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Full Length Research Paper

Comparison of contrast radiography and ultrasonography in diagnosing gastrointestinal obstruction in rabbits

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Gastrointestinal (GI) obstruction in rabbits is common due to the peculiarities of their gastrointestinal tract. This condition usually has an acute progression before the rabbit succumbs or recovers. Due to the acute nature of gastrointestinal obstruction in rabbits, early detection is important. Contrast radiography and ultrasonography are two non-invasive imaging procedures that can be used to detect underlying disease conditions and lesions. This study is designed to assess how these imaging procedures identify GI disturbance and obstruction and can be an aid to early medical intervention. Five male rabbits reared in single battery cages had their diet altered: they were given digestible fiber, starch and water per day to simulate GI obstruction. They were given a barium meal after being sedated and their GI tracts were imaged radiographically and ultrasonographically. The rabbits presented radiographic evidence of gastric dilatation, pooling of the barium meal in the stomach and distention of the small and large intestines with gas. Ultrasonographic features of gas distended stomachs and hyperechoic outlining of the small intestinal mucosa peculiar to GI disturbance were observed. Both imaging techniques were useful in diagnosing GI obstruction and will be useful in early diagnosis and consequent therapy. It can reduce mortality in rabbits. However, contrast radiography is possibly an easier tool to use.

Key words: Gastrointestinal obstruction, contrast radiography, ultrasonography, rabbits.

INTRODUCTION

Gastrointestinal (GI) obstruction refers to any condition that impedes the normal flow of the bowel or gastrointestinal tract. GI obstruction could be due to an intramural, extra-luminal or luminal causes that can compromise the normal anatomy and physiology of the gastrointestinal tract (GIT). Gastrointestinal obstruction is a common incidence in small animal practice. This can be attributed to several factors including environmental and habits exhibited by the small animals.

Any physical obstruction of the small intestines causes build-up of fluid and gas proximal to the obstruction Lennox (2013). Rabbits have a well-developed lower oesophageal sphincter; they are unable to perform emesis and so, in cases of complete small intestinal

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obstruction, the progression of gastric/intestinal dilation is rapid (Harcourt-Brown, 2013).

Causes of GI obstruction may vary from swallowed foreign objects to neoplasia. However, intussusception is recognized as a common cause of bowel obstruction in small animals. Intestinal adhesion is a common cause of bowel obstruction in cats (Levitt and Bauer, 1992). In rabbits, the common cause of GI obstruction is the impaction of faecal content with fur, polyester, nylon and other indigestible materials leading to a blockade. Linear or small foreign bodies are more likely to cause partial obstruction whereas round objects are likely to cause complete obstruction (Gibson, 2015). The most common cause of small intestinal obstruction in rabbits is a pellet of compressed hair (not to be confused with gastric trichobezoars) which were found to be responsible for 82% of cases in a retrospective study (Harcourt-Brown, 2007). Other less frequent causes of obstruction include ingested foreign material, strictures, intussusception, abscesses, adhesions, herniation and neoplasia (Schumann and Cope, 2014).

The most common sites of obstruction are the proximal duodenum and the ileocecocolic junction but obstruction can occur at any point along the small intestine (Oglesbee and Jenkins, 2012). Obstructive Ileus can occur following ingestion of foreign objects and can be difficult to distinguish from gastrointestinal stasis. History, clinical examination and radiography can all be used to distinguish these conditions. An accurate diagnosis ensures the rabbit receives the correct treatment (Jennifer, 2013).

Clinical signs of gastrointestinal disease can vary widely. The prognosis of the mammal patient with gastrointestinal disease depends on the timing of the diagnosis and initiation of treatment. Surgical conditions such as gastrointestinal obstruction can have a good outcome if diagnosed early (Ritzmann, 2014). Clinical signs that accompany GI obstruction include vomiting, diarrhea, constipation, tenesmus, anorexia and weight loss. The cause and onset of clinical signs and disease depends on the rate at which the obstruction develops and whether the obstruction is partial or completes (MacPhail, 2002). Depending on the inciting factor, the site of obstruction may undergo tissue damage and necrosis, perforation, leading to endotoxemia, and hypovolemic shock. Therefore, GI obstruction should be treated as an emergency (Gibson, 2015).

In small animal veterinary practice in Nigeria, diagnostic methods commonly include evaluation of clinical signs, laboratory tests, manual palpating and manipulation of the suspected area to detect the presence of foreign bodies. However, despite the time-saving advantage of these methods, accurate diagnosis may not always be achieved due to the result or tentative diagnosis being subject to the clinician's expertise and judgment. Gastrointestinal tract can be investigated by means of contrast radiography, fluoroscopy (Wray and Blunden, 2006), ultrasonography (Shorvon et al., 1987; Boysen et al., 2003), nuclear medicine (Balogh et al, 1999), computed tomography (Kim et al., 2004; Megibow et al., 1983) and magnetic resonance imaging (Kuriashkin and Losonsky, 2000) in animals and humans. Carrying out diagnostic imaging has been a helpful means of observing GIT. Sonography scanning techniques of the GIT present normal anatomy and appearance of the stomach, small intestine and large intestine as well as the ultrasound appearance of GIT inflammation, neoplastic disorders and obstruction (Larson and Biller, 2009). Radiography can also assist with the diagnosis of GI obstruction depending on the nature of the foreign body, that is, radiopaque foreign bodies and complete obstruction may result in radiography findings such as ileus and intestinal loop dilation with fluid or gas. Contrast radiography is useful in detecting radiolucent foreign bodies that create filling defects and in cases of intussusception. The most commonly used contrast media is Barium sulphate.

This study assessed the use of contrast radiography followed by sonography as is commonly done in clinical settings as tools for early detection of GI bowel obstruction.

MATERIALS AND METHODS

The experiment was done at the Department of Surgery and Radiology, University of Ibadan, Nigeria. The animals were handled in accordance with the Animal Care and Use Committee (ACUREC) of the University of Ibadan. Five male indigenous breeds of rabbits, weighing between 0.9 and 1.5 kg were used. They were aged between 3 and 6 weeks.

The experiment was initiated by altering the feed ration of the rabbits. The concentrate feed was altered to increase calories similar to a broiler finisher diet. Plant and fiber rations were completely eradicated from their meal ration and starch was incorporated into the concentrate to make boluses for the animals. Water intake was also reduced by almost 60% to aid the formation of compact feces. Water was given using syringes and was pegged at 80 ml per day per rabbit. The water ration was calculated using previous studies of water consumption in rabbits and derived an average of 200 ml of water per day. The battery cages where the rabbits were kept had a pellet collector beneath for monitoring the number of faecal pellets passed per rabbit per day. The highlights of changes in the feeding regimen and its impact on the study based on timelines are shown in Table 1. With close monitoring, it was observed that in the first 3 days, the rabbits became diahoeric. At the signs of complete anorexia, bloat and rectal prolapse in the rabbits, radiographs were taken to diagnose GI obstruction.

Radiographic procedures

Contrast suspension (7 ml), using a 5 ml syringe, was administered to each rabbit while they were still conscious. After administration of the contrast media, the rabbits were sedated using intramuscular injections of Ketamine (35 mg/kg) (Ketamin® Rotexmedica Germany) and Xylazine (5 mg/kg) (Kepro Holland).

Extended ventrodorsal and lateral radiographic views were taken.

Table 1. Schedule of feed ration in rabbits to cause gastrointestinal obstruction.

Timeline	Food Ration composition	Observation	Implication
16/11/2019-23/11/2019	Feed: Broiler finisher pellets, 120 g per rabbit per day. Water regimen: 80 ml per rabbit per day.	Initial acceptance of feed, production of diarrheic faecal pellets. Anorexia in some of the rabbits. Nuisance habits in other rabbits such as pica.	The diarrhea may have been as a result of a decline in coprophagy. This led to the production of soft feces instead of hard pellets. The high energy content of broiler finisher marsh may have induced diarrhea.
23/11/2019-4/12/2019	Feed: Finisher pellets mix with raw starch in a 3:2 ratio 120 g per rabbit per day. Water: 80 ml per day per rabbit administered in one go.	Dry small and hard pellets presenting white streaks. Minimal to zero urination. Sternal recumbency of some of the rabbits. 30% pellet production alongside complete anorexia in one rabbit.	The incorporation of uncooked starch with the feed seemed to amplify dehydration. Although the diarrhea saw a complete decline, the rabbits exhibited a greater level of discomfort.
05/11/2019-09/11/2019	As above	The rabbits continued to pass dry and small hard pellets.	The rabbits appeared to be coping with the gastrointestinal change but not showing symptoms of any discomfort.
9/12/2019 - 12/12/2019	Feed: Finisher pellets mixed with raw starch, nylon, and polyester. Water: 80 ml per day per rabbit administered in one go.	The rabbits that still had an appetite selectively consumed the nylon and polyester neglecting the pellet and starch mix. One of the rabbits on close inspection showed a physical rectal prolapse. 0% of pellets were passed in the last 3 days of this study.	The indigestible materials may have formed an impaction leading to total anorexia in all the rabbits. The rabbits were scheduled for radiographic imaging and ultrasounds.

Source: Author 2022

Exposure factors of 50 kvp/5 mAs were used for the dorsoventral view while 50 kvp/ 7.5 mAs was used for the lateral view.

Ultrasonography procedures

Ultrasonographic images were acquired using transducer frequency between 3 and 5 Mhz. This procedure was carried out on different (alternate) days from contrast radiography. This is because radiography is usually the primary diagnostic tool in most Nigerian clinical settings and ultrasound is a close second. The rabbits were carefully restrained manually after the application of ultrasound gel on the shaved abdomen. The scans focused on the left lateral abdomen.

RESULTS

Contrast radiographic images

Contrast radiograph exposed between 0 and 10 min of barium meal administration. Contrast media delineates upper respiratory tract (Figure 1). The contrast media is present in the upper gastrointestinal tract, that is, oesophagus and the contrast media flows to the proximal stomach (Figure 1, orange line).

Gas distended large intestines can be observed in the radiograph (Figure 1, green line drawing). A lone gas pocket can be observed ventral to the stomach (Figure 1, blue line drawing).

Contrast radiograph exposed between 15 and 25 min of barium meal administration shows contrast media within the stomach (Figure 2, orange line drawing). Several gas pockets within the small intestine and frothy gas with feacal material can also be observed in the large intestines (Figure 2, green line drawing).

Contrast radiograph exposed between 30 and 45 min of barium meal administration shows contrast media pooling in the stomach (Figure 3). The large intestines are ballooned and distended with air as seen with most of the other views and the stomach is dilated and filled with the contrast media (Figure 4).

Most of the radiographs show a relative oversize between the abdominal region and the animals' body. This may be due to the accumulation of gas and/or fluid in the gastrointestinal tracts of the rabbits.

Ultrasonographic images

Evaluating the ultrasonograms requires a different approach from evaluating contrast radiographs. The quality of images acquired is highly dependent on the frequency of the transducer used.

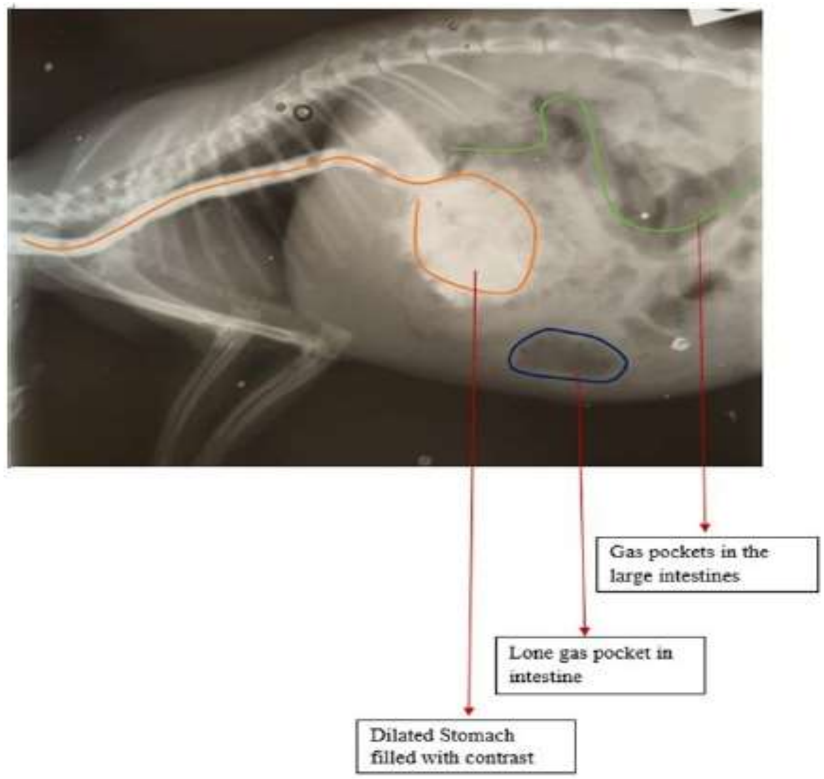

Figure 1. Contrast Radiograph showing early images of upper gastrointestinal tract (Left lateral view).
Source: Author 2022

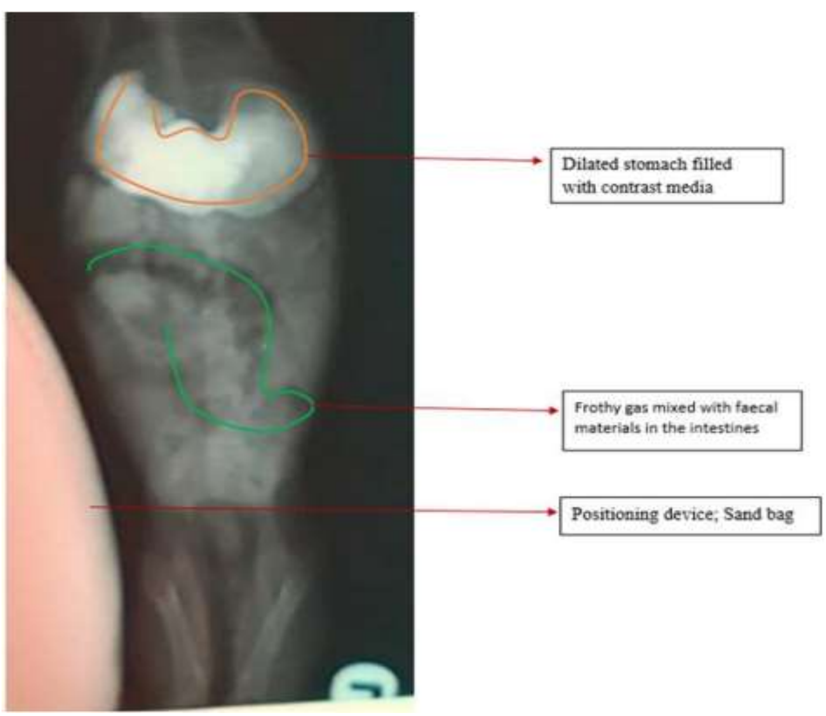

Figure 2. Contrast radiograph demonstrating gastric filling with contrast media into the stomach (Dorso-ventral view).

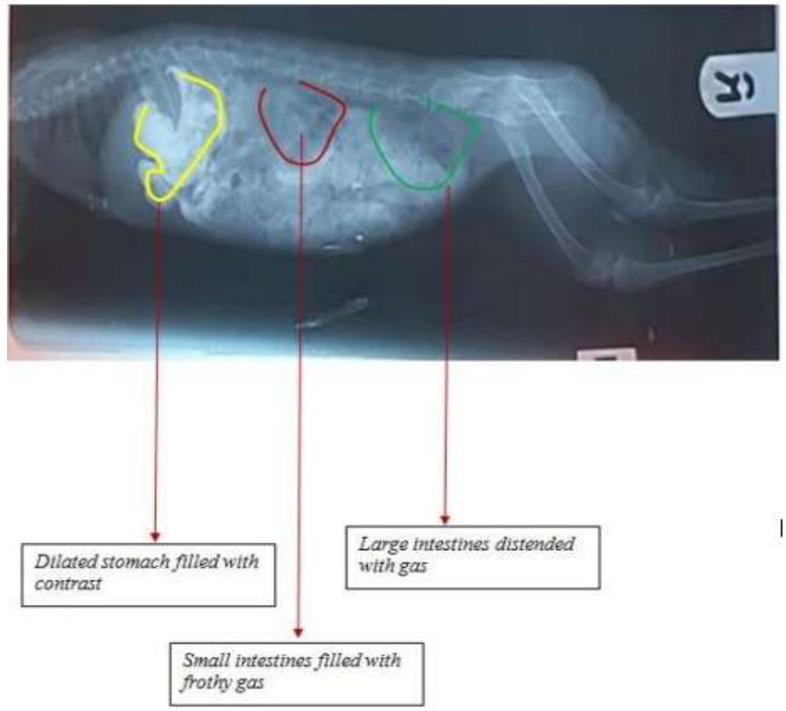

Figure 3. Contrast radiograph showing contrast media in the dilated stomach and streaks of contrast in the intestines with gas pockets in the large intestines (Right lateral view).
Source: Author 2022

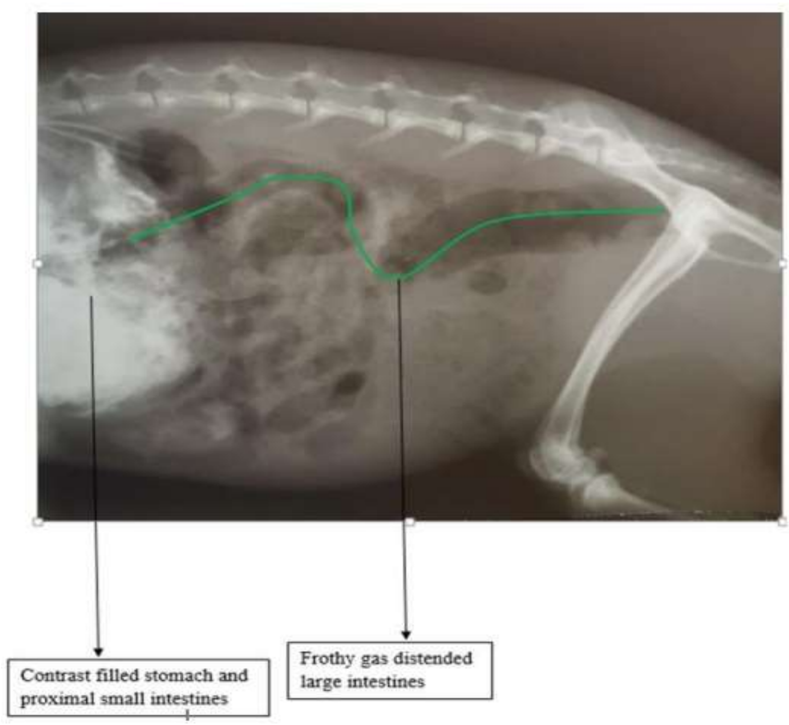

Figure 4. Contrast radiograph of the distal GIT showing gas in the small and large intestines (left lateral view).
Source: Author 2022

An artefact commonly observed from these ultrasonograms is the reverberation artefact which is produced by luminal gas in the GIT (Figure 6). Intestinal loop overlap, low transducer frequency and the size of the rabbits made it difficult to distinguish intestinal layers based on their echogenicity. The most commonly observed layers in this study were the hyperechoic mucosa and the hyperechoic submucosa. Absence of the rugal folds usually present in the stomach are also indicative of distension or may have just been due to the frequency of the transducer used. Presence of ingesta mixed with gas in the stomach was detected on the ultrasonograms (Figure 7) and together with dimensions of the mucosa in several segments of the small intestine which were poorly observed probably due to the range of the ultrasound machine may help to diagnose gastrointestinal obstruction in these animals. An ultrasonogram of the stomach filled with fluid and ingesta and gas as evidenced by the reverberation artefacts was observed. Mucosa is strongly hyperechoic and submucosa is slightly apparent.

DISCUSSION

As demonstrated in this study, most GI disturbances present with clinical signs like anorexia, recumbence, abdominal distension and constipation (Gibson, 2015). The observations from this study have made it evident that other GI disturbances such as ileus, GI stasis, GI obstruction and gastroenteritis may present the same clinical signs. Thus, clinical signs are insufficient for accurate diagnosis and would require more definitive means of diagnosis. Plain radiographs show little or no detail of the outlines of internal organs, and the gastrointestinal tract is visible only if marked by gas or radiopaque foreign bodies (Kim et al., 2004). Clinical evaluation of gastrointestinal obstructions are usually radiographic followed by ultrasound and with contrast media, this study demonstrates no interference with ultrasonography.

GI disturbance had a very acute phase in the rabbits that were affected and death occurred in 2 of the rabbits in 3 to 4 days of observing related clinical signs. Necropsy revealed mostly empty stomachs and gas filled intestinal loops with a pungent smell suggesting some putrefaction of the intestinal contents. In rabbits, fiber is an important component of GIT health but when anorexia or dietary inadequacies alter the balance, GI stasis results which can then lead to inhibition of normal GIT peristalsis (Davies and Davies, 2003). When GI motility is impaired, ingesta can accumulate in the stomach. Fluid is absorbed from the stomach. This further compacts the contents causing discomfort, contributing further to anorexia and exacerbating GI hypomotility (Oglesbee and Lord, 2020).

Gastrointestinal contrast study is divided into two types: upper gastrointestinal study (UGI study), barium swallow, that is a radiographic contrast study evaluating the esophagus, stomach and small intestine and lower gastrointestinal study (LGI study) commonly referred to as a barium enema, a radiographic contrast study evaluating rectum, colon and cecum (Lennox, 2013). Results from this study indicate that the contrast radiographs showed more definite signs related to GI disturbance such as barium meal stasis, distension of the small and large intestines with gas and abrupt termination of contrast medium and pooling of the contrast media in the proximal small intestines, as shown in radiograph (Figure 5).

According to a similar study in 2007 by Harcourt-Brown using 76 rabbits, radiography was a useful diagnostic tool because gas and/or fluid in the digestive tract outlined the dilated stomach and intestines. The aforementioned characteristics of survey radiographs are synergized in contrast radiography giving a more accurate idea of the portion of the GI tract affected. In agreement with Ritzmann (2014), who stated that GI diseases seen in small hind-gut fermenters are a result of suboptimal diets lacking high amounts of coarse fiber leading to abnormal cecal fermentation dysbiosis, enteritis and gastric obstruction or volvulus, the feeding regime of the rabbits in this study was based on this. The symptoms seen and diagnosis reached at the end of the study demonstrate that this is true.

The use of ultrasonography in veterinary diagnosis is only second to radiography and is complimentary. The images in this study revealed stomach full of a mixture of gas and food material and accurately showed the small intestinal gas distension which confirms ultrasonography as a diagnostic tool useful for the gastrointestinal tract (Boysen et al., 2003). The pylorus and mucosa of the small intestine revealed as hyperechoic were easily evaluated to confirm the lack of ingesta within and the gas distension could be seen in the increased luminal diameter of the small intestines. In a few of the rabbits, an empty stomach is present with gas distension in both small and large intestines and also gas present in parts of the large intestine. While the radiographic diagnosis is quick and easily identifiable, ultrasound diagnosis requires a more than average competence to identify. Both imaging modalities are however found to adequately demonstrate gastrointestinal obstruction to enable early therapeutic intervention.

A further finding of this study is that the incidence of GI obstruction in rabbits seems high in exotic breeds due to the changes made to their diet (Ritzmann, 2014). However, in indigenous breeds, there is more incidence of GI stasis, gastric dilatation and other GI disturbances. The incidence of true intraluminal obstruction found in exotic breeds may be attributed to the amount of fur produced by the exotic rabbits due to genetics relative to

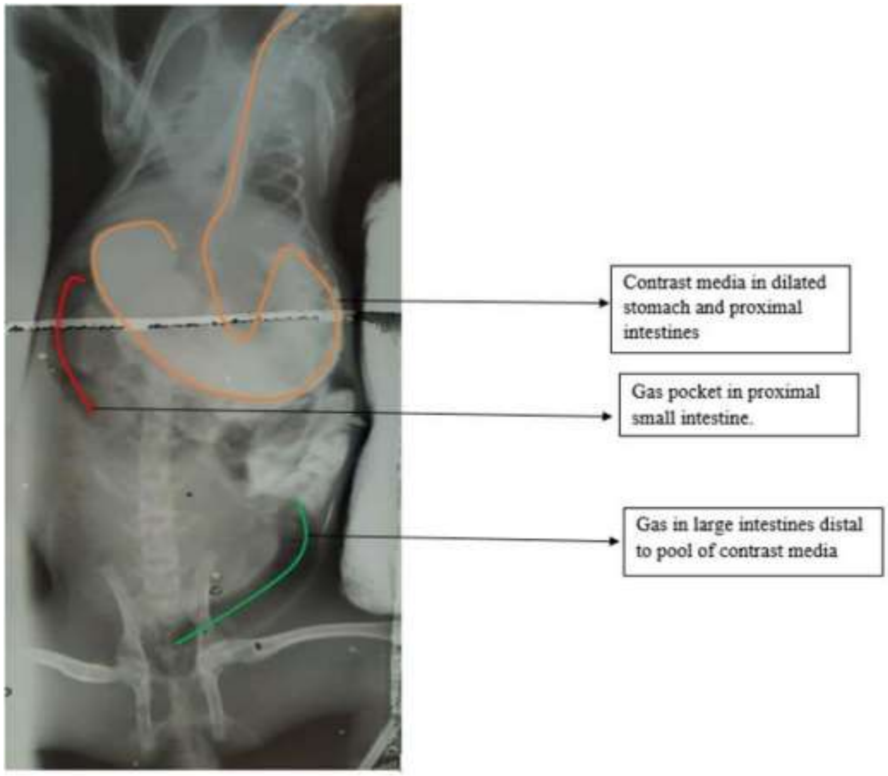

Figure 5. Contrast Radiograph showing the presence of the contrast media in the dilated stomach and pooled contrast in the small intestines (Ventro-dorsal view).
Source: Author 2022

Figure 6. Ultrasonogram showing hyperechoic mucosa and reverberation artifact.
Source: Author 2022

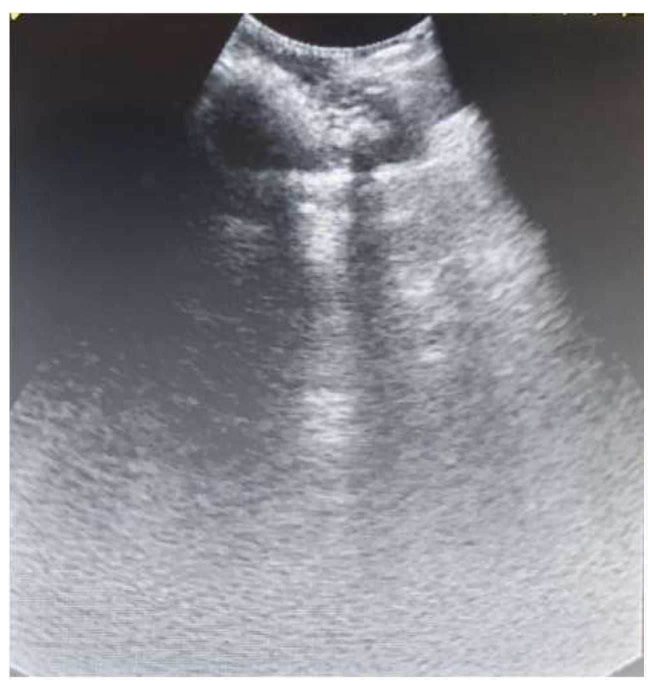

Figure 7. Sonogram of the stomach filled with fluid, ingesta and gas.
Source: Author 2022

the local breeds. This leads to the formation of true trichobezoars. A comparison of contrast radiography and ultrasonography for the diagnosis of gastrointestinal obstruction in rabbits demonstrated that a quick and easy tool for clinicians is contrast radiography because it is easy to acquire and is cheap. While ultrasonography is a useful tool, the artifacts seen and the level of expertise required to be able to recognize and diagnose gastrointestinal obstruction early may be limited.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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