https://doi.org/10.17221/18/2019-VETMED

Ultrasound-guided removal of soft tissue foreign bodies in companion animals: A case series

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Citation: Manfredi S, Covi G, Bonazzi M, Gnudi G, Fumeo M, Miduri F, Daga E, Volta A (2020): Ultrasound-guided removal of soft tissue foreign bodies in companion animals: A case series. Vet Med-Czech 65, 49–55.

Abstract: Foreign bodies (FBs) retained in the subcutaneous tissues are a common reason for medical consultation. In small animals, FBs usually consist of vegetal materials, especially grass awns. Failure to remove the FBs is likely to give rise to acute or late complications. The surgical removal of the FBs can be invasive, costly and technically challenging. Ultrasound has become a mainstay in the detection of FBs and it can be used to guide the extraction of the FBs with a minimally invasive technique. This study describes the detection and extraction of soft-tissue FBs in small animals. One hundred-sixty-two patients, presenting at two veterinary clinics with suspected FBs retained in the soft tissues of various body districts, were considered. Once an ultrasound diagnosis was established, the ultrasound-guided removal of the FB was performed. A high-frequency linear transducer, a skin disinfection, sedation or anaesthesia was used when needed and a scalpel and some Hartmann forceps were also used. One hundred-eighty-two FBs were successfully removed in all the patients. In six cases, the FB was identified during a second ultrasonographic examination, after recurrence of the fistula. No complications were reported after the procedure. The extraction of the FB was performed in an echographic suite in 138 cases and in a surgery room with surgical intervention in 24 cases. In the latter situation, the surgical minimally invasive dissection of tissues under ultrasound guidance was performed before the removal of the FB. In conclusion, the ultrasound-guided removal of the FBs retained in the superficial soft tissue can be considered a good alternative to surgery. However, failure to remove a FB does not preclude the removal by traditional surgery.

Keywords: sonography; extraction; grass awn; dogs; cats

Superficial soft-tissue foreign bodies (FBs) are a common cause of clinical problems in small animals, usually associated with complications such as abscesses or granulomas (Della Santa et al. 2008), swelling or draining tracts (Armbrust et al. 2003). The most common FBs are organic and specifically, migrating vegetal materials (Frendin et al. 1999; Armbrust et al. 2003; Staudte et al. 2004) with grass awns being the most common type in small animals. Dogs are affected more commonly than cats, and hunting, working and long-haired canine breeds are over-represented (Schultz and Zwingenberger 2008). As many FB sites located in the subcutaneous and underlying soft-tissue structures are reported in dogs as in humans (Brennan and Ihrke 1983; Armbrust et al. 2003; Ober et al. 2008; Callegari et al. 2009; Bradley 2012; Fabbi et al. 2014). Presently, many reports

https://doi.org/10.17221/18/2019-VETMED

have demonstrated the usefulness of sonography in the detection of FBs; an ultrasound examination provides valuable information as it identifies the presence and location of the FBs in relation to anatomical landmarks and facilitates the planning of the surgical approach (Staudte et al. 2004). The main limitation of an ultrasound is that it is an operator-dependent technique (Boyse et al. 2001). Familiarity with the ultrasound appearances of the soft-tissue FBs and a systematic evaluation of the region of interest in both projections are needed for an accurate assessment (Boyse et al. 2001; Armbrust et al. 2003). A high-frequency linear transducer is needed to optimise the near-field spatial resolution (Boyse et al. 2001). The echo patterns of the FBs depend on the nature, size and retention time of the embedded materials. FBs are always described as being hyperechoic (Horton et al. 2001).

Different sizes and natures can have various artefacts, such as acoustic shadows, a comet-tail and reverberation (Chen et al. 2016). According to Boyse (2001), the features of the artefacts are mainly correlated to the shape of the FB rather than to its character. Definitive treatment of subcutaneous or subfascial FBs requires their removal (Staudte et al. 2004; Della Santa et al. 2008; Callegari et al. 2009; Bradley 2012). The role of the ultrasound to guide the extraction of the superficial FBs has been described for both species (Gnudi et al. 2005; Della Santa et al. 2008; Callegari et al. 2009; Bradley 2012; Chen et al. 2016). Different techniques are described, and many approaches for the localisation and removal of FBs in different anatomical districts are reported, especially in human medicine (Della Santa et al. 2008; Callegari et al. 2009; Mills and Butts 2009; Bradley 2012; Zwingerberger et al. 2015). A series of patients in whom sonography was successfully used for the detection, localisation and removal of soft-tissue FBs in superficial anatomical structures in companion animals is reported on.

MATERIAL AND METHODS

A medical database covering the years 2008–2017 was searched for dogs and cats referred to two veterinary clinics with a suspicion of superficial FBs. All the animals were submitted for an ultrasonographic examination and underwent ultrasound-guided minimally invasive FB retrieval. The FBs had to be identified and extracted in all the patients. The inclusion criteria were: full signalment; clinical examination; type, size and localisation of the lesion; the ultrasound features of the FB and the lesion; the technique employed to extract the FB; confirmation of the presence of the FB after the extraction; sedation or anaesthesia, if performed; equipment employed; follow-up and outcome (at least five months).

The ultrasound examination was performed, after clipping the region and the application of a gel, with two ultrasound systems (Esaote MyLab 30 Vet Gold and Esaote MyLab Class C, Genova, Italy) equipped with a 7.5–12 MHz linear transducer or a 12–18 MHz micro-linear transducer. The FB had to be identified based on specific imaging criteria (Gnudi et al. 2005; Della Santa et al. 2008) and the extraction of the FB had to be described in the echographic report.

When necessary, the dogs were sedated with an intramuscular injection of dexmedetomidine (Dexdomitor; Orion Pharma, Milan, Italy), 5 micro/kg b.w. (body weight) combined with butorphanol (Dolorex; Intervet, Milan, Italy), 0.2 mg/kg b.w. (Leonardi et al. 2019). If general anaesthesia was necessary, a standardised anaesthetic protocol was used (Bendinelli et al. 2019).

Furthermore, the postoperative analgesic protocols were determined on an individual basis. All the dogs were positioned in dorsal or lateral recumbency according to the position of the FB. After disinfection of the patient's skin with a Chlorhexidine solution, the ultrasound was repeated in order to precisely localise the FB and guide its complete removal. For this procedure, a sterile transducer sheath was then used. If a draining tract was not present, under constant ultrasound guidance, the skin was incised with a scalpel, together with the underlying fascia if necessary. The incision had to be just large enough for the surgical forceps to be inserted, or in the case of a particularly large FB, wide enough for the FB to pass through. The incision was performed cranial to the FB, with the FB imaged in a longitudinal section. The operator then used his/her dominant hand to insert the Hartmann forceps through the fistula or skin incision according to a previously described technique (Gnudi et al. 2005; Della Santa et al. 2008) and always under ultrasound guidance. The forceps arms were then opened slightly, displacing the tissues surrounding the FB, in order to grip the object.

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The abscess/fistula was then rescanned to determine any possible residuals of the FB (Della Santa et al. 2008). Flushing with betadine was performed after the removal of the FB. The percutaneous-guided extraction was performed in an ultrasound room by a radiologist with previous experience of guided removals, but with no formal surgical training.

When an FB was determined to be localised more deeply or adjacent to the muscular planes, its extraction was performed in a surgery room with surgical intervention and intraoperative ultrasound (using an Esaote MyLab 30 Vet Gold machine, Genova, Italy). A minimal incision and slow dissection of the soft-tissue and muscular planes was performed by a surgeon under constant ultrasound guidance. The ultrasound was performed by a radiologist in a sterile way. The FB had to be located in the tract of the surgical dissection. When the FB was quite close to being secured, it was extracted by forceps with the same technique described above and under direct continuous ultrasound guidance. The antibiotic prophylaxis was prescribed for seven days after the removal procedure to prevent any iatrogenic septic complication or sequel caused by the mobilisation of the FB.

RESULTS

One hundred-sixty-two subjects met the inclusion criteria (159 dogs and three cats), 76 females and 86 males. Among the dogs, 43 were mixed breed and 119 belonged to 40 pure breeds. Eighty-five per cent of the dogs were medium-large size dogs, and 62% of the included dogs were hunting, working and long-haired breeds. Their mean age was 5.6 years (range 6 months – 16 years). The general condition of the animals was good, except for patients with a lumbar-flank localisation, in which more systemic signs, such as fever, depression and anorexia, were recorded. In a few cases, moderate to severe concomitant diseases were described in the medical records (severe aortic stenosis, severe mitral valve disease, diabetes mellitus, chronic renal failure, epilepsy). On presentation, the lesions were identified on the distal limbs in 28% of the cases (interdigital, metacarpal, metatarsal and carpal regions), and in the lumbar and flank region in 18% of the cases. Other regions such as the neck, thigh, leg, perineum, larynx, retropharyngeal space, axillary, prepuce, paravaginal, thoracic wall (cutis subcutis and muscular planes), sternal region, inguinal region, mammary gland and orbital region were identified (Table 1). In total, 182 FBs were successfully removed, 98% of which were of organic material: 158 grass awns, seven seeds (Figure 1), one pine needle, two lumps of hair, six wood fragments (Figure 2A and 2B), two thorns, two pieces of bone and one nail, and 2% were inorganic: one microchip (Figure 3), one insulin needle and one wire (Table 2). Five dogs had more than one grass awn in the same anatomical district (Figure 4).

Table 1. The distribution of the FBs in the body districts

Site distribution	Number
Distal limbs	45
Flank-lumbar region	29
Thoracic wall (cutis, subcutis and muscular planes)	13
Neck	15
Thigh	12
Leg	5
Perineum	5
Larynx	4
Retropharyngeal space	4
Prepuce	4
Paravaginal	4
Mammary gland	1
Orbital region	1
Axillary region	13
Sternal region	1
Inguinal region	6

Figure 1. A seed removed by Hartmann forceps (axillary region from a cat)

https://doi.org/10.17221/18/2019-VETMED

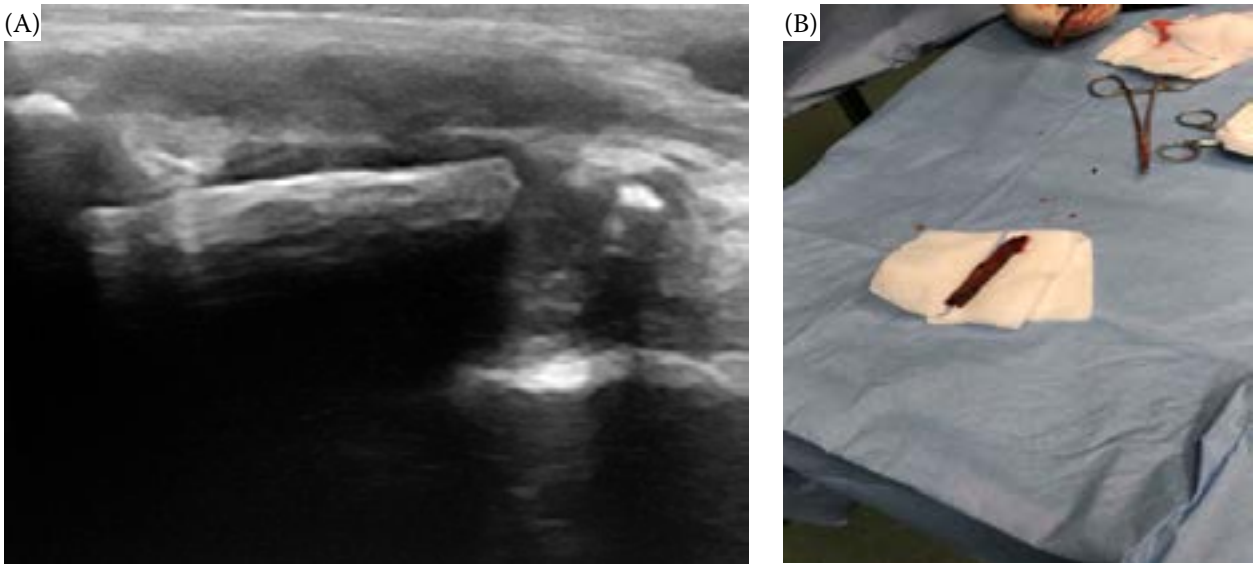

Figure 2. (A) The ultrasonographic appearance of a piece of wood: a thick, hyperechoic line with strong acoustic shadowing. (B) An FB found in the thoracic wall of a hunting dog

Figure 3. The removed microchip placed between two scalpel blades

Table 2. The types of FB removed under ultrasound-guidance

Type of FB	Number
Grass awns	158
Seeds	7
Wood fragments	6
Piece of bone	2
Thorn	2
Nail (cat claw)	1
Pine needle	1
Lump of hair	2
Insulin needle	1
Microchip	1
Metallic wire	1

A fistulous tract was present in the majority of the dogs with an FB located in the interdigital space (Figure 5); the cutaneous situs was the starting point to follow the tract of the FB with the ultrasound. In the dogs with a draining sinus in the flank, the FB was localised in the sub-lumbar muscle tissues in four cases. In 85 cases, a subcutaneous abscess described as a cavitary mass with a echogenic capsule containing particulate fluid and sometimes internal echogenic septa (D'Anjou and Blond 2015) was identified, while granuloma (solid mass with a hypoechoic halo surrounding the FB that consisted of haematoma, oedema and granulation tissue) (Shiels et al. 1990) was visualised in 25 cases. In three cases, a pattern of subcutaneous and diffuse cellulitis was observed (generalised swelling, with a moderate amount of subcutaneous fluid and hyperechoic fat lobules separated by hypoechoic fluid-filled areas, with a typical cobblestone appearance) (Hertzberg and Middleton 2016). The median length of the FBs was 25.5 mm (range 0.3–50 mm). In six dogs, the ultrasonographic examination was repeated a second time after the conclusion of antibiotic therapy. The FB was visualised during the second exam, after reoccurrence of the abscess/fistula. In the five dogs with the lesion located in the flank, the FB was localised peripherally and cranially to the abscess, and usually deeply in the muscu-

https://doi.org/10.17221/18/2019-VETMED

Figure 4. Several grass awns removed from the same anatomical district of the same dog

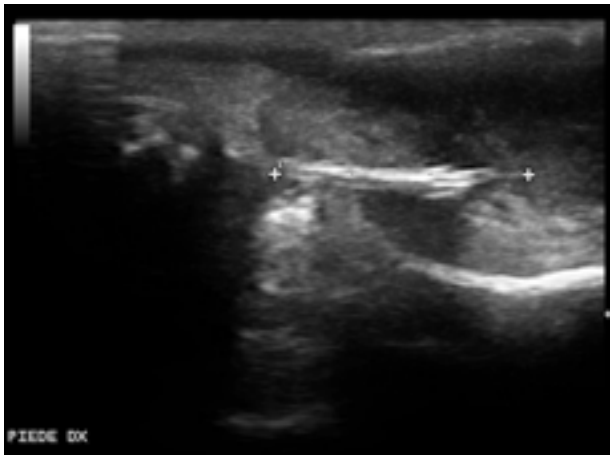

Figure 5. A hyperechoic FB located in the interdigital space (located between the electronic cursors (+), right above the bone hyperechoic interface

lar planes. In three cases, the FB was found using an abdominal approach, identifying the FB in the iliopsoas muscle. In two cases, when the ultrasound was repeated 24 and 48 h after initial examination to plan the extraction, the FB had already migrated and was found in another location (4 cm more peripherally in the case of the FB in the flank and from the dorsal to the palmar aspect in the case of the FB located in the carpus). In 138 cases, the retrieval procedures were performed in a sonography suite, in 24 cases they were undertaken in a surgery room with surgical intervention. Among the cases performed in the ultrasonography suite, sedation was performed in 19 cases. All the procedures performed in the surgery room were carried out under general anaesthesia. A resolution of clinical signs was observed in all the cases. No animal had any recurrence of the abscess or fistula.

DISCUSSION

Soft-tissue FBs from penetrating injuries are common causes of consultation in veterinary medicine. In this case series, the most common type of FB encountered is represented by vegetal ones, especially grass awns, similar to previous reports (Gnudi et al. 2005; Della Santa et al. 2008). Other organic FBs found in the cases consisted of wooden fragments, a pine needle, seeds, a lump of hairs, pieces of bones, thorns and a nail (cat claw). These findings are in contrast with the literature on FBs in humans, in which the most common superficial FBs are represented by inorganic types (Callegari et al. 2009; Bradley 2012).

Between the inorganic FBs retrieved, two were iatrogenic (an insulin needle and a microchip device).

The extraction of the FBs was performed in an ultrasound room in the majority of the cases. In humans, several methods have been described for the ultrasound-guided removal of FBs. A skin marker can be used to mark the object in the sonographic long and short axis prior to the incision. Alternatively, a sterile needle may be introduced under real-time ultrasound guidance until it touches the FB. The incision and then the dissection is performed around the needle toward the tip, where the FB will be found. In another technique, two needles are used. In veterinary medicine, two papers describe the removal of grass awns by the fistulous tract or making minimal tissue dissection under ultrasound guidance (Gnudi et al. 2005; Della Santa et al. 2008). Furthermore, another study mentions the method of inserting a needle adjacent to the FB under ultrasound guidance (Zwingerberger et al. 2015). The removal techniques utilised abided by the first two methods described in the small animals and were successfully useful in extracting both the organic and inorganic FB types.

In the cases in which a surgical intervention is preferable, a very slow and accurate dissection of the tissues to avoid the entrance of air bubbles is suggested. The disturbance by gas can be minimised by the haemorrhage and by applying pressure on the excised tissues with the probe as described by Gnudi et al. (2005).

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The economic cost of the FB extraction with sonography can be significantly lower than that of a small conventional surgery. Furthermore, shortening the act of surgery may have other benefits. Anaesthesia may not be required in some cases, or just a mild sedation may be necessary, reducing the potential risks for the patients and the costs for the owners. At this institution, there is an agreement between surgeons and clinicians that the sonographer shall try, in the first instance, to remove the FB when located in the superficial tissues. In selected cases, the ultrasound alone can fail in the removal and does not exclude the extraction under ultrasound guidance with a surgical intervention. However, even under continual ultrasound guidance, extraction is not always resolute or possible, and conventional surgery must be performed. The ultrasound-guided removal of an FB can be difficult in the case of small parts, the rupture of the FB during the removal attempts or when an accurate tissue dissection is not possible. The natural soft-tissue reaction to isolate the FB and the accumulation of inflammatory fluid around it are helpful in the FB identification, creating an anechoic halo ring and providing better visualisation of the interferences (Gnudi et al. 2005; Chen et al. 2016). In fact, the presence of fluid increases the contrast between the echogenic object and the surrounding affected tissue, highlighting the FB. In this study, the FB could not be identified at the first examination in six patients under antibiotic treatment. It is assumed that the therapy healed the abscess and the tissues around the FB became hyperechoic, drying the fluid and losing the natural contrast between the echoic FB and the hypoechoic fluid. After suspension of the therapy and the natural reoccurrence of infection, the FB was successfully detected. In this case, performing an ultrasound when the abscess or the sinus tract are present and the animal is without an antibiotic therapy is suggested. In those cases, in which the abscess or fistulous tract were located in the lumbar and flank region, the FB was not found in the superficial tissues, but in deeper structures; in all the cases, the FB was found located more cranially than the palpable superficial lesion. In these cases, searching for the FB more deeply and more cranially to the visible abscess or fistula is proposed. Furthermore, in cases that need conventional surgery in particular, rechecking the position of the FB the same day as the intervention, as FBs can migrate a long distance in a short time, is recommended. With a strong suspicion of a subcutaneous FB, performing a diagnostic ultrasound before inserting the forceps is recommended. In fact, with this intervention, it is possible to introduce gas into the soft tissues, so that the characterisation of the FB becomes more difficult (a reverberation artefact can hide FBs). This aspect is demonstrated in some reports (Gnudi et al. 2005; Gatel et al. 2014) and in all the cases reported here, since, after the procedure of the FB extraction, some gas bubbles were visualised in the lesion by the ultrasound, due to the entrance of the forceps. As mentioned above, the ultrasound retrieval of an FB can be performed in the ultrasound room and sometimes without sedation, especially if a fistulous tract is present. Even if sedation makes the procedure more comfortable for both the patient and operator, it is possible, as in some of the cases reported, that the anaesthetic risks are very high and the use of some medication is not recommended. The main limitation of this study is that only cases with the successful extraction of an FB with ultrasound guidance are included. Furthermore, the pitfalls of the procedure are not described, and neither is when the ultrasound failed to diagnose the presence of an FB. In conclusion, the first imaging method to be performed in cases of suspecting superficial FBs should be sonography, before any kind of intervention and antibiotic therapy; the ultrasound allows for the diagnosis, interventional procedure removal and follow-up after the procedure.

Acknowledgement

The authors thank Dr. Carlo Bellino, Dr. Silvia Bechini and Dr. Sara Dall'Asta for clinical suggestions.

Conflict of interest

The authors declare no conflict of interest.

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Received: February 5, 2019
Accepted: January 22, 2020