

## Ultrasound-guided removal of vegetal foreign bodies in the lower extremities of dogs: a retrospective study of 19 cases

*Echobegeleide verwijdering van plantaardige vreemde voorwerpen ter hoogte van de distale extremiteiten bij honden: een retrospectieve studie van 19 casussen*

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### ABSTRACT

Subcutaneous abscesses or granulomas in the lower extremities of dogs commonly occur secondary to the penetration and migration of vegetal foreign bodies (FBs). The aim of this study was to describe the clinical presentation and ultrasonographic appearance of intact grass awn FBs in the lower extremities of dogs, and their ultrasound-guided retrieval with particular emphasis on the feasibility, effectiveness and prognosis associated with this technique. In this retrospective study, 22 FBs were identified ultrasonographically in 19 dogs. The procedure resulted in the successful retrieval of the FB in 100% of dogs, and the clinical signs resolved in 90% (n=17) in less than ten days. No complications or recurrence were encountered. This study shows that ultrasonographic examination should be the first-choice modality when a vegetal FB is suspected within the distal extremity, as it allows both identification and removal of the FB with a minimally invasive procedure, with short- and long-term effectiveness and good prognosis.

### SAMENVATTING

Subcutane abcessen of granuloma's in de distale extremiteiten komen bij de hond frequent voor na penetratie en migratie van plantaardige vreemde voorwerpen (VV). Het doel van deze studie was om de klinische presentatie van deze patiënten te beschrijven. Vervolgens wordt het echografische beeld van intacte grasaren in de distale extremiteiten belicht, alsook het echobegeleid verwijderen van het VV met de nadruk op de haalbaarheid, effectiviteit van en prognose na de procedure. In deze retrospectieve studie werden 22 VV geïdentificeerd bij 19 honden. De procedure had een slaagkans van 100% wat betreft het verwijderen van het VV. De klinische klachten verdwenen bij 90% van de honden (n=17) binnen de tien dagen. Er werden geen complicaties of herval gezien. De resultaten van deze studie geven aan dat een echografisch onderzoek eerste keuze kan zijn wanneer de aanwezigheid van een VV van plantaardige oorsprong vermoed wordt. Zowel de identificatie van het VV als het verwijderen ervan door een minimaal invasieve ingreep met een goede effectiviteit en prognose is mogelijk, zowel op korte als op lange termijn.

### INTRODUCTION

Subcutaneous abscesses or granulomas in lower extremities are commonly diagnosed in dogs. Vegetal foreign body (FB) penetration and migration are a common cause for these lesions and are well described in the veterinary literature (Armbrust et al., 2003; Gnudi et al., 2005; Ober et al., 2008). Vegetal FBs in the subcutaneous and underlying soft tissue structures are difficult to identify on initial physical examination, and therefore, further diagnostic imaging is advised. Radiographs are routinely taken to exclude the presence of radiopaque FBs and to exclude alternative differential diagnoses such as pri-

mary bone neoplasia or osteomyelitis. However, radiographs cannot detect radiolucent FBs, and numerous vegetal FBs therefore remain undetected. In one study, it has been reported that less than 15% of wooden FBs are detected with radiography (Anderson et al., 1982). A previous cadaveric study compared ultrasonography (US), computed tomography (CT) and magnetic resonance imaging in the detection of acute wooden FBs in the canine manus (Ober et al., 2008). In this study, CT was found to be the most sensitive modality for the detection of wooden FBs. In human medicine on the other hand, US has been shown to be more sensitive than CT in the detection of superficial, radiolucent FBs (Mizel et al., 1994), although 38%

of retained FBs are overlooked at initial examination (Anderson et al., 1982). The sensitivity and specificity of ultrasound in the diagnosis of FBs of various composition (wood, metal or glass) in the hand have been studied *in vitro* and reported to be 94% and 99% respectively (Bray et al., 1995). The application and limitations of US for detecting and localizing subcutaneous FBs has already been described in human and veterinary medicine (Fornage and Schernberg, 1986, 1987; Jones, 1988; Bray et al., 1995; Horton et al., 2001; Armbrust et al., 2003). More specifically, the ultrasonographic appearance of grass awns FBs has already been described (Gnudi et al., 2005), allowing its identification and localization before removal. Ultrasonographically, grass awns appear as a double or triple spindle-shaped echogenic interface of variable length within soft tissue. Ultrasonographic findings and outcomes have also been described in a series of 43 cases with suspected migrating intrathoracic grass awns in dogs (Caivano et al., 2016). In this study, the usefulness of transthoracic, transesophageal and intra-operative ultrasonography for the localization and surgical removal of migrating intrathoracic grass awns has also been reported. Recently, the usefulness of preoperative and intraoperative ultrasound to aid the removal of migrating plant material causing iliopsoas myositis via ventral midline celiotomy has been described (Biretoni et al., 2017).

The removal of vegetal FBs from the distal extremities can be challenging and both medical and surgical approaches may lead to multiple recurrences irrespective of the anatomical location (Bouabdallah et al., 2014). Minimally invasive ultrasound-guided FBs retrieval has already been used and described in humans and animals (Shiels et al., 1990; Blankstein et al., 2000; Stades et al., 2003; Della Santa et al., 2008; Callegari et al., 2009). In animals, the procedure has been described using two different techniques: one using Hartmann alligator forceps (HAF) and another using small flexible endoscopic forceps to reduce the acoustic shadowing produced by larger instruments (Della Santa et al., 2008; Segalen and Durieux, 2010). In two additional case reports, the successful removal of foreign bodies from the vagina (Gatel et al., 2014) and the retro-bulbar space (Stades et al., 2003) using a similar technique has been described. In a further study, it has been demonstrated that the addition of intra-operative ultrasound, during surgery to retrieve FBs detected via pre-operative CT or ultrasound increases the probability of successfully retrieving the FB (Anttanasi et al., 2011). To the authors' knowledge, there are currently no studies focusing on the ultrasonographic description of grass awns FBs in the lower extremities of dogs, or evaluating the long-term outcome of ultrasound-guided techniques for grass awn removal. The objectives of this study were: (1) to describe the clinical presentation of dogs with grass awns in the lower extremities, (2) to describe the ultrasonographic appearance of these grass awn FBs in the distal extremities, (3) to describe the ultrasound-guid-

ed removal technique and report its success rate, and (4) to report the immediate and long-term effectiveness and prognosis associated with using this technique at this specific location.

## MATERIALS AND METHODS

Medical records obtained between January 2012 to January 2015 from a veterinary referral center (Centre Hospitalier Vétérinaire Frégis, France) were retrospectively reviewed. The inclusion criteria were dogs of any breed, age or sex that had a confirmed intact grass awn FB identified from the distal carpus or tarsus with attempt of removal under ultrasound guidance. Clinical information collected of each dog included: breed, age, sex, treatment history, the duration of clinical signs, physical examination findings and ultrasonographic examination findings. The instruments employed for FB removal and the short-term and long-term follow-up data of each dog were also recorded. Short-term follow-up data were considered to be data obtained within one month post-retrieval of the FB. Long-term follow-up data were considered to be any data available from at least three months post-retrieval (range 3-45 months). Dogs were excluded from the study if there was insufficient clinical data relating to the aforementioned parameters or if they did not meet the minimum follow-up period of three months.

The diagnosis of FB was based on the findings of ultrasonography performed by a board-certified and a third-year resident radiologist. In each instance, a grass awn FB was suspected by the radiologist based upon the identification of a double or triple spindle-shaped echogenic interface within the soft tissues. The ultrasonographic examination (Philips CX50, Andover, Massachusetts, USA) was performed in all dogs using a high resolution microconvex array transducer (5-8 MHz) operating at 8 MHz and a linear array transducer (15 MHz). The ultrasound field included the entire area of soft tissue swelling within the distal extremity, including 2-3 cm of normal tissue at the periphery. If a draining sinus tract was present, it was followed from the skin surface to its termination or until it could no longer be visualized. The size of each foreign body was recorded.

An intravenous catheter was placed and all dogs were sedated using medetomidine (4 mg/kg IV) and butorphanol (0,3 mg/kg IV). The dogs were positioned in lateral recumbency, and the region of interest was clipped and aseptically prepared. Whenever a fistula was not present, a small stab incision was made within the skin using a #11 scalpel blade close to the ultrasonographic location of the FB. Removal of the FB was then attempted via blunt dissection using Hartmann alligator forceps. The ultrasound examination was repeated to confirm the complete removal of the FB. The surrounding abscess was subsequently flushed with 0.9% saline.

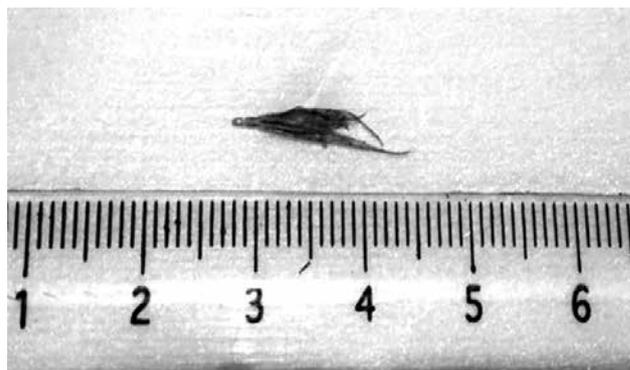
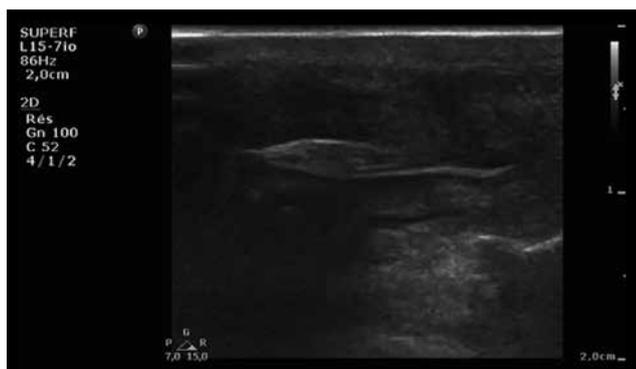


Figure 1A. Sagittal sonographic image of an interdigital plant awn FB. 1B. Corresponding retrieved plant awn FB.

No additional local treatment was applied to the wound. An Elizabethan collar was placed to prevent the dog from licking the wound and all dogs were discharged the same day. Oral antibiotics (amoxicillin and clavulanic acid at 12.5 mg/kg bid or cephalexin at 15 mg/kg bid) were prescribed for 7 to 10 days and oral anti-inflammatory therapy Meloxicam (Boehringer Ingelheim, Germany) at 0.1 mg/kg sid or Carprofen (Pfizer, US) at 4 mg/kg sid) for a period of five days.

The follow-up information relating to each patient was obtained from their respective medical records directly and from the questionnaires completed by both owners and referring veterinarians during telephone interviews with a single investigator. The queries raised during these interview related to the time of resolution of the clinical signs and the presence or absence of recurrence during the short-term and long-term follow-up periods. Resolution of the clinical signs was considered to be the closure of the fistula, the absence of lameness and the normalization of any swelling or pain within the affected limb that had been observed at initial clinical examination.

Descriptive statistics were produced during the analysis of all clinical data and the results were expressed as the median (range).

## RESULTS

Twenty-two dogs were identified with an intact plant awn foreign body within a distal extremity, nineteen of which were included in the study. Three dogs were excluded because of the lack of follow-up information.

The breeds in the study included: Cotton de Tuléar (3), Shih-tzu (2), Cocker spaniels (2), West Highland White terriers (2), Toy poodle (1), German shepherd (1), Brittany spaniel (1), White Swiss shepherd (1), Shar Pei (1), Pug (1), Munster spaniel (1), Bull terrier (1), Bull mastiff (1) and French bulldog (1).

The median age was five years (range: 1-13 years) and the median weight was 14kg (range: 7-53kg). Fourteen dogs were male (74%) and five (26%) were female.

Ten dogs (53%) were indoor dogs with controlled outings and six dogs (32%) enjoyed free outdoor access, among which two were hunting dogs. The duration of the clinical signs before referral varied between 1 day and 60 days (median: four days). Previous surgery or drainage had been performed in five dogs, with a FB found in one dog. Several dogs had medical therapy initiated before referral, which included one or more antibiotics (cephalexin, amoxicillin and clavulanic acid, marbofloxacin) (n=4) (one dog had additional local disinfection) or antibiotics combined with anti-inflammatories (n=7) (three dogs had additional local disinfection). Three dogs received only local disinfection and five dogs did not receive any therapy before referral. Within this medically treated subsection of the population (n=14), seven dogs had shown temporary improvement but the recurrence of clinical signs had prompted referral in each instance.

At presentation, eighteen dogs (95 %) were systemically healthy, and one dog presented with lethargy. The most common presenting complaints included focal swelling of the affected lower extremity (19/19), an associated sinus tract (10/19), lameness within the affected limb (8/19) and pain on palpation (3/19). Lesions were interdigital in fourteen dogs (74 %), metacarpal in one dog (5 %), metatarsal in one dog (5 %), carpal in two dogs (11%), and tarsal in one dog (5 %).

One dog underwent MRI before ultrasonography, which identified both the FB and sinus tract. During ultrasonographic examination, a linear, spindle-shaped structure, with two or more reflecting interfaces, was identified in all nineteen dogs (100%), similar to the ultrasonographic appearance of grass awns previously described in dogs (Gnudi et al., 2005) (Figure 1). Acoustic shadowing was associated with the FB in one dog (5%). The grass awns were identified in the centre of a well-defined, anechoic or hypoechoic cavity lesion in sixteen dogs consistent with focal accumulation of inflammatory fluid. In the three other cases, the grass awns were not highlighted by surrounding fluid but identified with the same ultrasonographic appearance in the subcutaneous tissue. A hypoechoic to anechoic tract of variable diameter, extending from the loculated fluid pocket to the skin surface and consistent with a sinus tract, was seen ultrasonographi-

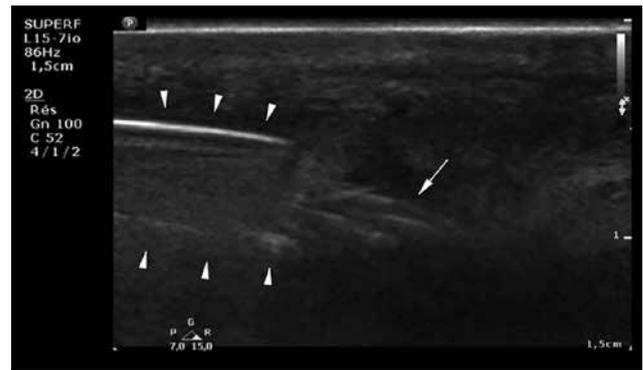
cally in ten dogs (53%). The subcutaneous tissues surrounding these aforementioned lesions were thickened and mildly-to-moderately hyperechoic with a marbled appearance. Some small subcutaneous vessels also appeared mildly distended in response to focal inflammation. Two foreign bodies were identified in three dogs (16%) and one FB was found in each of sixteen, thus a total of twenty-two grass awn FBs detected across all nineteen dogs. The median length of the FB was 10.0mm (range: 5-36.0 mm) and the mean width was 5.0 mm (range: 0.1-11.0mm).

Finally, FB retrieval was performed successfully in all twenty-two instances (100%), once the location of the foreign body had been identified ultrasonographically. A HAF was inserted through the draining sinus tract or through the stab incision in the skin. It was directed toward the FB imaged in longitudinal plane in its long axis under ultrasound guidance, while maintaining the jaws of the HAF in a closed position. The HAF was opened in a plane perpendicular to the image plane of the microconvex transducer. The FB was grasped between the jaws of the HAF and withdrawn under US guidance (Figure 2). All FB were successfully removed with this technique. The controlled ultrasound examination didn't reveal any additional FB or residual piece of FB after removal. However, this US examination hampered by the presence of reverberation artefacts caused by gas bubbles introduced by the forceps during the removal procedure.

Following the extraction of the FB, a complete resolution of clinical signs was observed in less than five days in fourteen dogs (74%), within five to ten days in three dogs (16%), and in over ten days in two dogs (10%). The dog presenting lethargy at the initial presentation had a complete resolution of clinical signs in more than ten days. The long-term follow-up varied between 3 to 45 months with a median of 15 months. No dog presented with recurrent abscessation at the same site during this long-term follow-up period. An additional FB was found within the distal extremity of four dogs during the follow-up period. These additional episodes were not considered as the recurrence of the original lesion due to their differing location.

## DISCUSSION

This study demonstrates that ultrasound-guided removal of plant awn foreign bodies from the distal extremity is a highly effective technique with a success rate of 100% once the FB has been correctly located via ultrasonography. The clinical signs of the presented dogs resolved in ten days or less in 90% of cases. No complications, such as recurrent abscessation at the site of removal were encountered during the short-term or long-term follow-up period. Ultrasonographically guided removal can therefore be considered an efficient technique for grass awn FBs in the distal extremities of dogs.



**Figure 2.** Open jaws of the Hartmann alligator forceps (arrow heads) are visible in proximity of the plant awn FB (arrow).

In this study, the region investigated was limited to the distal extremity, as this represented the anatomical region most frequently affected by foreign bodies in the practice of the authors. The high frequency of FBs at this anatomical location is thought to be a reflection of the increased exposure of this particular region to grass awns (Ober et al., 2008). In contrast, in another former study, the anatomical region most commonly affected by foreign bodies was found to be the thoracic region (Gnudi et al., 2005). However, this study included a large number of hunting and working breed, whereas in the present study, several different breeds were included but only two were hunting dogs whereas the majority of the dogs included lived in urban areas with controlled outings.

The most frequent clinical presentation is focal swelling of the affected lower extremity with an associated sinus tract, lameness within the affected limb and pain on palpation of the affected area. The dogs were clinically healthy except for one dog that presented with lethargy. There was no mention in the case files of the causative factors for the lethargy reported in this dog.

Ultrasonography offers considerable advantages over other diagnostic imaging modalities in the diagnosis and management of foreign bodies: 1. ultrasound enables rapid identification, localization and quantification of the amount of foreign material present, 2. ultrasound can identify both radiopaque and radiolucent FBs, 3. ultrasound can be used in a dynamic fashion to guide the extraction of a foreign body in real-time without risk to the operator of ionising radiation, and 4. ultrasound is inexpensive, portable, and in general also readily available to most practitioners.

Ultrasonographic examination of the distal extremity can be challenging, because of the thin and superficial nature of the soft tissue structures within the manus and pes. A high-frequency transducer should therefore be used to scan the entire thickness of the superficial soft tissues at the best possible axial resolution, facilitating the rapid identification of a FB. An alternative technique to improve the visualization of superficial structures would be the use of a stand-off

pad. A stand-off pad is known to facilitate the ultrasonographic examination of superficial structures, as the pad displaces these superficial structures from the near field deeper into the field of view, and therefore nearer to the focal zone of the transducer for optimal visualization at the highest possible lateral resolution (Biller and Myer, 1988). However, this technique was not employed in the present study due to the operators' preferences.

The complex anatomy of the manus and pes can further complicate the ultrasonographic identification and removal of FBs from the distal extremity. The use of a microconvex probe during FB removal facilitates access to a smaller anatomical window, such as the interdigital clefts, without obstructing the insertion and manipulation of the HAF due to the smaller footprint of the probe. Other factors hampering the ultrasonographic detection of a FB in the distal extremity include the presence of gas, mineralized tissues or ossified cartilage within the affected area, which could again be confused with foreign material. Gas in particular is a common complicating factor during the ultrasonographic examination for FBs whenever a surgical procedure has been performed prior to an ultrasound examination (Della Santa et al., 2008). There are therefore limitations to the successful identification of FBs with ultrasound, especially when considering the influence of operator experience and familiarity with the region being examined.

Ultrasonographic examination of the distal extremity requires a good knowledge of the local anatomy, because of the presence of multiple, small, hyperechoic and/or acoustic shadowing structures, such as tendons or bones, which could be mistaken for a FB. Methodical scanning of the distal limb in multiple planes is imperative and has previously been described (Armbrust et al., 2003). Although the normal appearance of the soft tissue structures within the canine tarsus has been described (Caine et al., 2009), no description of the normal ultrasonographic appearance of the phalangeal, metacarpal, metatarsal and tarsal region of the dog are found in the veterinary literature.

The ultrasonographic appearance of grass awns FBs in the distal extremities is similar to what has been described previously in other anatomical areas. In short, they appear as linear, spindle-shape structures with two or more reflecting interfaces.

When a negative scan is obtained in a patient with a suspicion of FB penetration, another imaging modality can be employed, such as sinography, computed tomodensitometry or magnetic resonance imaging (Staudte et al., 2004). In a study by Ober et al., (2008), comparing the accuracy of ultrasound, computed tomography (CT), and magnetic resonance imaging (MR) imaging during the detection of acute wooden FBs within the canine manus, it was found that CT was the most accurate modality. This particular study was however performed on cadavers and the impact upon the ultrasonographic appearance of

foreign bodies when directly comparing live patients with post-mortem specimens remains unknown. The fluid accumulation frequently observed around a FB in live patients provides additional contrast to the lesion and thereby improves the visualization of the FB. It is speculated that the absence of such fluid in post-mortem specimens might reduce the sensitivity of ultrasound in such circumstances. Moreover, the results of this former study cannot be directly applied to the detection of plant awn FBs, because their size and physical density are not necessarily comparable to those of a wooden FB. The superiority of CT during the identification of plant awn FBs in the canine manus has not been reported.

Surgical foreign body removal can be difficult without wide exploration of the affected area, as extensive regional inflammation may easily obscure the FB. Conversely, minimally invasive techniques, such as those described in this study, help to reduce the degree of hemorrhage and physical trauma within anatomical structures surrounding the FB (Callegari et al., 2009). On a similar note, the small skin incision used as the entry site for the HAF during FB retrieval (usually less than one centimeter in length) results in only a small residual scar with little or no negative esthetic impact.

Hydrodissection is a new technique described in human medicine to remove wooden FBs in the extremities assisted by ultrasound guidance from the extremities (Park et al., 2015). The technique involves the injection of a local anesthetic agent (2% lidocaine solution) around the FB to separate it from surrounding tissues and thereby facilitate its removal. The use of a guide wire and serial dilators may help to minimize soft tissue injury and facilitate the introduction of forceps with minimal force. Although there are only reports describing this technique in the human medical literature and long-term follow-up information is still lacking, these approaches could be used in dogs to help decrease iatrogenic soft tissue trauma even further.

The use of antibiotic therapy is described in the present cases after removal of the FB, but no former study has reported the effectiveness of this treatment. The use of a first-line antibiotic therapy such as  $\beta$ -lactam antibiotics (e.g. amoxicillin, cephalexin) for a short period was selected. It has been suggested that antibiotics are not necessarily warranted after the removal of a FB. In case antibiotics are given, they should always be selected based on bacterial isolation and sensitivity testing, but further studies are needed to evaluate the benefit of prophylactic antibiotics.

A complete resolution of clinical signs was observed in all dogs and no recurrence was recorded at the same site during the short- and long-term follow-up period imparting a good prognostic outcome with this technique. However, further studies should be performed to compare the prognosis using different removal techniques.

The main limitations of this study are the retro-

spective nature, the limited number of cases and the absence of a comparison with a control group. Additionally, the patient selection excluded cases with incomplete grass awns and foreign bodies of another nature. Such a bias within the selection of cases means that ultrasonographically undetected FBs and partial or fragmented FBs were not considered within the results of this study. In three cases, follow-up information had not been obtained and all three were duly excluded from the study as the effectiveness of the ultrasound-guided FB removal procedure was unknown.

Further prospective comparative studies are needed to confirm the benefit of this ultrasound-guided technique, relative to the more conventional surgical approach, in the removal of FBs in the lower extremity of dogs. Despite the small size of the cohort of the present study, the results are encouraging and suggest that ultrasonographic examination and ultrasonographic assisted removal should be considered when a vegetal FB of the distal extremity is suspected.

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