Introduction

Many cancers are capable of lymphangiogenesis and can utilize these lymphatics to metastasize.1–3 Sentinel lymph nodes (SLN) are the first lymph nodes receiving lymphatic drainage from a tumor. Sentinel lymph node mapping/biopsy is performed to stage many types of human cancers4–8 and is gaining utility in veterinary medicine.9–11 Described methods of pre-operative SLN mapping in veterinary medicine include lymphoscintigraphy,9 contrast-enhanced ultrasonography,12–13 lipid-soluble iodinated contrast (LIC) with radiography12,14,15 or computed tomography.12–14,17,18 And water-soluble iodinated contrast (WIC) with computed tomography.14,15,17,19,20 However, such studies only describe evaluating SLN and lymphatic channels using computed tomography. Development of a more economic and available technique for SLN mapping could be beneficial to veterinary patients. Water-soluble contrast is inexpensive and available in most veterinary practices, including primary care veterinary facilities. Radiography is also more readily available in veterinary practices than is computed tomography.

The hypotheses of this study were as follows:

1. Subcutaneously-injected WIC would be identifiable and traceable in the lymphatics and the draining lymph node
2. The popliteal lymph node would be the primary lymphatic drainage of the distal pelvic limb

Materials and Methods

A prospective, pilot study was designed using 8 beagles. The dogs underwent a physical examination to rule out pre-existing conditions. The dogs were sedated with dexmedetomidine and butorphanol. Aqueous contrast (1-2 milliliters) was injected subcutaneously using a 21 ga needle in 4 separate aliquots overlying the pes, mimicking a circumferential, peri-tumoral injection. Lateral radiographic images were acquired at specific time intervals ranging from 0-50 minutes. All dogs were re-examined immediately after injection of contrast, after recovery from sedation, and 24 hours post-injection. Data recorded included initial time to lymphatic channel enhancement, time of maximal lymphatic channel enhancement, initial time of lymph node enhancement, time of maximal lymph node enhancement, time at which lymph node enhancement decreased, if present, course of the lymphatic channel(s), and which lymph node(s) enhanced, if any.

Results

All dogs had visible enhancement of lymphatic channels. The median time to initial enhancement of lymphatic channels was immediately post injection. Seven of 8 dogs (88%) had enhancement of 8 lymph nodes (Figure 1) including 7 popliteal lymph nodes and 1 superficial inguinal lymph node. Median time for initial enhancement of the lymph nodes was 20 minutes (range 5-50 minutes). One lymph node had mild decrease of contrast enhancement at 40 minutes, but the lymph node remained enhanced in comparison to pre-contrast images. One dog had enhancement of the lymphatic vasculature, but not the draining lymph node. Enhancement of both the superficial inguinal and popliteal lymph node occurred in one dog at 20 and 50 minutes, respectively (Figure 2). Seven of 8 dogs had enhancement of multiple lymphatic channels.

Discussion

All but 1 dog had enhancement of the draining lymph node. This was the first dog of the study and received only 1 milliliter of WIC and radiographic images to 20 minutes. Due to failure of contrast enhancement of the lymph node in this dog, the dose of WIC was increased to 2 milliliters in the subsequent dogs and additional radiographs were obtained if needed.

Three patterns of lymphatic drainage were identified. The draining pathway from the plantar aspect of the pes coursed caudally over the tarsus, caudal to the tibia and the stifle, and consistently drained to the area of the superficial inguinal lymph node. Drainage from the plantar aspect via lymphatic branches coursing to the dorsal aspect of the pes was observed. The drainage from the dorsum of the pes continued cranially over the tarsus and, at the level of the distal third of the tibia, transitioned to a more caudal position in its course to the popliteal lymph node. In one study, a third lymphatic channel was identified (Figure 3). It was undetermined whether this channel was medial or lateral because caudocranial images of the limb were not obtained. However, the ultimate course of this pathway was similar to the dorsal lymphatic drainage and terminated in the area of the popliteal lymph node. Based on the results of this study, subcutaneously-injected, water-soluble, iodinated contrast material provides a relatively quick and effective means of tracing the lymphatic channels from the pes to the draining lymph node(s). The results of this study also show that lesions of the distal pelvic limb might not have primary lymphatic drainage only to the popliteal lymph node.

Radiographic evaluation of subcutaneously injected, water-soluble, iodinated contrast for lymphography

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