

Surgical diagnostic procedures in cattle: An overview

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Summary

In addition to a detailed clinical examination, certain diseases or disorders in cattle may require ancillary laboratory tests and/or additional diagnostic procedures before a definitive diagnosis may be reached. This paper provides a brief overview of a number of surgical diagnostic procedures that can be relatively easily undertaken in clinical cattle practice, including exploratory laparotomy, rumenocentesis, abdomenocentesis, liverbiopsy, pericardiocentesis, pleurocentesis, lung biopsy, needle aspirates and hoof biopsy.

Key words

Diagnostic procedures; surgery; cattle

Introduction

Clinical reasoning and the art of diagnosis are central to the role of the large animal veterinarian in production animal medicine. When treating an individual animal, observing and interpreting change in its behaviour, body function and production underpin the establishment of a diagnosis. When treating herds or groups, these same observations have to be combined with the clinical acumen to select the most appropriate individual animals for more detailed examination.

The diagnosis might involve a condition expressing as frank clinical disease, a condition in which the signs are very mild, or a condition simply involving reduced performance. Once an accurate diagnosis has been made, the options for clinical management of the condition can be examined and evaluated.

Making a diagnosis may be a simple or a complex procedure. Some diseases are easy to recognise clinically, while others may require a more detailed clinical examination of a

specific organ system or systems, careful interpretation of key findings, ancillary laboratory tests or additional diagnostic procedures, if an accurate diagnosis is to be made. Examples of complex diagnoses are abdominal catastrophes, subacute rumen acidosis, diffuse liver disease and trace mineral deficiencies.

This paper provides an overview of a number of surgical diagnostic procedures that can be undertaken in cattle in the field.

Exploratory laparotomy

During the routine clinical examination of a sick animal, abnormalities may be suspected and/or detected in one or more organ systems that are located in the abdominal cavity. A standing, left or right flank exploratory laparotomy (celiotomy) is a most useful diagnostic procedure to examine those systems in more detail. Research indicates that exploratory laparotomy may provide information for the diagnosis of 20% of cases undiagnosed by standard clinical examination and clinical pathology tests (Vermunt 1999). With good technique and proper attention to asepsis, it is a relatively quick, easy and innocuous procedure that may provide a wealth of information and, in surgical conditions of the rumen, abomasum, intestinal tract and uterus, also provides access for treatment.

However, before embarking on surgery, it is absolutely essential that one has a sound knowledge and clear mental image of the character and anatomical position of the various abdominal organs and structures. The procedure is indicated if there is no specific diagnosis made, but the condition appears to be associated with the gastrointestinal tract or uterus, especially if:

- the heart rate is >100 beats/min;
- there is gastrointestinal hypomotility, along with absence or marked reduction in faecal passage;
- there is abdominal distension due to pooling of fluid in the abomasum, intestines or caecum;
- there is abdominal pain of greater than 8 hours duration;
- gas cap(s) or 'pings' are detected on the right side of the abdominal wall.

The surgery should be performed on the standing animal, which facilitates intra-abdominal exploration and manipulation. In the standing animal there is minimal intra-abdominal pressure, which reduces the risk of evisceration. The animal should be restrained in a crush,

or any other position that provides ample access to the left or right flank, depending on the indication. A head bail is desirable, but placing the animal against the front gate of the left bail (left flank approach) or right bail (right flank approach) of a herringbone shed may offer the best restraint that is available. However, in such situations there is less protection for the surgeon than when using a suitable crush. Most animals need no sedation, particularly when their clinical condition is serious. With fractious animals, 10-15 mg xylazine can be administered intravenously.

The incision site should be chosen on the basis of the suspected problem. For example, the left paralumbar region is best in a case of traumatic reticuloperitonitis, while the right paralumbar fossa is indicated for conditions such as abomasal volvulus, caecal dilatation and volvulus, intussusception and intestinal phytobezoar. An area approximately 20 cm wide and 30 cm long should be prepared for aseptic surgery and analgesia provided by a line, an inverted 'L' or paravertebral block.

The surgeon's arm (all the way up, including the armpit and shoulder) should be bare, washed and scrubbed thoroughly. Arm-length rectal examination gloves should not be used; these are too damaging to the delicate intra-abdominal tissues, and they also significantly reduce the sense of touch. However, due consideration should be given to wearing surgical gloves, particularly by those clinicians who do not wear protective gloves for claw trimming and other work in cattle practice that causes gross contamination of the hands.

The paracostal incision should be started 5 to 7.5 cm ventral to the transverse process of the second lumbar vertebrae and proceed ventrally and parallel to the last rib for about 20 cm. Some clinicians use a simple straight incision, while others prefer to use a muscle-spreading incision, in which each layer is cut in the direction of its fibres. For the latter, the created 'key-hole' permits adequate access for the surgeon to explore the abdominal cavity, to perform surgical procedures, such as rumenotomy and omentopexy, and is easy to close afterwards. The original incision can be extended downwards or an alternative incision can be made if other surgical procedures that require better or more access are to be carried out.

After opening the abdominal cavity, visible features such as volume and colour of peritoneal fluid appearance and position of the greater omentum with descending duodenum, should be checked out before the abdominal contents are examined. In order to limit peritoneal cavity contamination, a thorough and systematic exploration should always be carried out before manipulating or incising any abdominal viscus.

In the case of a left flank approach the following features can be palpated routinely: rumen, spleen, reticulum and its associated diaphragmatic area, left margin of the liver, left

kidney, viscera within the omental bursa, uterus and bladder. Following this exploration, any specific surgery may be carried out. With right flank laparotomy, the greater omentum and mesoduodenum with the descending duodenum, the abomasum and pyloric area, omasum, visceral surface of the liver, gall bladder, right half of the diaphragm, visceral structures within the omental bursa (small and large intestine and caecum), left and right kidneys, bladder and uterus are all palpable features. This examination should be followed by any indicated surgical procedures.

Closure of the laparotomy incision should be done in a routine fashion and should avoid leaving any dead space, especially between muscle layers. It should be noted that the internal abdominal muscle (transverse abdominus muscle) layer on the cranial aspect of the incision tends to slip forward and is easily missed, particularly when suturing all muscle layers together in a simple continuous pattern. Routine intra-abdominal medication is rarely required but, depending on the procedure, prophylactic antibiotics (e.g. procaine penicillin) should be administered systemically for 3 days.

Rumenocentesis

With increasing levels of concentrate feeding in many dairy herds worldwide, acute and subacute rumen acidosis are becoming issues of increasing importance. Perhaps the most sensitive measure of rumen health and function is assessment of the rumen microflora. Normal rumen liquor (fluid) contains large numbers of protozoa with ciliate and flagellate forms that are highly active. One of the first changes in rumen acidosis (even before the pH falls significantly) is reduced motility of protozoa. Later in the course protozoa can no longer be found.

Methods of obtaining samples of rumen fluid from the live cows include oral or nasal intubation, and rumenocentesis (rumen paracentesis). Contamination with bicarbonate-rich saliva is often a problem when using oral or nasal intubation. Rumenocentesis is the most practical field method of collecting a rumen fluid sample that will be free of saliva contamination.

In simple terms, rumenocentesis involves inserting a needle into the main body of the rumen and aspirating a sample of rumen fluid. Various techniques of rumenocentesis have been reported. However, in the author's experience, the technique described by Nordlund and Garrett (1994) provides the most consistent results. With this particular procedure, light

sedation is recommended, but not essential. However, hobbling the rear legs or securing the near-rear limb is strongly advised. Alternatively, a tail jack (pushing up the tail) should be applied by an assistant during the sampling procedure. At the same time the cow's head should be pulled to the right side using a halter or a pair of nose grips.

Landmarks for the puncture site are the left side on a horizontal line level with the top of the patella, approximately 15-20 cm posterior to the last rib or 15-20 cm caudoventral to the costochondral junction of the last rib. The ventral sac of the rumen must be identified beneath the body wall before sampling is attempted. The site should be clipped and surgically prepared in a standard fashion. A 16 gauge \times 4 inch needle should initially be inserted through the skin only. Usually, the animal will object most when penetrating the skin. When the animal is settled the needle should be inserted to the hub with a smooth, but firm, thrust.

With the needle in the rumen, rumen fluid should be collected with very slight suction, using a 10-20 mL syringe with an eccentric tip. The needle may become blocked by food particles, which can be dislodged by forcing a small volume of air or fluid back through the needle. By holding the syringe with the eccentric tip uppermost, most of the collected fluid can be retained in the syringe while clearing the needle with air. When the needle becomes obstructed, it is important not to create a negative pressure within the syringe as CO₂ will leave the fluid, thereby increasing the pH of the fluid sample. Typically, 3-5 mL of rumen fluid can be collected without too much difficulty. When a sufficient volume has been obtained, any excess air should be evacuated from the syringe and the pH measured immediately.

Abdominocentesis

In conditions where there is excessive free fluid in the peritoneum it is sometimes possible to perform abdominocentesis (abdominal paracentesis). However, the omentum of the cow is extremely efficient at trapping fluid and many attempts at paracentesis do not yield a sample. Additionally, abnormal peritoneal fluid may be confined to a small area of the peritoneal cavity, which may be missed during abdominocentesis. Nevertheless, it is not a difficult procedure and may be very informative when a sample is obtained. Grossly abnormal samples can be interpreted cow-side, (e.g. if there is urine present or turbid inflammatory fluid that clots), but other samples require laboratory examination.

In mature cattle, the choice of sites for abdominocentesis is a problem because the rumen occupies a large portion of the ventral abdominal wall, and avoiding its penetration may prove difficult. A number of sites for abdominocentesis have been described:

- A commonly used site is located left to the midline, approximately 3-4 cm medial and 5-7 cm cranial to the foramen where the left mammary vein enters the ventral body wall.
- Another recommended site is 10 cm cranial and 10 cm to the right of the umbilicus when standing left to the cow and facing towards the head.
- Alternatively, a site in the anterior abdomen, 5-10 cm caudal to the xiphisternum and 8-10 cm lateral (i.e. either to the left or right) of the midline can be used.
- Other sites are on the left or right abdominal wall, just cranial to the attachment of the udder to the ventral body wall and medial to the fold of the flank.

The animal should be restrained by applying a tail jack and the selected site clipped, swabbed and infiltrated with a 2% local anaesthetic solution. A small scalpel cut is made through the skin, and a metal teat cannula pushed carefully and slowly through the abdominal wall. The cannula will twitch when the peritoneum is punctured. Alternatively, an 18 gauge \times 2 inch needle may be used, in which case local anaesthetic may not be required. It may be necessary to move the needle or cannula back and forth in a few different directions before fluid is obtained. A sample can be collected either by free flow or applying gentle suction with a syringe. If the initially chosen site does not yield fluid, the process may be repeated at another site a few centimetres caudally. A dry tap cannot be taken to mean that excessive fluid is not present in the abdomen, or that a local site of peritonitis is not present.

Occasionally, the cannula or needle may penetrate the rumen or the abomasum, but neither causes any apparent problem. This is common if sharp needles are used for abdominocentesis. Rumen liquor is relatively easy to recognise and abomasal fluid can be identified by its low pH.

Fluid should be collected into EDTA tubes for cytology and protein analysis, and into plain tubes for bacteriology and biochemistry. Smears may reveal inflammatory cells, tumour cells, haemorrhage, bacteria and leakage of gastro-intestinal contents. Protein concentrations can be used to distinguish between transudate and exudate, being significantly higher in the latter. Peritoneal fluid can also be cultured for bacteria and analysed for urea.

Liver biopsy

This is a relatively safe and simple technique. A small core of liver tissue is removed from the liver via a percutaneously introduced biopsy needle. Diffuse lesions, as seen in most toxic and metabolic liver diseases, can usually be diagnosed by histological examination of biopsy sections. This may also give an indication of the extent of liver damage in the sampled lobe and indicate a cause. Biopsy samples may also be used to assess total liver concentrations of certain trace minerals, usually copper, selenium and vitamin B12 (cobalt).

The size of the biopsy sample needed is dictated by the laboratory tests to be performed. Small cores of tissue suitable for histopathology are very easy to obtain with Tru-cut® biopsy needles. In cattle, a re-usable liver biopsy instrument with an internal diameter 2-3 mm is more commonly used to obtain the larger samples needed for biochemistry (Vermunt 2005).

The site for taking a liver biopsy is the right thoracic wall in the 11th (second to last) intercostal space, at about the level of a line drawn between the upper margin of the right tuber coxa and the ipsilateral elbow. The area over this site should be clipped or shaved, aseptically prepared and subcutaneously infiltrated with a local anaesthetic solution. In order to minimise haemorrhage, it is important to choose a biopsy site close to the cranial margin of the 12th rib, because the major dorsal intercostal blood vessels run close to the caudal border of the ribs.

A small stab incision should be made, the biopsy instrument inserted and, using firm but controlled pressure, directed toward the animal's opposite elbow, i.e. slightly cranially and ventrally. After penetrating the muscular diaphragm (often recognised as a slight 'popping' sensation), the tip of the instrument will be embedded in, or rests on, the liver. Now the trocar should be removed and the needle gently advanced into the liver in a rotary fashion, with minimal resistance. A characteristic 'grating' sensation is felt as the needle cuts through the liver parenchyma. Slight suction (about 2-3 mL) should be applied to the instrument with a 10 mL syringe, and the instrument removed while maintaining the vacuum. If necessary, the needle may be withdrawn slightly and re-directed one or two more times to ensure adequate sampling.

The sample should then be ejected from the needle on to a sterile swab. Any excess blood and fluid should be carefully blotted away from the core of liver, before it is placed in fixative (in case of histopathology) or a sealable container (in case of trace mineral analysis).

Although not strictly necessary, the skin incision may be sutured or closed with a Michel™ clip.

In the case of trace mineral assays, it is best to check the amount of tissue and transport medium needed by the laboratory before taking the biopsy. Also, chemical disinfectants should not be used on the skin because of the possible contamination of the liver sample, which may potentially influence the analyses.

Complications following liver biopsy are not common. Mortalities associated with clostridial diseases have been reported, but one therapeutic dose of penicillin post sampling appears to be an effective preventative in unvaccinated animals. Occasionally, a branch of a hepatic or portal vein may be penetrated, which results in a steady flow of venous blood from the needle when the trocar is withdrawn. In such cases the needle should be either advanced further into the liver or slightly withdrawn and then re-directed into the liver parenchyma, followed by taking the sample as described. Laceration and subsequent massive haemorrhage from the liver is a potential problem, but apparently occurs very rarely and only when a haemorrhagic tendency is present. Pneumothorax may sometimes occur as a complication of liver biopsy but, if it happens, it is always unilateral and usually resolves within one or two hours.

Pericardiocentesis

In normal animals, only a small amount of clear to slightly straw-coloured pericardial fluid can be obtained. In a case of traumatic pericarditis, a dark, foul-smelling fluid containing large numbers of white blood cells is commonly obtained. Cattle with lymphosarcoma may shed neoplastic lymphocytes into the pericardial fluid. Congestive heart failure can be accompanied by a large volume of pericardial fluid, which has a normal cytological distribution and protein concentration.

Most cases of pericarditis are diagnosed on auscultation of extraneous sounds over the heart area which are associated with the heart beat, but not with any particular heart sound. These are sometimes described as ‘washing machine’ sounds and are regenerated by the mixing of gas and fluid. Muffling of the heart sounds is another common finding with pericarditis. Collection of a sample of fluid from the pericardial sac may confirm a provisional diagnosis of pericarditis.

The intercostal space between the 5th and 6th ribs should be clipped, scrubbed and infiltrated with a local anaesthetic solution. A 15 cm spinal needle of size 17 BWG (or a 14-16-gauge over-the-needle catheter with a minimum length of 15 cm) should be used. The needle, with syringe attached, should be advanced carefully towards the heart, preferably under the guidance of ultrasound. To confirm that the catheter is in the pericardial sac and not the pleural cavity, approximately 20 mL of air may be injected through the catheter and the heart auscultated on the opposite side of the cow. Washing machine sounds should be generated and audible.

Fluid obtained by pericardial paracentesis should be collected into EDTA blood tubes for cytology and protein analysis, and into a separate container or plain blood tube for culture, if required.

Pleurocentesis

Normal cattle have small volumes of clear to slightly turbid yellowish, non-clotting pleural fluid. The procedure of pleurocentesis (thoracocentesis or pleural paracentesis) is of value when the presence of fluid in the pleural cavity is suspected. It can be used to obtain samples for diagnostic purposes and to withdraw excessive pleural fluid. Insertion of a needle or catheter into the pleural space can also be used to infuse an antibiotic solution (e.g. in the treatment of unilateral pyothorax).

A 12-14 gauge needle, 8-10 cm in length, a pleural catheter or a teat siphon (cannula), should be inserted in the 6th or 7th intercostal space, below the level of the suspected fluid line, which has been determined by percussion or ultrasonography prior to carrying out the procedure.

Lung biopsy

Percutaneous lung biopsy is of most value in lung conditions of a generalised nature. However, it is a potentially hazardous procedure, and its use should be limited to those cases where less invasive procedures, such as broncho-alveolar lavage and trans-tracheal aspiration, cannot be used to obtain the necessary diagnostic material.

An area of skin over the 6th or 7th intercostal space, in the mid-section of the thorax, should be clipped, aseptically prepared and anaesthetised. A stab incision should be made over the intercostal space. The skin should be moved caudally (so that on removal of the biopsy

instrument the skin incision is not in line with the deeper wound, thus minimising the risk of subsequent pneumothorax) and a Tru-cut® biopsy needle pushed through the cutaneous incision, through the intercostal muscles, and into the parenchyma of the lung. The cutting stylet of the Tru-cut® needle should be advanced to cut the sample. The cover should be pushed over the cutting stylet to retain the biopsy sample, after which the biopsy needle should be removed. Samples obtained by this technique are small and may not be representative of other portions of the lung.

Potential complications of lung biopsy include lung collapse, pneumothorax, haemothorax, haemoptysis and dissemination of infection.

Needle aspirates (needle biopsy samples)

Needle aspiration biopsy, also known as fine-needle aspiration, is a diagnostic procedure that is frequently used to investigate superficial lumps or masses. A classical example in cattle is the diagnosis of enzootic bovine leukosis (EBL); enlargement of one or more peripheral lymph nodes occurs in 75-90% of EBL cases that develop lymphosarcoma.

In this technique, a thin, hollow needle is inserted into the mass to extract cells that, after being stained, will be examined under a microscope. Fine-needle aspiration biopsies are safe, minor surgical procedures; a major surgical (excisional or open) biopsy can often be avoided by performing a needle aspiration biopsy instead.

The skin above the area to be biopsied should be clipped first and scrubbed with an antiseptic solution. The skin, underlying fat, and muscle may be anaesthetised with a local anaesthetic solution, although this is often not necessary in cattle with superficial masses. After locating and stabilizing the mass for biopsy, using palpation, an injection needle of fine diameter should be passed into the mass. After the needle is placed into the mass, cells are withdrawn by aspiration with a syringe and are then spread onto a glass slide. The needle may be inserted and withdrawn several times. Often, several passes are needed to obtain enough cells for cytology/histopathology.

Using this procedure, there is a risk, because the biopsy is very small (only a few cells), that the problematic cells will be missed, resulting in a false-negative result. There is also a risk that the cells taken will not enable a definitive diagnosis to be made.

Hoof biopsy

Although rarely used in cattle practice, hoof biopsies may be indicated in research situations where serial changes during the progress of a particular claw disease, such as laminitis, need to be studied over a period of time (Singh et al. 1993).

The animals should be adequately restrained in a claw trimming crush or on a tipping table. The claws should be cleaned, pared and washed thoroughly with a povidone iodine solution. Regional intravenous anaesthesia of the lower limb foot can be provided by injecting 15-20 mL of a local anaesthetic solution into any accessible vein or venous plexus. When using this particular anaesthetic technique, biopsies can be taken from any part of the claw such as the parietal corium (abaxial wall) and sole corium (sole surface).

Using a hand or electric drill with a 7-8 mm bit, a hole is made in the claw horn in order to remove most of the horn, but without puncturing the underlying corium (i.e. leaving a thin layer of horn covering the corium, which can be judged by the pinkish tinged corium that becomes visible through the horn). A 3-4 mm disposable biopsy punch should be used to penetrate through the horn and into the corium (laminae/papillae). The punch is inserted up to its full length and then, after 6-8 rotations, carefully withdrawn. The biopsy tissue is removed from the punch and fixed immediately in 2.5% glutaraldehyde or 10% formol saline. The hole should be filled in with sterile gauze, some type of resin or methylmethacrylate compound. Antibiotics should be administered systemically to reduce the risk of infection.

Other diagnostic procedures

There are several other diagnostic procedures or tools that can be used in cattle. Examples are broncho-alveolar lavage, trans-tracheal aspiration, diagnostic imaging including radiology and ultrasonography, and endoscopy. However, none of these have a significant surgical component or are routinely used in cattle practice, with the possible exception of ultrasound examination. Therefore, they have not been covered in this paper.

Further reading

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