

Minimally invasive excision of non-palpable lymph nodes after preoperative ultrasound-guided hook-wire localization in dogs



Introduction and aim of the study: We present a technique for preoperative tracking and the subsequent surgical removal of non-palpable lymph nodes in dogs.

Materials and Methods: A disposable localization needle was positioned preoperatively under ultrasound guidance, before elective excision of the inguinal lymph node in four dogs. The needle contains a steel wire, with a hook on the tip that springs open when protruded beyond the needle tip, and anchors the wire into the tissues. After that, the introducer needle was pulled out leaving the wire anchored to the target, then the dog was able to be carried to the operating room. A small incision was required immediately close to the wire skin entry, then the wire led the surgeon's dissection down to the lymph node. After the coagulation of lymph vessels and isolation from surrounding tissues the lymph node was removed, then dead space and skin were closed routinely.

Results: This technique was used in four dogs allowing quick and minimally invasive excision of the targeted lymph node (inguinal) in all of them without complications.

Discussion: Percutaneous localization of non-palpable lymph nodes in dogs, using hook-wire needles under ultrasound guidance, seems to be a useful tool to perform rapid and minimally invasive lymphadenectomy, with potential application in other clinical settings.

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INTRODUCTION

Non-palpable or hardly palpable lymph nodes that should be removed pose several challenges to veterinary surgeons. Indeed, the excision of regional lymph nodes in addition to tumors resection, is nowadays often required by veterinary oncologist, because of metastatic disease or due to clinical staging.^{1,2}

In human medicine wire-guided localization is currently the standard method for tracking non-palpable breast lesions prior to surgical excision.³ Moreover, it is considered a reliable and convenient method that can be applied to facilitate the resection of small pulmonary nodules by video-assisted thoracoscopic surgery,⁴ and to facilitate excisional biopsies of non-palpable soft tissue tu-

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mors.⁵ It is a safe and effective procedure that may be performed under mammographic, ultrasound (US), computed tomography or magnetic resonance imaging guidance. The wire guides the surgeon to the exact site of the lesion allowing unnecessary removal of a large volume of tissue to be avoided, and shortening the duration of the surgical intervention.^{3,4,5}

Intraoperative lymph node identification is not always straightforward in small animals, and lymphadenectomy can turn into an unforeseen time consuming and invasive surgery. The purpose of this study is to describe a novel technique to facilitate the excision of non-palpable lymph nodes in dogs, reporting our experience in four cases of preoperative localization by ultrasound-guided hook-wire placement, followed by minimally invasive lymphadenectomy.

Wire-guided localization has proven to be a safe and well-established technique for preoperative localization of non-palpable lesions in human medicine, that allows unnecessary removal of tissue and shortens the operating time.

MATERIALS AND METHODS

This prospective study included all dogs with tumors scheduled to undergo elective excision of non-palpable lymph nodes, for staging or therapeutic purpose, in July 2019 at our veterinary clinic. Data, electronic artwork on animals and the procedures carried out, as well as any relevant perioperative events and their management, were recorded. Patients were followed up to at least four weeks. All dogs underwent a physical examination and blood test analysis before executing the procedure. A written informed consent was signed by all the owners.

For all cases, a 20 G x 7 cm double hook non-repositionable needle for localization of mammary nodules (OIMX, Biomedical Srl, Firenze - Italy) was used. A stainless-steel guide wire with a curved end (hook) is preloaded inside the needle introducer, that ranges in length and gauge. Depending on the manufacturer, the atraumatic ‘anchor’ on the tip of the wire is available in different geometric version. Centimeter markings and a sliding stopper are usually present on the needle, as well as marks on the wire indicating the hook position into the needle.

After premedication and clipping of the surgical sites, sedated dogs were positioned in dorsal recumbency with the hind limbs pulled backward and the proper skin area was aseptically prepared. Dog’s inguinal lymph node was examined by handheld linear array US probe (4-15 MHz frequency, MyLabTMEightVET Esaote), and, if there were any doubt on its nature, checked by fine-needle aspiration and subsequent cytology (Fig. 1). Under the free-hand guidance method, the optimal puncture site was determined and insertion of the introducer needle was carried out advancing the needle under the long axis of the US transducer under real-time scanner. Once the tip of the needle was placed adjacent to the deepest part of the lymph node, the wire was driven forward releasing the over-bent hook inside the needle (that springs open when protruded beyond the needle tip and anchors the wire) just behind the node. Once the hook was placed, its anchorage to tissues was checked by gentle traction, then the introducer needle was carefully pulled out leaving the wire anchored to the target (Video 1).



Video 1
Ultrasound of a preoperative inguinal lymph node localization by hook-wire needle placement in a dog
<https://www.scivac.it/it/v/18022/1>

Preoperative localization by ultrasound-guided hook-wire placement and minimally invasive lymphadenectomy of non-palpable inguinal lymph nodes were performed in four dogs.

Following wire placement, for all dogs, two post-procedure radiographs were obtained to confirm the final position of the hook-wire (Fig. 2), after which patients were carried to the operating room with all necessary precautions to prevent dislodgment of the hook-wire. If necessary, part of the wire protruding from the operative field was trimmed before preparing the skin for aseptic surgery. Dogs were placed in dorsal recumbency and a minimally invasive lymphadenectomy of the tracked lymph nodes



Figure 1 - Sonogram of a superficial inguinal lymph node checked by fine-needle aspiration for cytological analysis.

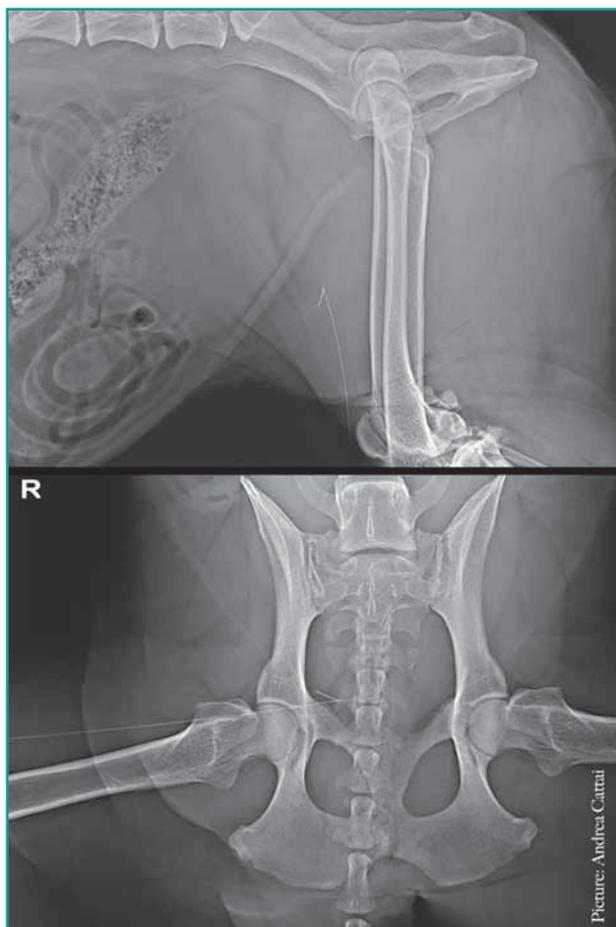


Figure 2 - Radiographs to confirm the final position of the hook-wire.



Video 2
Minimally invasive inguinal lymphadenectomy after preoperative hook-wire guided localization in a dog
<https://www.scivac.it/it/v/18022/2>

was performed under general anaesthesia before proceeding with any other required excision (e.g. tumors, palpable lymph nodes, infiltrated organs).

A small incision was made immediately close to the hook-wire skin entry, then the wire guided the surgeon down to the lymph node. Great attention was given not to cut the wire accidentally. Once isolated the node from surrounding tissue, before removing it, the lymph vessels of the hilus were bound or coagulated to prevent hemorrhage if needed.

The dead space was closed and the skin sutured routinely. Excised lymph nodes were stored in formalin and sent to the lab for histology (Video 2).

RESULTS

A total of four elective removals of non-palpable inguinal lymph nodes after preoperative hook-wire guided localization were performed. For all dogs, lymphadenectomy was performed contextually to the excision of primary cutaneous/subcutaneous mast cell tumors for the clinical staging purpose. Key information and relevant records concerning the cases of this study are reported in Table 1.

Table 1 - Summary of key information concerning the cases of this study mast cell tumors (MCT), lymph node (LN), histological nodal status (HN0-3)

	Demographic data	Type of surgery	Hook-wire placement	Complications (last follow-up)	Histopathology
Case 1	Labrador retriever spayed female 30 kg, 7 years	Cutaneous MCT excision Lymphadenectomy (inguinal LN) Splenoectomy	Sagittal angled	Any (45 days)	Grade II (Patnaik), low-grade (Kiupel) MCT LN with early metastasis (HN2) Extramedullary hematopoiesis
Case 2	Golden retriever spayed female 34 kg, 10 years	Cutaneous MCT excision Lymphadenectomy (inguinal and popliteal LNs)	Transversal	Any (45 days)	Grade III (Patnaik), high-grade (Kiupel) MCT LNs with metastasis (HN3)
Case 3	Mixed-breed spayed female 12 kg, 3 years	Cutaneous MCT excision Lymphadenectomy (inguinal and popliteal LNs)	Sagittal angled	Any (30 days)	Grade II (Patnaik), low-grade (Kiupel) MCT LNs without metastasis (HN0)
Case 4	Swiss Mountain Dog, male 56 kg, 3 years	Cutaneous MCT excision Lymphadenectomy (inguinal and popliteal LNs)	Transversal	Any (30 days)	Grade II (Patnaik), low-grade (Kiupel) MCT Inguinal LN (HN2) Popliteal LN (HN0)

For all cases no perioperative complications were observed and quick surgery with minimal removal of extra substance were performed; histology reports of targeted inguinal lymph nodes showed the presence of metastases in three cases out of the four (Fig. 3).

US-guided hook-wire applications were performed by two different operators. To achieve the target avoiding the mammary gland, two different approaches of placement of the hook-wire were used: transversal or sagittal with slight angulation respect to the median plane (Figs 4 and 5).

Two different surgeons performed the surgical procedures. Except for preemptive ligation or coagulation of the hilus of the node to avoid bleeding, only one case (case 4) required surgical hemostasis of a vessel (external pudendal artery) during the dissection. No complications were observed over a follow-up period of 30-45 days.

All cases have been characterized by quick surgery with minimal removal of extra substance and no complications.



Figure 3 - Excised inguinal lymph node with the anchored hook-wire.



Figure 4 - Transversal approach of placement of the hook-wire to localize the right inguinal lymph node of a dog. A wire black mark, indicating the leakage of the hook from the tip of the needle, is visible through the transparent luer of the needle.



Figure 5 - Sagittal approach of placement of the hook-wire to localize the left inguinal lymph node of a dog. Notice the slight angulation respect to the median plane.

DISCUSSION

Evidence of cancer cells in local lymph nodes is an important indicator of systemic metastasis and predictive for the prognosis of several tumors, thus, knowledge of lymph node status might be important for the clinical staging and adjuvant therapy of cats and dogs with cancer. Lymph node biopsy ideally should be performed via excisional biopsy, given the theoretical advantage of cytoreduction: lymph node metastases may act as a new source for further spread of tumor emboli, and lymphadenectomy could slow down the rate of metastasis.⁶ Although a definitive role for lymphadenectomy remains unclear, it may be part of a tumor-debulking procedure (to increase local control) and may be combined with adjuvant therapies.⁶

Surgical removal of lymph nodes might be important for the clinical staging and adjuvant therapy.

Depending on the size and location of the nodes, and therefore the difficulty of their detection, elective traditional lymphadenectomy can turn into a serious and invasive procedure. Inspired by a method described and used in human medicine for tracking of non-palpable lesions,^{3,4,5} we applied the hook-wire guided localization to perform minimally invasive excision of targeted inguinal lymph nodes in dogs. The superficial inguinal lymph node is located adjacent and caudal to the inguinal mammary gland and it is hardly localizable by palpation, while on the contrary, it is easy to find by sonographic detection. We successfully performed ultrasound-guided hook-wire localization preoperatively in all our cases, without procedural complications, after which localized lymph nodes were surgically excised with relative easiness and minimum invasiveness.

Some important considerations of the technique presented in this article need to be made. The first with regard to the positioning of the hook-wire. It is recommended to enter the skin almost over the most superficial surface of the lymph node and advanced downwards with an angle from the skin surface that is adequately sloped to facilitate the needle ultrasound view during placement, but also perpendicular as much as possible to reduce the surgical dissection. As regards the direction, it should facilitate the surgical action to make it as less-invasively as possible. In this study, we suggest a transversal or sagittal (with slight angulation respect to the median plane) placement orientation of the hook-wire (Figs 4 and 5). It is advisable for a medial-lateral approach rather than the opposite direction in order to re-

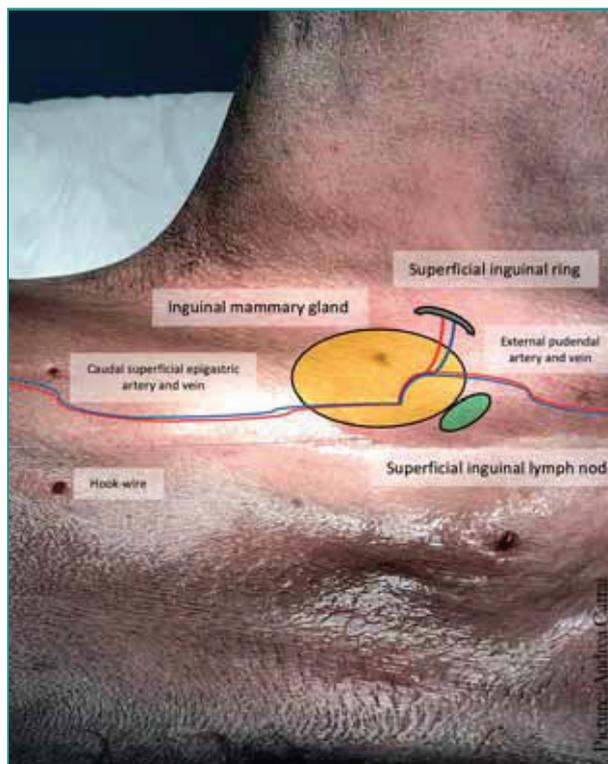


Figure 6 - Same picture as previous one with illustration of the key anatomical structures (Anatomical references from Miller's Anatomy of the Dog 4th Ed. St. Louis: Elsevier-Saunders 2013, p. 644).

The needle's orientation and direction, the position of the tip before hook-releasing, and the subsequent check and management of the hook-wire, are fundamental points.

duce the risk of damaging the external pudendal or the caudal superficial epigastric vessels during the surgical dissection (Fig. 6). The same indication is especially true in the case of concurrent inguinal hernia or if vessels mentioned above must be preserved to perform local skin flaps. Because of the presence of penis, in the male dog, the transversal lateral-to-medial approach allows easier hook-wire placement. Another suggestion concerns the position of the tip of the needle before releasing the hook into the tissues. Lymph nodes are bean-shaped structures with a convex surface and a small flat or concave hilus usually found encased in fat. We placed the tip so that the hook opens up adjacent to the deepest part of the node rather than inside it, that's because the higher resistance of the node might damage the hook-wire up to its break, or, in the case of a tiny lymph node, the hook might bust it. However, since there is no scientific evidence on that, it is just a point of the authors. As experience-based opinion it is also recommended to verify the correct anchorage of the hook-wire by a triple-

check: by ultrasound scan, by the wire mark indicating the leakage of the hook from the tip of the needle (usually visible through the transparent luer) (Fig. 4), and exerting slight distal-proximal tractions of the wire to check the proper attachment. Finally, careful attention should be paid throughout the subsequent management of the patient, to prevent and avoid the hook-wire displacement, rupture or accidentally cutting during transportation, surgical scrub and surgery.

Wire-guided localization has proven to be a safe, cost-effective and well-established technique for preoperative localization of non-palpable lesions in human medicine, that speeds up the operating time and limits the extent of the excisional biopsy.^{3,5} These considerations appear to be valid also for its application in veterinary medicine, as emerged from this study for the inguinal lymphadenectomy in the dog.

Hook-wire localization using ultrasound guidance requires no specialized equipment or expertise and enables rapid and accurate lymphadenectomy with minimal trauma, improving outcomes for patients.

Hook-wire localization using ultrasound guidance seems to be an invaluable tool to assist in directing the surgeon to the lesion intraoperatively. This avoids the need for relatively blind dissection to localize the target and, hence, minimizes the damage to surrounding tissues. Moreover, it requires no specialized equipment or expertise. Compared to 'traditional' surgery, in the cases here reported, this technique enabled lower invasiveness (with almost no need for surgical hemostasis during dissection) and subjectively faster execution, and as a result, less post-operative patient pain and discomfort, shorter recovery time and less risk of adverse events.

The present study has some limitations. The limited number of cases here reported to describe the technique does not allow to conclude on its safety, since too small to be statistically meaningful. In humans some potential adverse events have been described, essentially, possible wire migration or transection and patient dis-

comfort.^{7,8} Lymphedema is rare after lymphadenectomy because collateral pathways form, and if occurs, it is usually transient and seldom requires specific therapy. After lymphadenectomy, the patient should be monitored for swelling at the surgical site, which is usually associated with hematoma formation as a result of inadequate hemostasis or with seroma formation if dead space was not obliterated.⁹ In these four dogs we had seen no complications until a month after, however, further studies must be carried out. Patient sedation before performing the localization procedure and proper precautions to avoid the wire dislocation or break, are two key points to avoid complications. This was a retrospective study of a single-institution experience, a prospective study might have had fewer potential sources of bias and confounding compare to it. Moreover, impressions and suggestions of this study arising more from personal experiences and reasoning rather than objective measurable data.

As evidenced by scientific literature in humans, although it was born as a method for tracking of non-palpable breast lesions, image-guided hook-wire placement does not have a single-use. It has been applied in breast surgery, as well as in spinal surgery, thoracoscopic surgery, laparoscopic surgery and for the precise localization of soft tissue tumors.^{3,4,5,10} Future studies can be directed also in veterinary medicine to investigate the pros and cons of the hook-wire guided localization technique, in different species and different sites, to assist the surgical treatment of structures intraoperatively difficult to find.

At present ultrasound is low-cost and widely available in veterinary medicine. Hook-wire localization under ultrasound guidance seems to be a simple and very useful tool to aid surgical excision of non-palpable lymph nodes, with potential application in other clinical settings. Percutaneous preoperative localization offers an opportunity to make a rapid and accurate excision with minimal trauma and the least tissue damage, improving outcomes for patients. The use of this technique for selective inguinal lymph nodes excision in dogs has enabled quick and minimally invasive lymphadenectomy without complications.

KEY POINTS

- One of the demands the veterinary oncology makes more and more nowadays is the excision of regional lymph nodes, which poses several challenges to veterinary surgeons.
- In human medicine wire-guided localization is a safe and effective procedure that guides the surgeon to the exact site of the lesion, allowing unnecessary removal of large volume of tissue and shortening the duration of surgeries.
- Hook-wire localization under ultrasound guidance seems to be a simple and very useful tool to aid surgical excision of non-palpable lymph nodes in dogs, with potential application in other clinical settings.
- This novel technique offers an opportunity to make a quick and minimally invasive lymphadenectomy with the least tissue damage, improving outcomes for patients.
- During hook-wire placement, special attention should be given to the orientation and direction of the needle, as well as to the position of the tip.
- It is recommended to check the correct anchorage of the hook-wire and to pay careful attention to prevent its displacement, rupture or accidentally cutting during transportation, surgical scrub and surgery.

Exeresi mininvasiva di linfonodi non palpabili previa localizzazione ecoguidata preoperatoria con guida metallica nel cane

Riassunto

Introduzione e scopo del lavoro: Presentiamo una tecnica per la tracciatura preoperatoria e successiva rimozione chirurgica di linfonodi non palpabili nei cani.

Materiali e metodi: Un ago monouso per localizzazioni veniva preoperatoriamente posizionato sotto guida ecografica, prima dell'asportazione chirurgica programmata del linfonodo inguinale in quattro cani. L'ago contiene un filo guida in acciaio, con all'estremità un'ancoretta che si apre non appena sporge oltre la punta dell'ago stesso, ancorando così il filo ai tessuti. Una volta ancorato il bersaglio (linfonodo), l'ago introduttore veniva rimosso lasciando in sede solo il filo guida. Il paziente veniva così spostato in sala operatoria. Effettuata una piccola incisione cutanea in prossimità dell'ingresso del filo in acciaio, lo stesso guidava in maniera precisa la dissezione chirurgica fino al linfonodo. Dopo coagulazione dei vasi linfatici e l'isolamento dai tessuti circostanti, il linfonodo veniva rimosso, quindi lo spazio morto e la cute venivano chiusi come di routine.

Risultati: Questa tecnica è stata utilizzata in quattro cani e in tutti ha consentito un'escissione rapida e mini-invasiva del linfonodo bersaglio (inguinale) senza complicazioni.

Discussione: La localizzazione percutanea di linfonodi non palpabili nei cani, utilizzando aghi con filo metallico uncinato sotto guida ecografica, sembra essere un valido metodo per eseguire linfadenectomie rapide e mini-invasive, potenzialmente applicabile anche in altri contesti clinici.

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