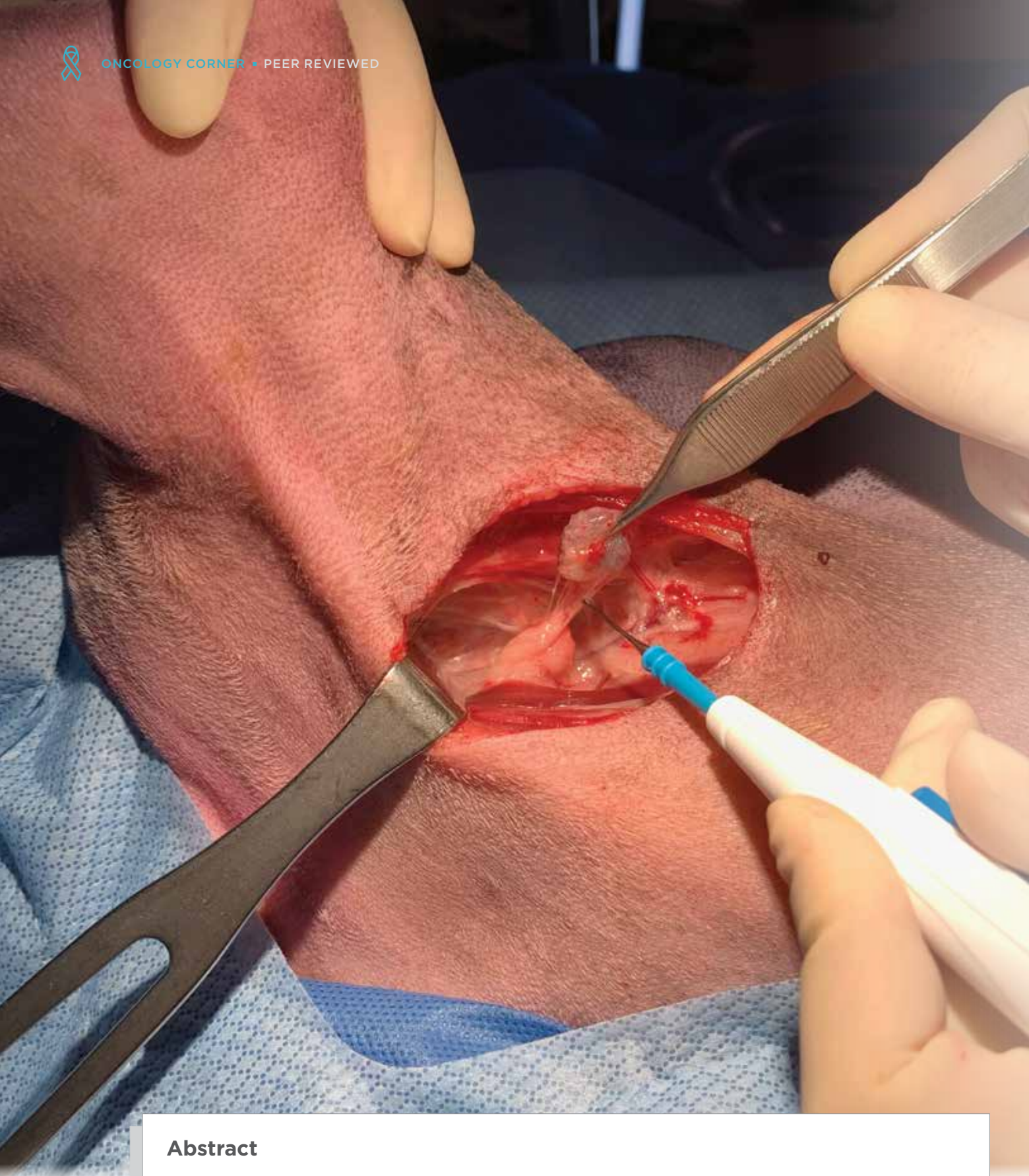




Abstract

A thorough understanding of the indications and local anatomy are important for successful removal of the axillary and superficial inguinal lymph nodes. This article provides anatomic landmarks for the axillary and superficial inguinal lymph nodes, reviews the surgical approach to removal of these lymph nodes, and discusses surgical considerations and complications.



ONCOLOGY

Axillary and Superficial Inguinal Lymphadenectomy: Anatomic Review and Step-by-Step Guide

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The axillary and superficial inguinal lymph nodes are important drainage centers for tumors of the forelimbs, ventral abdomen, mammary glands, scrotum, and pelvic limbs yet are often not sampled cytologically when they are normal sized.¹⁻⁴ The inguinal lymph node sits within the inguinal fat pad and can often be 5 mm or less in diameter, making visualization and removal difficult without guidance, while the axillary lymph node is in a challenging anatomic location. Knowledge of lymph node drainage patterns is important for surgical planning, and removal of draining lymph nodes should be

considered for staging if the lymph node is normal on palpation or for treatment if the lymph node is metastatic.⁵

In normal animals, the axillary and inguinal lymph nodes should not be palpable on physical examination; therefore, additional techniques, such as sentinel lymph node (SLN) mapping, may be needed to help in identification.^{3,4} SLN mapping is a technique that involves visual identification of the first draining lymph node through the local injection of dyes or contrast agents, and SLN mapping techniques were

Take-Home Points

- Cytology alone is often insufficient for staging subclinical lymph node metastasis. Histopathology is the gold standard, and collecting histopathology samples typically involves complete removal of the lymph node of interest.
- The axillary and inguinal lymph nodes are important lymph nodes for staging of superficial malignancies, but they are infrequently sampled due to lack of familiarity with the techniques, size, and anatomic complexity.
- Understanding the key anatomic landmarks is important to minimize incision size and patient morbidity.
- The use of pre- and/or intraoperative sentinel lymph node mapping can aid in identification and visualization of normal-sized lymph nodes and improve surgeon confidence.
- Overall, removal of the axillary and inguinal lymph nodes is straightforward, with a low rate of associated complications.



described in a previous *Today's Veterinary Practice* article.⁶ This complementary article describes the anatomic landmarks of the axillary and superficial inguinal lymph nodes and discusses the surgical approach to lymphadenectomy and its associated complications. For descriptions of approaches to the removal of additional peripheral lymph nodes (mandibular, medial retropharyngeal, superficial cervical, and popliteal), see go.navc.com/4d7bNW0.

PREOPERATIVE PLANNING AND DIAGNOSTIC TESTING

Moderately to markedly enlarged axillary and inguinal lymph nodes can often be palpated externally, and surgical approaches can be based on palpation and direct incision over the lymph node, which can be removed using the information provided below. The necessary equipment is listed in **BOX 1**.

If the lymph node is not palpable, SLN mapping via radiographic lymphography using iodinated contrast can be useful to identify the location of the primary draining lymph node for surgical planning and preparation.⁶ However, SLN mapping is reserved for cases in which the lymph node has subclinical disease. It may not work if the lymph node is completely effaced with tumor cells.⁷ If available, a computed tomography (CT) lymphangiogram can also be considered.

Fine-needle aspiration, either of palpably enlarged lymph nodes or via ultrasound guidance, and cytology

can help to determine if there is evidence of lymph node metastasis. Depending on the tumor type, additional staging to assess the patient for metastasis may include 3-view thoracic radiography, abdominal ultrasonography, and CT, depending on availability and the expected metastasis patterns.

AXILLARY LYMPH NODE

Anatomy

The axillary lymph node is located medial to the shoulder and ranges from 0.3 to 5 cm in size.³ It is adjacent to the teres major muscle laterally and deep pectoral (pectoralis profundus) muscle medially. The caudal pectoral nerve is typically located medial or ventral to the lymph node, with the thoracodorsal artery and vein running dorsal to it (**FIGURE 1**).^{3,8} Lymphatic drainage to the axillary lymph node is from the thoracic wall, cranioventral abdominal wall, thoracic limb, and mammary glands.^{2,3} This lymph node is usually singular; however, an accessory counterpart has been reported.^{3,8} Unless it is enlarged, peripheral palpation of the axillary lymph node during a physical examination should not be possible.

Surgical Technique for Removal

1. Position the patient in lateral or dorsal recumbency with the thoracic limb extended cranially or abducted. The axillary region should be clipped (extending from the axillary fold to the shoulder and nipples), aseptically prepared, and draped (**FIGURE 2**).
2. Palpate the axillary region for a physical depression located at the intersection between the latissimus dorsi and pectoralis muscles.
3. Make a 3- to 5-cm incision in a craniocaudal direction that extends from the level of the manubrium to the level of the second rib (**FIGURE 3**).
 - **Tip:** The axillary skin fold can be a helpful marker for the direction of the incision, as the incision will extend parallel to the fold when the limb is extended.
4. Bluntly dissect, with Metzenbaum scissors, through the underlying subcutaneous tissue until the intersection between the latissimus dorsi and deep pectoralis muscles is visualized (**FIGURE 4**).
5. Locate the plane between the latissimus and deep pectoralis muscles and continue dissecting dorsally into the axillary space (**FIGURE 5**).

BOX 1 General Lymphadenectomy Supplies

- Scalpel (#10 blade)
- Tools for blunt or sharp dissection (e.g., cotton-tip applicators, Metzenbaum scissors)
- Monopolar electrocoagulation (optional)
- Army–Navy or Senn retractors
- Forceps (e.g., Debakey, Adson–Brown, Allis tissue)
- 3-0 or 4-0 monofilament absorbable and nonabsorbable suture
- Surgical marker (optional)

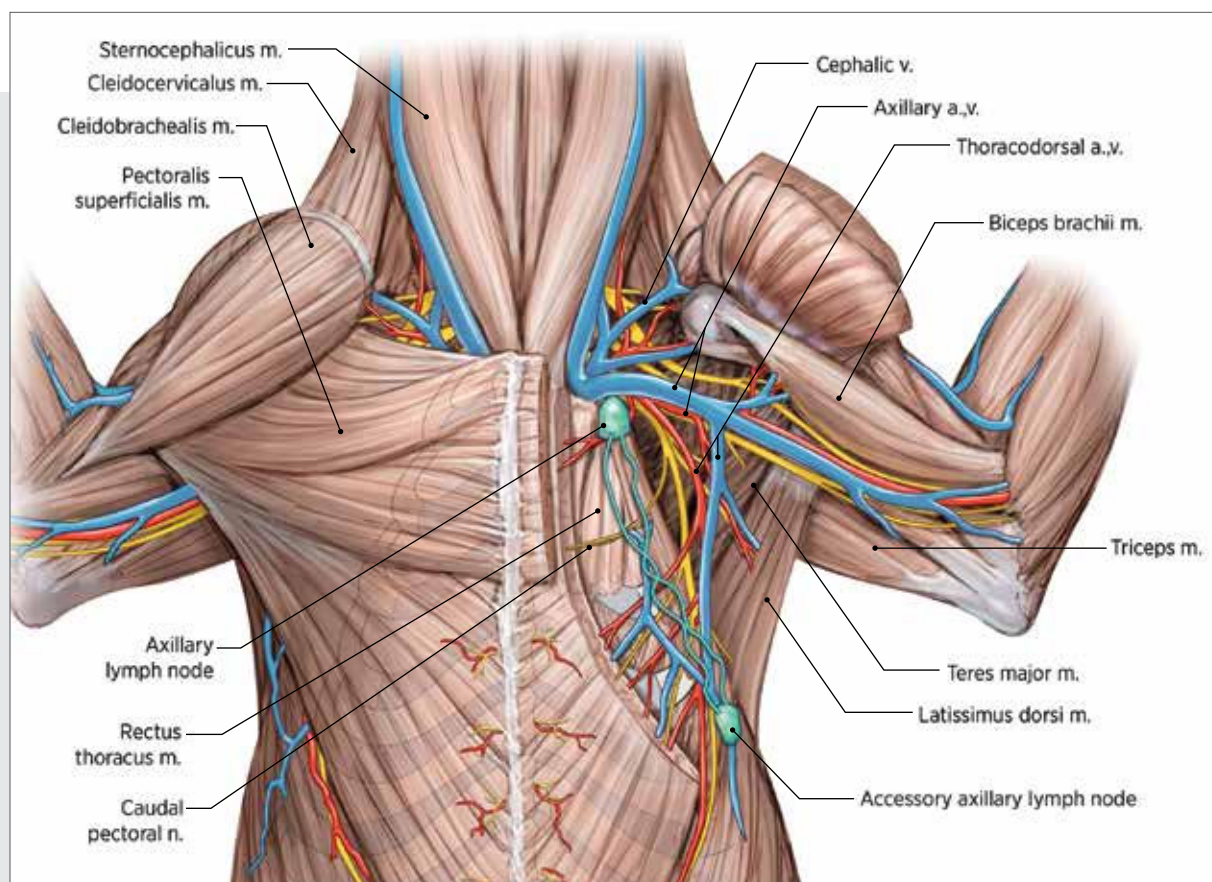


FIGURE 1. Illustration of the pertinent anatomic landmarks for axillary and accessory lymph node extirpation.
a = artery; m = muscle; n = nerve; v = vein.

- **Tip:** You should not have to cut the muscle to reach the lymph node but may need to split the pectoralis muscle depending on the location of the incision.
- 6. Identify the brachial vein and look for the lymph node immediately caudal (**FIGURE 6**).



FIGURE 2. Positioning of a dog in lateral recumbency for left axillary lymphadenectomy with the head to the left of the image and left forelimb abducted and pulled forward.

- 7. Grasp the perinodal fat of the lymph node using forceps (thumb or Allis tissue) and dissect it away from its surrounding tissues (**FIGURE 7**). A single pedicle with the lymphatic duct and vessels can be ligated with an interrupted suture pattern of 3-0 or 4-0 monofilament absorbable suture. Alternatively, monopolar electrocoagulation can be used for hemostasis during dissection.
- 8. Remove the accessory axillary lymph node if it is present (located caudal to the axillary lymph node; **FIGURE 8**).
- 9. Lavage the site with sterile saline and dry the site with gauze or a laparotomy sponge.
- 10. Reapproximate the latissimus dorsi and deep pectoralis muscles using 3-0 or 4-0 monofilament absorbable suture in a simple continuous suture pattern.
- 11. Close the subcutaneous tissues using 3-0 or 4-0 monofilament absorbable suture in a simple continuous suture pattern.
- 12. Close the dermis using a 3-0 monofilament absorbable or nonabsorbable suture in a simple intradermal or interrupted cruciate suture pattern.

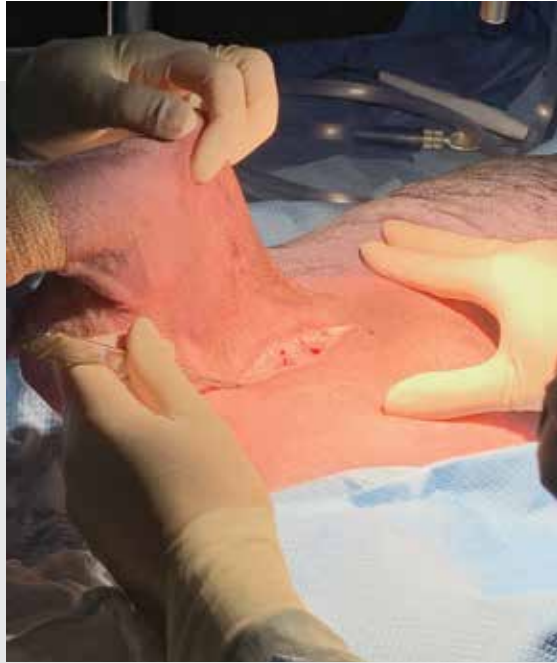


FIGURE 3. Surgical approach to the axillary lymph node. The physical depression is palpated and an incision is made on the medial aspect of the limb. The dog is positioned in lateral recumbency with the head to the left of the image and left forelimb abducted and pulled forward.



FIGURE 4. Blunt dissection is continued through the subcutaneous tissue to identify the boundaries of the latissimus dorsi muscle ventrally and deep pectoralis muscle medially.

SUPERFICIAL INGUINAL LYMPH NODE

Anatomy

The superficial inguinal lymph node is located cranial to the pubis and dorsolateral to the penis (in males) or the mammary glands (in females).^{4,9} It has been



FIGURE 5. Dissection is continued between muscle planes into the axillary region, where the lymph node can be identified. Army-Navy or Senn retractors are used to aid in visualization. The pectoralis muscle is visible within the medial aspect of the incision (**arrow**).

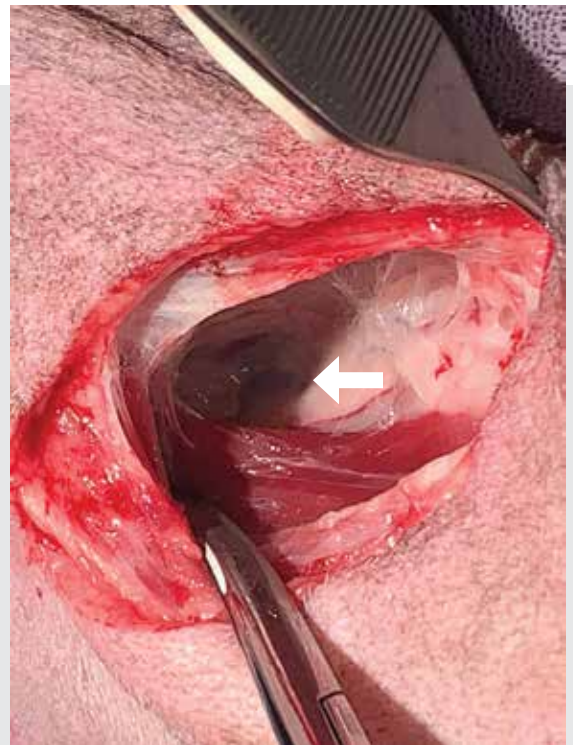


FIGURE 6. The right axillary lymph node is visualized within the deep fat (**arrow**).



reported to be 0.5 to 6.8 cm in size (although in the authors' experience is typically closer to 0.5 cm in size) and is surrounded by the gracilis muscle and the aponeurosis of the external abdominal oblique muscle.⁴ The external pudendal artery and vein are located lateral to the superficial inguinal lymph node, when singular, or between the lymph nodes when there are 2 (FIGURE 9).⁴ Lymphatic drainage to the superficial inguinal lymph node is from the ventral abdominal wall, skin of the prepuce and scrotum, mammary glands, and pelvic limb. There can be 1 to 3 lymph nodes in this location per side.^{4,10}

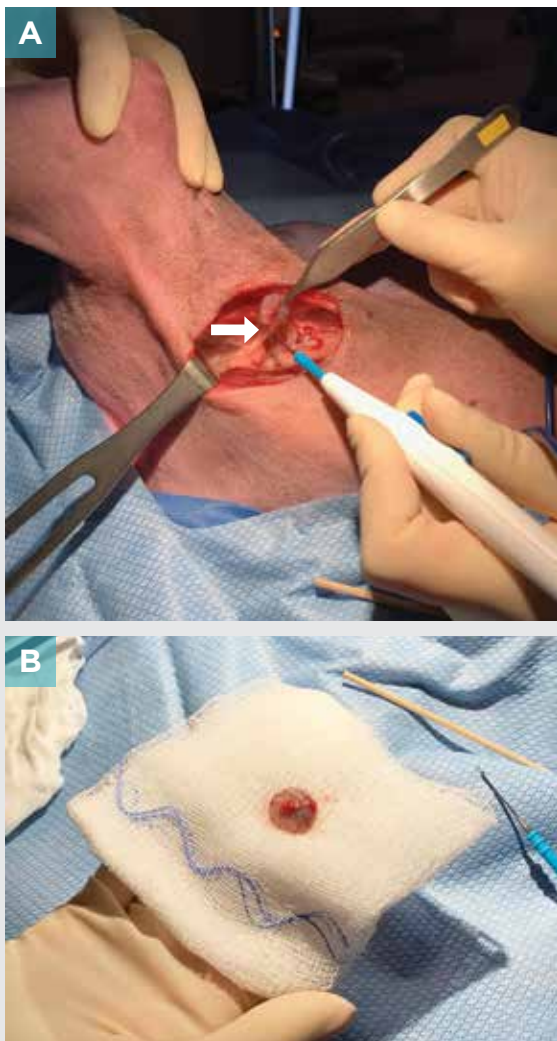


FIGURE 7. The right axillary lymph node is grasped and removed using a combination of sharp and blunt dissection. **(A)** The vascular bundle (arrow) is located caudally. The dog is positioned in dorsal recumbency with the head to left of the image and right forelimb abducted and pulled forward. **(B)** The removed right axillary lymph node is seen on clean gauze.

Surgical Technique for Removal

1. Position the patient in dorsal recumbency with the pelvic limbs extended. The inguinal region should be clipped (extending beyond the last mammary gland or base of the penis), aseptically prepared, and draped.
 - **Tip:** A surgical staple or needle can be placed in the skin at the level of the lymph node and placement confirmed with a radiograph at the time of SLN mapping with iodinated contrast medium (FIGURE 10).⁶ The staple can be left in place during aseptic skin preparation and used as a landmark for the surgical incision.
2. Palpate the cranial and medial border of the gracilis muscle and the caudal border of the inguinal mammary gland.
3. Make a 3- to 5-cm craniocaudal paramedian skin incision (FIGURE 11).
4. Bluntly dissect, with Metzenbaum scissors, through the underlying subcutaneous tissues and identify the external pudendal vessels (FIGURE 12).
5. Identify the superficial inguinal lymph node either medial to the pudendal vessel (for single lymph node) or on either side of the pudendal vessel (for multiple lymph nodes) (FIGURE 12).
 - **Tip:** A peritumoral injection of methylene blue can help to locate the inguinal lymph node and surrounding lymphatics (with uptake of blue dye) as a means of intraoperative SLN mapping (FIGURES 12B AND 12C).⁶
6. Grasp the perinodal tissues of the superficial inguinal lymph node using forceps (thumb or Allis tissue) for minimal tissue trauma and dissect



FIGURE 8. The accessory axillary lymph node (tip of forceps) is visible superficially and caudal to the axilla. The axillary lymph node is within the fat at the tip of the Metzenbaum scissors.

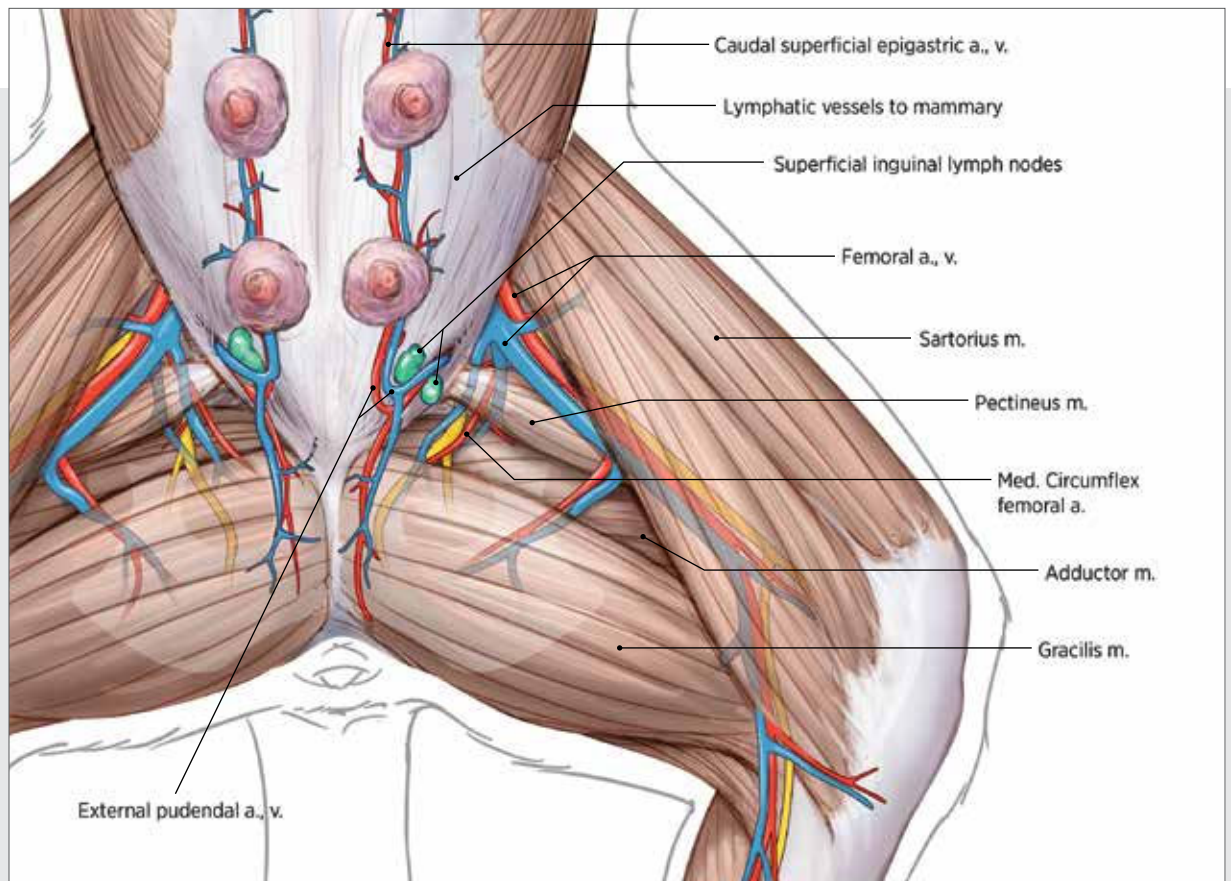


FIGURE 9. Illustration of the pertinent anatomic landmarks for superficial inguinal lymph node extirpation. a = artery; m = muscle; n = nerve; v = vein.



FIGURE 10. Intraoperative radiograph of an aseptically prepared and draped dog showing staples (arrowheads) at the level of the inguinal lymph nodes. The dog is positioned in dorsal recumbency with its head to the top of the image.

it away from its surrounding tissues (**FIGURE 13**). The external pudendal artery and vein, located lateral to the superficial inguinal lymph node, may be encountered during dissection.

7. Lavage the site with sterile saline and dry the site with gauze or a laparotomy sponge.
8. Close the subcutaneous tissues using 3-0 or 4-0 monofilament absorbable suture in a simple continuous suture pattern.
9. Close the dermis using a 3-0 monofilament absorbable or nonabsorbable suture in a simple intradermal or interrupted cruciate suture pattern.

SURGICAL CONSIDERATIONS AND COMPLICATIONS

The lateral thoracic, thoracodorsal, and intercostobrachial nerves are located within the field of dissection during the surgical approach to the axillary lymph node. Care must be taken to avoid damage to these nerves, although compromise of these nerves will have minimal clinical effects. As the axillary lymph

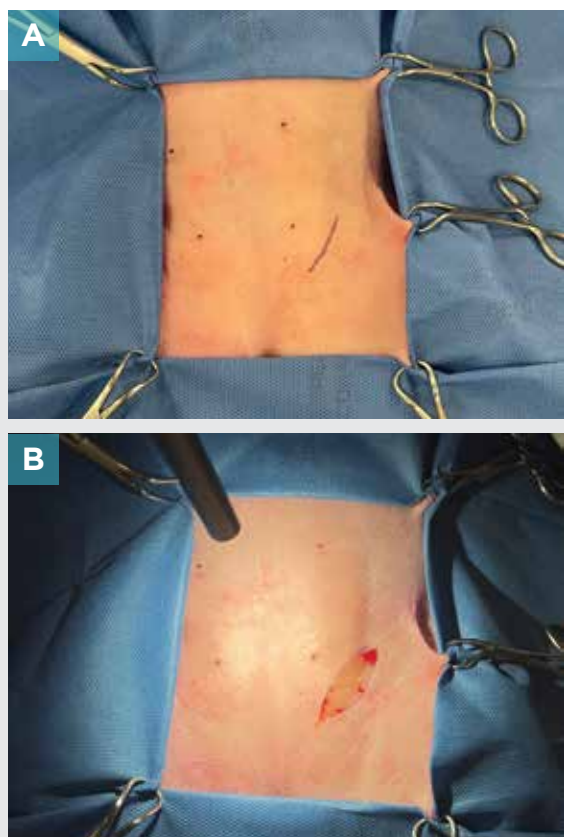


FIGURE 11. (A) Surgical marker showing the planned incision to access the inguinal lymph node in an aseptically prepared and draped female patient. **(B)** The borders of the gracilis muscle and mammary gland are palpated and an incision made in a craniolateral to caudodorsal direction. The dog is positioned in dorsal recumbency with the head to the top of the image and pelvic limbs abducted.

node is located caudal to the brachial plexus, gentle and minimal dissection is recommended to reduce the risk of brachial plexus nerve damage leading to impaired forelimb function.^{3,8}

Other potential complications of lymphadenectomy include seroma formation, surgical site infection or dehiscence, hemorrhage, and lymphedema. These surgical sites are in areas of high motion; therefore, seroma formation is the most common complication from axillary and superficial inguinal lymph node extirpation.⁹ This complication is usually self-limiting and is easily managed with exercise restriction and warm packing of the surgical site. Drainage of the seroma or placement of an active closed suction drain is not recommended due to the increased risk of introducing infection.

Lymphadenectomy should be performed prior to primary tumor excision to reduce contamination of

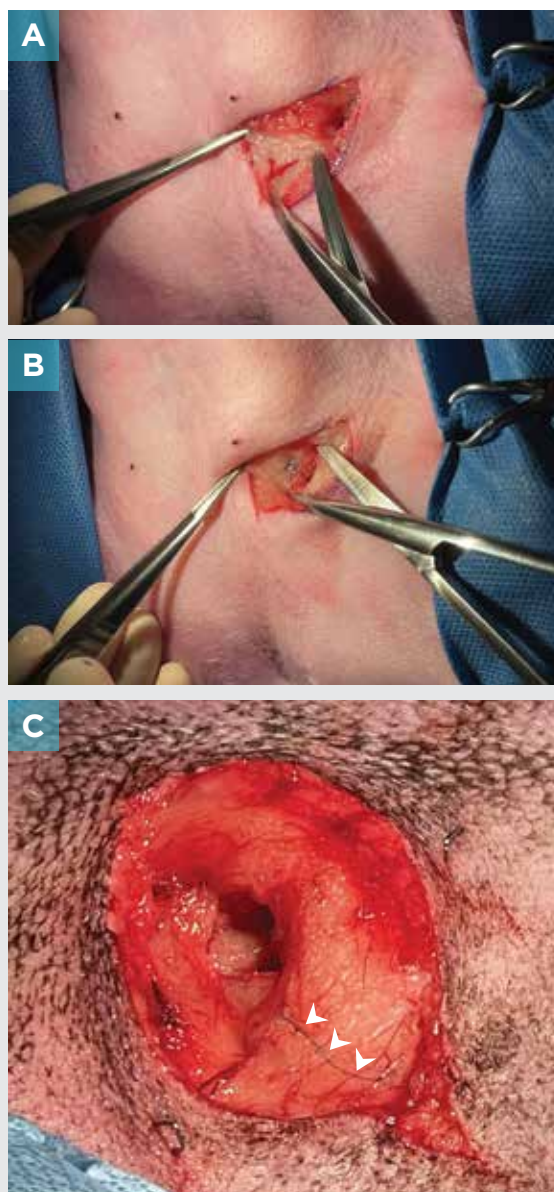


FIGURE 12. Blunt dissection within the inguinal region allows access to the inguinal lymph node. **(A)** Pudendal vasculature (tip of Metzenbaum scissors) can be utilized for identification of the lymph node, but note that the lymph node can be difficult to visualize in the subcutaneous tissue. Methylene blue can be injected and aid in visualization of **(B)** the lymph node and **(C)** local lymphatics (arrowheads). The dog is positioned in dorsal recumbency with the head to the top of the image and the pelvic limbs extended.

tumor cells at the surgical site and risk of tumor seeding. Dissection of the lymph node can be made easier using cotton-tip applicators or the top of the electro-surgical unit.

SUMMARY

Axillary and superficial inguinal lymphadenectomy are

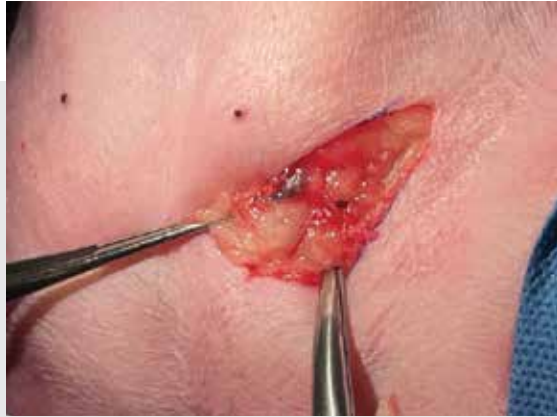


FIGURE 13. The perinodal fat of the left inguinal lymph node is grasped and the lymph node is removed using a combination of sharp and blunt dissection and electrocoagulation. The dog is positioned in dorsal recumbency with the head to the top of the image and pelvic limbs extended.

straightforward, low-risk procedures that should be considered in conjunction with primary tumor excision for cancer staging when malignant disease is present and to reduce microscopic disease burden in certain cancer types. **TVP**

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Charly McKenna is the research manager of the Animal Health Partners Veterinary Innovation Platform and Clinical Trials at the Ontario Veterinary College (OVC). She has experience at every level of research from working in laboratories, industry, veterinary clinics, and research animal facilities and has a strong background in preclinical research and animal models, research administration, and clinical data management. Charly has been involved with multiple safety studies for novel therapeutics and is interested in collaborations where companion animals can be utilized as a naturally occurring disease model in humans.



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Dr. Oblak is an associate professor of soft tissue and oncologic surgery at OVC in Canada. She is the Animal Health Partners Research Chair in Veterinary Medical Innovation and the president of the Veterinary Society of Surgical Oncology. Much of her translational research program focuses on lymph node mapping and using novel technology in these techniques. She regularly presents her work throughout the world and mentors veterinary students, interns, and residents. Dr. Oblak received her veterinary degree from OVC and then completed an ACVS surgical oncology fellowship at the University of Florida College of Veterinary Medicine.