anderson 2009). All sheep had decreased appetite, weight loss; reduced faecal production, lethargy and apparent depression. Routine blood test including CBC was performed before surgery.

Radiographic examination. Abdominal radiography was performed with an X-ray unit (Mobile Drive AR 30, Model TM8105, Smam X-Ray Equipment, Muggio Lombardy, Milan 20053, Italy). A 10 : I, 103 line-per-inch focused grid was employed with rare-earth screens and medium-speed film. Radiographs were taken in all animals without sedation or anaesthesia; instead, sheep were held down by handlers.

Plain lateral and ventrodorsal radiographs were made with sheep positioned in right lateral and dorsal recumbency. Based on our clinical experience, contrast abomasography was performed with barium sulphate (Barex, Darou Pakhsh Pharmaceutical Mfg. Co. Tehran, Iran) at 35% W/V, and 50 ml/kg of body weight through a 50 ml syringe orally, in a similar dosage to a previous study (Sanoeep et al. 1984). No attempts were made to close the oesophagoreticular groove before barium sulphate administration. Lateral and ventrodorsal radiographs were made at 30 min, 24, 48, 72 and 96 h after barium administration (Figure 1). The radiographs were made at exposure settings of 70–80 kVp; 10 mAs and 70–80 kVp; 15 mAs, respectively, and at a focal-film distance of 100 cm.

In sheep with abomasal phytobezoariasis, abdominal survey radiography was performed in right lateral recumbency. Additional contrast radiography was performed in six sheep at 48 h (n = 2), 72 h (n = 2) and 96 h (n = 2) after oral administration of barium sulphate. The exposure settings for survey and contrast radiography were the same as for the control sheep. The radiographs were reviewed conventionally, using a light box (Gs3 Fluorescent 36w circular, Ghabsazan Company, Tehran, 02133482348, Iran), by a veterinary radiologist. Density of phytobezoars was determined using contrast abomasography in control sheep. Presence, number, and diameter of phytobezoars were recorded in suspected sheep accordingly.

Surgical methods. In the sheep with abomasal phytobezoariasis, a definitive diagnosis of abomasal phytobezoariasis was confirmed using abdominal exploratory abomasotomy via a right paramedian approach. Sheep were restrained in a left lateral recumbent position and 2% lidocaine hydrochloride was used for local analgesia in an inverted L method (Hofmeyr 1986; Haskell 2004). A 15-cm incision was made parallel to and 5 cm away from the midline. Subcutaneous tissues and muscle layers were sharply incised. The peritoneum was tented and entered sharply. The greater curvature of the abomasum was exteriorised and isolated from the rest of the abdomen with sterile towels. An incision was made in the abomasal wall, and the phytobezoars removed. Abomasal closure was done in two layers with an inverting pattern in the second layer using chromic catgut (No. 1). Therefore the peritoneum and internal rectus abdominis muscle sheath were closed with a simple continuous pattern using chromic catgut (No. 1), as was the external sheath of the rectus abdominis muscle using chromic catgut (No. 2). The skin was sutured with nylon (No. 1) using interrupted horizontal mattress sutures. The sheep were under continuous intravenous infusion of Ringer's lactate containing Flunixin (1 mg/kg). Postoperative care consisted of Stropen1+1® (Penicillin G Procaine 1 MIU and Dihydrostreptomycin Sulfate eq. to 1 g, Nasr Pharmaceutical Co. Tehran, Iran) for five days at 10 000 IU/kg dosage, a single dose (5 ml) of Adevit® (Vitamin A 50 000 IU/ml, Vitamin D3 at 1000 IU/ml, Vitamin E at 20 mg/ml, Razak Laboratories, Tehran,

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Iran), topical spray with oxytetracycline and post-operative analgesia using Flunex® (Flunixin 50 mg/ml, Razak Laboratories, Tehran, Iran) at 1 mg/kg for two days. Following removal, the number and diameter of the phytobezoars were determined. For non-spherical phytobezoars, the widest diameter was recorded.

Statistical analysis. Frequencies, means and standard deviations were calculated and results from the radiological and surgical examinations compared using an unpaired *t*-test and the Pearson's correlation coefficient test for association (Daniel 1991). Regarding differences in the number of phytobezoars diagnosed radiologically and after surgery, and the fact that the larger phytobezoars can be better seen on radiograph, the correlation was calculated based on all counted phytobezoars in radiology and the same number of larger phytobezoars counted post-surgical removal. All tests used a critical significance value of $P < 0.05$. The statistical software program SPSS 13 (SPSS Inc., Chicago, IL) was used for analysis.

RESULTS

Imaging findings

Healthy sheep. In the survey radiographs the abomasum could not be determined in the ventrodorsal view because of superimposition by forestomachs. However, the craniolateral ruminal sac, caudal border of the reticulum and cranial portion of the abomasum were seen in the cranioventral abdomen in the lateral radiograph (Figure 1A).

Pre-contrast gastrointestinal ingesta had an amorphous granular appearance. In the post-contrast radiographs the cranial part of the abomasum and some segments of the gastrointestinal tract were distinguishable (Figure 1). The rumen and reticulum were opacified well at 30 min after administration of the barium sulphate. The abomasum and omasum were opacified well and clearly seen after 24 and 48 h, respectively (Figures 1B, 1C and 1D). The faecal pellet in the descending colon was visible only at 48 h post-contrast (Figure 1D).

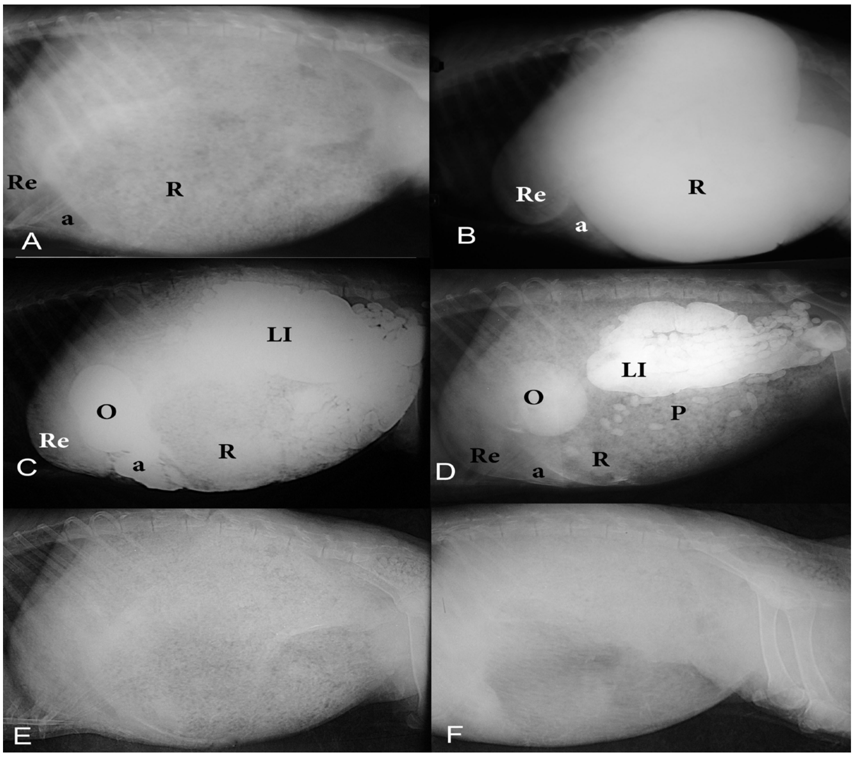

Figure 1. Right lateral recumbent survey (**A**) and post-contrast (**B**, **C**, **D**, **E**, **F**) radiographs of the abdomen in a healthy sheep at 30 min, 24, 48, 72 and 96 h after barium sulphate administration. Mild opacification of the reticulum can be seen at 30 min (**B**) with good opacification of the omasum and abomasum at 24 and 48 h, respectively (**C** and **D**). At 48 h post-contrast the large colon is well opacified. Contrast media cannot be appreciated at 72 and 96 h post-barium sulphate administration (**E** and **F**)

a = abomasum, LI = ascending colon, O = omasum, P = faecal pellets in descending colon, R = rumen, Re = reticulum

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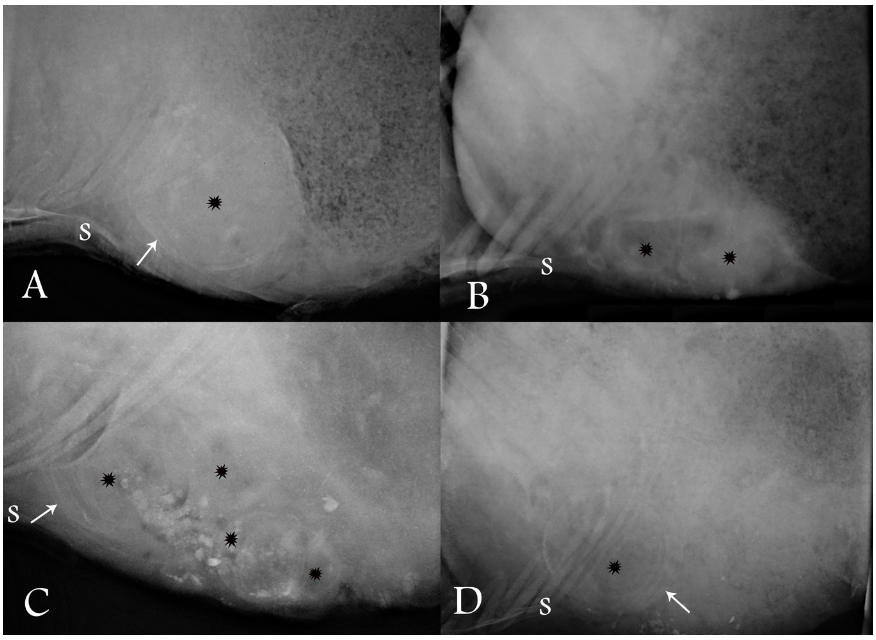

Figure 2. Survey radiographs of abomasal phytobezoars in four sheep. The phytobezoar opacity (star) is seen caudal to the sternum (s). The phytobezoars are seen between the rumen and the reticulum with some caudodorsal displacement of the cranial ruminal sac (**A** and **B**). In **A**, **C** and **D**, a marginal radiopaque line and multi-layers of phytobezoars are seen (white arrows). In **C**, two ventrocaudally superimposed phytobezoars and gravel opacities are seen ventrally in the abomasum

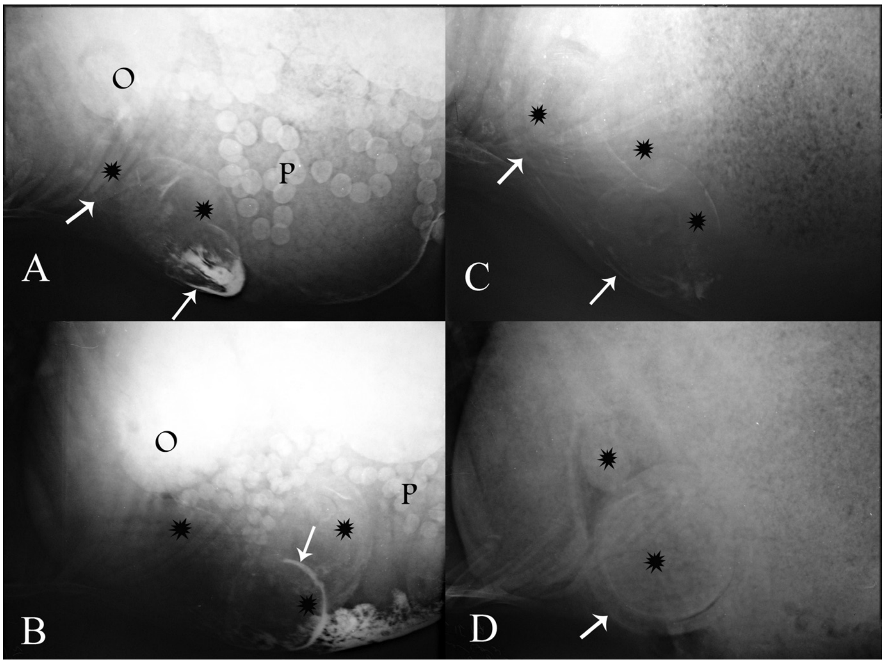

Figure 3. Right lateral recumbent contrast radiographs of the abomasal region in sheep with abomasal phytobezoariasis. **A** and **B**, (48 h post-contrast administration) the residual barium (white arrows) on the outer surface of phytobezoars (star) resulting allowed better visualization. **C**, (72 h post-contrast administration) a fine layer of contrast media remains on the outer surface of the phytobezoars (white arrows). **D**, (at 96 h post contrast administration) there is no evidence of residual barium on the phytobezoars. However, a multi-layered pattern of the larger phytobezoar is clearly seen (white arrow)

O = omasum, P = normal faecal pellets with the descending colon

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Contrast media was not seen in the gastrointestinal tract after 72 h (Figures 1E and 1F).

Sheep with abomasal phytobezoariasis. Phytobezoars were identified by lateral survey radiographs in 25 of 27 sheep (92%). They appeared as round-to-oval shapes with thin radiopaque lines in the periphery. The radiopacity of the centres of the phytobezoars was the same or more than that of the ingesta. In this study the abomasal phytobezoars were seen just caudal to the sternum near the abdominal wall. Ruminal compression and displacement by the phytobezoars were also seen in some animals (Figures 2A, 2B and 3D).

The phytobezoars were located on the cranioventral abdomen behind the sternum, in the region of the cranial portion of the abomasum (Figures 2 and 3). In most of the radiographs the rumen was mildly displaced caudodorsally by the phytobezoars and in some the masses were seen between the rumen and the reticulum (Figures 2A and 2B). Occasionally, a multilayer pattern was seen at the outer layer of the phytobezoars (Figures 2A, 2C, 2D, 3C and 3D). Survey radiographs failed to detect phytobezoars in two sheep, which had distention and hazy appearance on cranioventral abdomen.

The numbers of the phytobezoars were estimated to be 1–4 (mean 2 ± 0.26), and their diameters ranged from 35 to 130 mm (mean 73 ± 3.2 mm) only on survey radiographs (Table 1).

The phytobezoar opacities were clearly illustrated in the six sheep with contrast abomasography. Phytobezoars were optimally visualised at 48 h post-contrast administration (Figure 3).

Surgical findings

Phytobezoars were removed surgically from the abomasum in all animals (Table 1). They were thick, very dense and spherical-to-oval in shape. In two sheep without radiographic evidence of phytobezoars, surgical findings revealed six and 12 abomasal phytobezoars, respectively, and additional descending duodenal obstruction by a phytobezoar. The numbers and diameters of phytobezoars ranged from one to 18 (mean 5.24 ± 0.88) and from 15 to 130 mm (mean 44.9 ± 2.19), respectively (Table 1).

Correlation of radiographic and surgical findings

There was a statistically significant difference between the mean number of phytobezoars found in radiological and surgical analyses ($P < 0.001$). Correlation analysis revealed a good Pearson's correlation ($r = 0.65$, $P < 0.001$) between size of the phytobezoars measured radiologically and after surgical removal.

DISCUSSION

Abomasal phytobezoars were detected in 25 out of the 27 sheep (92%) using survey radiography. This suggests that in this population of sheep, survey radiography of the cranial abdomen in right lateral recumbency was a valuable diagnostic method for detection of abomasal phytobezoariasis.

Table 1. Radiological and surgical comparison of abomasal phytobezoar numbers

CN	PNIR	PNIS	CN	PNIR	PNIS	CN	PNIR	PNIS
1	0	6	10	1	2	19	3	5
2	2	3	11	1	2	20	3	3
3	2	3	12	2	4	21	3	4
4	1	1	13	2	3	22	3	7
5	2	2	14	3	4	23	2	6
6	3	3	15	2	5	24	3	5
7	4	7	16	2	5	25	1	3
8	0	18	17	2	8	26	1	4
9	4	10	18	4	12	27	2	6
Total							58^{+} 1–4 (mean 2.15 ± 1.1)	141^{+} 1–18 (mean 5.22 ± 3.57)

CN = case number (sheep), PNIR = phytobezoars number in radiology, PNIS = phytobezoars number in surgery

$^{+}P < 0.001$, significantly different vs PDIS

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In this study only lateral radiographs were made in sheep with phytobezoariasis because of superimposition of abomasum with forestomachs in the ventrodorsal view. Also, post-contrast abomasography was not taken at 30 min and 24 h because in these time points forestomachs were filled with barium sulphate and phytobezoars were masked.

In the present study, survey radiography failed to detect any phytobezoar masses in two sheep, where surgical findings revealed descending duodenal obstruction by a phytobezoar and abomasal impaction with fluid, ingesta and phytobezoars.

Their radiographs showed an ascites-like appearance in the abomasal topographic situation indicating abomasal fluid accumulation. This should be taken into consideration in clinical findings from sheep suspected of abomasal phytobezoariasis when survey radiography does not support physical examination.

The cranial part of the abomasal fundus is extensively connected to the reticulum, atrium, and ventral sac of the rumen (Dyce et al. 1996), as was seen on survey lateral radiographs of two healthy sheep (Figure 1). In the present study the phytobezoars were seen just in the position of the fundus of the abomasum on the survey radiographs in the sheep suspected of phytobezoriasis. This is similar to a previous report stating that palpation of the abomasum immediately caudal to the xiphoid cartilage could be used to identify the presence of abomasal phytobezoars in goats and sheep (Bath et al. 2005). Hence, we conclude that in the current study the phytobezoars that were visible radiographically were in fact with the abomasum. The reasons for the significant difference between the number of phytobezoars found in radiological and surgical examinations can be attributed to the small size of phytobezoars, or superimposition of some of them resulting in border effacement of the caudal abomasum and the rumen. Abdominal survey lateral radiography is therefore not suitable for the assessment of the precise number of abomasal phytobezoars present, but can give an approximation. The multi-layered pattern of the phytobezoars may result from true multilayering of the phytobezoars developing within the abomasum.

Barium esophagography has been reported for diagnosing an oesophageal phytobezoar in a horse (Orsini et al. 1991). In the present study, contrast abomasography was performed to confirm the opacities suspected to be abomasal phytobezoars in survey radiographs, and to detect the optimal time to visualise the phytobezoars after barium administration. Stomach foreign bodies are best demonstrated by positive contrast. Frequently, the foreign body is most clearly seen when most of the barium has left the stomach. It is then outlined by residual barium adhering to it (Kealy et al. 2011). In the present study, the phytobezoars were easily visualised on contrast media radiographs compared to those of the survey radiographs. The optimal time for detecting phytobezoars was 48 h after barium sulphate administration. This is because within 48 h the contrast medium was absorbed by the phytobezoars and the rest was passed from the forestomach and abomasum.

Due to the time involved in performing a contrast study, it is suggested that it only be used when a sheep is suspected of having abomasal phytobezoariasis, with no clinical or survey radiographic evidence of the disease.

Statistically, there was a significant correlation between the size of phytobezoars found radiographically and surgically, indicating that radiography can be useful for assisting in size estimation of the phytobezoars even though radiographic magnification occurs. This study shows that right lateral recumbent survey radiography is superior to ventrodorsal positioning to evaluate the abomasum of sheep. This could be because of lower thickness of the cranioventral abdomen and an uncovering of the cranial part of the abomasum by other organs.

The results of this study have shown that barium sulphate contrast gastro-intestinal radiography is very useful for detection of abomasal phytobezoars in sheep. The optimal time for radiography post barium administration is 48 h. In addition, abdominal survey radiography in right lateral recumbency is a fast and easy method in assessing the presence of sheep abomasal phytobezoariasis, as well as in estimating their size and number, and can thus assist in surgery planning.

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Corresponding Author:
Seyed Mohammad Hashemiasl, Urmia University, Faculty of Veterinary Medicine, Department of Surgery and Diagnostic Imaging, PO Box 57155/1177, Urmia, Iran
E-mail: mm.hashemi@urmia.ac.ir