

Summary

Four examples of severe chylous lymph effusions into serous cavities are reported. In each case there was an associated lymphocytopenia. This resembled and confirmed the findings noted in experimental lymph drainage from cannulated thoracic ducts in which the subject invariably develops lymphocytopenia as the lymph is permitted to drain. Each of these patients had communications between the lymph structures and the serous cavities. In two instances actual leakage of the lymphography contrast material was demonstrated. The performance of repeated thoracenteses and paracenteses in the presence of communications between the lymph structures and serous cavities added to the effect of converting the situation to one similar to thoracic duct drainage. The progressive immaturity of the lymphocytes which was noted in two patients lead to the problem of differentiating them from malignant cells. The explanation lay in the known progressive immaturity of lymphocytes which appear when lymph drainage persists.

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The Superficial Lymphatic System of the Cat

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Abstract

The superficial lymphatic system of fifty-four domestic cats was studied after the subcutaneous injection of India ink. The drainage areas of the lymph nodes are as follows: The lymph vessels of the head and neck drain into the parotid, mandibular, and superficial cervical lymph nodes. The vessels of the lateral surface of the forelimb and shoulder drain into the superficial cervical lymph node. The vessels of the medial aspect of the forelimb and shoulder course to the axillary and accessory axillary lymph nodes. The accessory axillary and internal lymph nodes receive the afferent vessels from the dorsum. The superficial inguinal lymph node drains the ventral portions of the abdominal and pelvic regions, the male external genitalia and flank. The mammary glands

are drained by numerous afferent vessels of the accessory axillary and superficial inguinal lymph nodes. The lateral surface of the hindlimb is drained by the popliteal and superficial inguinal lymph nodes; the medial aspect of the hindlimb is served by the afferent vessels of the superficial inguinal lymph node. The vessels of the tail course to the internal iliac, lateral sacral, and deep inguinal lymph nodes. The lymph vessels and nodes of the abdominal and pelvic cavities that were revealed by subcutaneous injection are described. The nodes included in this section are the internal iliac, lateral sacral, deepinguinal, external iliac, and lumbar nodes:

Introduction

The superficial lymphatic system of the cat forms an extensive plexus in the subcutaneous areas of the body. This interconnecting network drains into the regional lymph nodes which are usually superficially located. The distribution of the lymph vessels exhibits great variability; however, the emphasis of this study is on the generalized pattern.

The lymphatic system of the cat has been studied by several workers. *Huntington* (1) and *McClure* (2) described the development of the lymphatic system, *Sugimura* (3) and *Sugimura, Kudo and Takahata* (4, 5, 6) described the lymph nodes of the cat, *Winkler* (7) described the lymphatics of the gall bladder, and *Ottaviani and Cavalli* (8) examined the entire lymphatic system of the cat. Several important differences in the results of the current study and the results of *Ottaviani and Cavalli*, and *Sugimura*, et al., will be discussed.

Materials and Methods

Fifty-four cats (*Felis domesticus*) of unknown parentage were used in this study. They ranged in age from six weeks to about five years and appeared to be in good physical condition, i. e., there was no evidence of malnutrition or of local or systemic infections.

The animals were anesthetized by intraperitoneal injections of six percent sodium pentobarbital. They were then injected subcutaneously in various regions of the body with 0.25 to 2.0cc of unfiltered India Ink. Each cat was injected in four to eight sites depending upon the size of the animal and the areas of the individual injections. After 20 to 40 minutes, during which time the lymph vessels filled with ink, the animals were exsanguinated. The vessels were traced by dissection.

Three lactating animals were used to demonstrate the lymph vessels draining the mammary glands. All attempts to reveal the vessels from the mammary glands of non-lactating animals failed.

Results

Lymph Nodes and Vessels of the Head and Neck

The parotid lymph nodes (Figs. 1 and 2), usually two in number, lie posteroventral to the auricular cartilage of the ear and posteriodorsal to the parotid salivary gland. Occasionally they may be embedded in this gland. They receive eight to ten afferent

vessels from the dorsal part of the head, neck, eye, and ear. Usually two efferent vessels course along the posterior margin of the *m. digastricus* and pass beneath the *m. sternomastoideus* to the medial retropharyngeal lymph node (Figs. 1 and 2).

The mandibular lymph nodes (Figs. 1 and 2), usually two in number, lie at the angle of the mandible near the union of the facial vein with the external jugular vein. These nodes receive six to ten afferent vessels from the subcutaneous areas of the eye, rostrum, chin, lower jaw, and a limited portion of the ventral part of the neck. The two or three efferent vessels course medial to the *m. sternomastoideus* to the medial retropharyngeal lymph node.

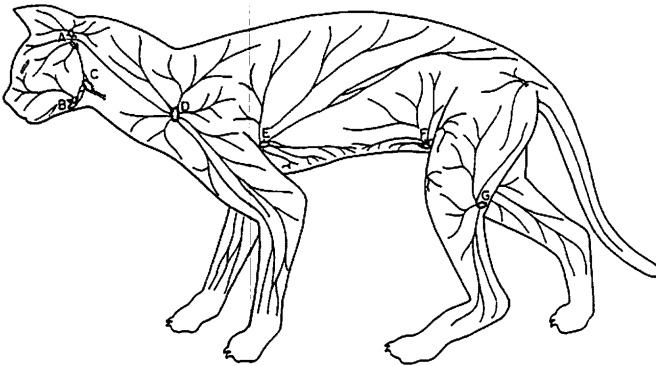


Fig. 1 The superficial lymphatic system of the cat. A. Parotid l. n. B. Mandibular l. n. C. Medial retropharyngeal l. n. D. Superficial cervical l. n. E. Accessory axillary l. n. F. Superficial inguinal l. n. G. Popliteal l. n.

The medial retropharyngeal lymph node (Figs. 1 and 2) is located deep to the *m. sternomastoideus* at the level of the atlas. It lies adjacent to the carotid sheath and is bounded medially by the *m. scalenus* and pharyngeal musculature. Five to eight afferent vessels course to this node from the tongue, linings of the nasal and oral passage, and the salivary glands. It receives the efferent lymph vessels from the parotid and mandibular lymph nodes.

The superficial cervical lymph node (Figs. 1 and 3) is located anterior to the scapula under the *m. trapezius cervicis* at the level of the *m. omotransversarius*. It receives two or three vessels from all of the regions of the neck not drained by the parotid and mandibular lymph nodes. In five animals the superficial cervical lymph node received a single afferent vessel from the eye region (Fig. 1).

Lymph Nodes and Vessels of the Forelimb

The superficial cervical lymph node, described above, also receives one to two vessels from the lateral surface of the forelimb and one to three vessels from the lateral surface of the shoulder (Fig. 3).

The axillary lymph node (Fig. 4) lies on the medial surface of the forelimb at the level of the scapulo-humeral joint. It is bordered laterally by the *m. subscapularis*, *m. teres major*, anteriorly by the *m. biceps brachii*, and medially by the muscles of the thoracic wall. It receives one or two afferent vessels from the anterior portion of the medial surface of the forelimb. One or two vessels also drain into this node from the medial surface of the shoulder.

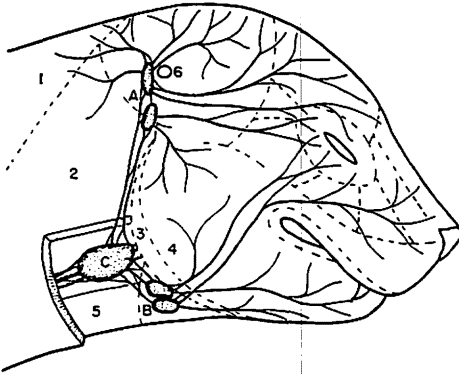


Fig. 2

Fig. 2 The lymph nodes and vessels of the head. A. Parotid l. n. B. Mandibular l. n. C. Medial retropharyngeal l. n. 1. *m. trapezius cervicis*. 2. *m. sternomastoideus*. 3. *m. digastricus*. 4. *m. masseter* 5. *m. sternothyroideus*. 6. *meatus acusticus externus*.

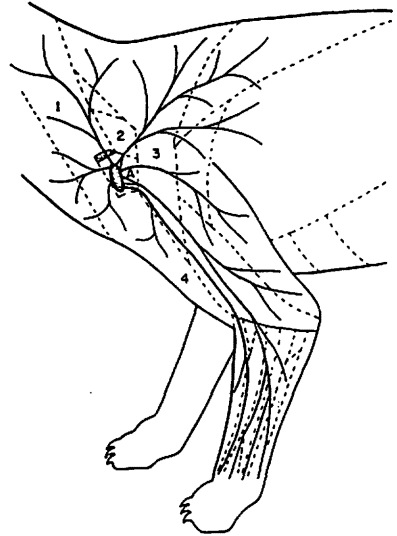


Fig. 3

Fig. 3 The lymph node and vessels of the lateral aspect of the neck and forelimb. A. Superficial cervical l. n. 1. *m. trapezius cervicis*. 2. *m. omotransversarius*. 3. *Pars acromialis m. deltoidei*. 4. *m. cleidobrachialis*.

The accessory axillary lymph node (Figs. 1, 4 and 5) is located medial to the *m. latissimus dorsi*, along the thoracico-dorsal blood vessels, two to five centimeters posterior to the axillary lymph node. It receives one or two afferent vessels from the posterior parts of the medial surface of the forelimb. This node also receives the vessels from the ventro-medial portions of the subscapular musculature. In ten animals, in which the accessory axillary lymph nodes were absent, the axillary lymph node drained those areas normally served by the accessory axillary node.

Lymph Nodes and Vessels of the Thorax and Abdomen

Drainage from the Dorsum

Three to five vessels drain the dorsum from the posterior part of the shoulder to the base of the tail and course to the accessory axillary lymph node (Fig. 1). The afferent vessels of the lateral sacral lymph node (Fig. 8), located in the pelvic cavity on the

ventral surface of the *m. sacrococcygeus ventralis lateralis*, drain the base of the tail. These vessels generally overlap with the afferent vessels of the accessory axillary lymph node (Fig. 1).

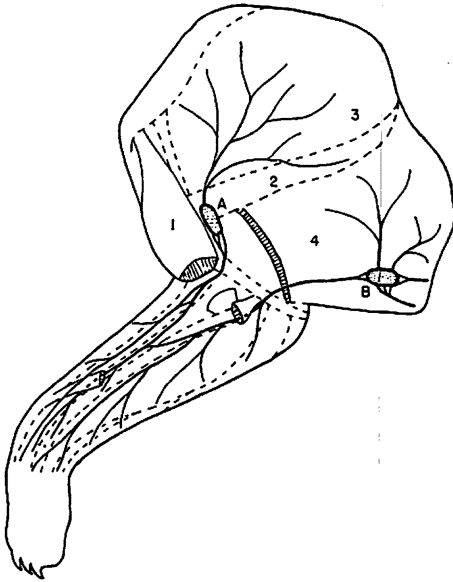


Fig. 4

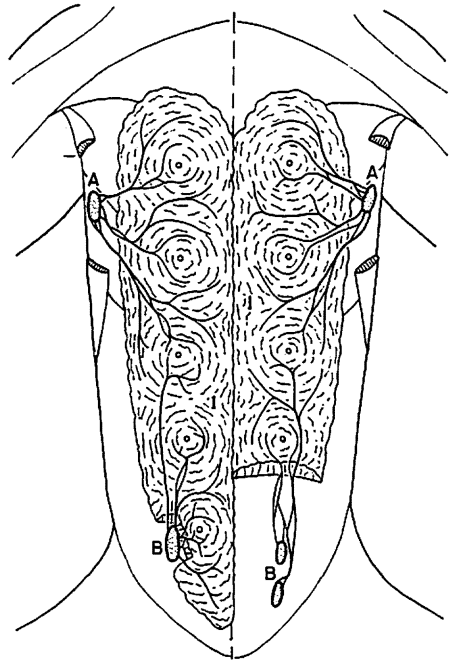


Fig. 5

Fig. 4 The lymph nodes and vessels of the medial aspect of the forelimb. A. Axillary l. n. B. Accessory axillary l. n. 1. *m. biceps brachii* (cut). 2. *m. teres major*. 3. *m. subscapularis*. 4. *m. latissimus dorsi*.

Fig. 5 The lymphatic drainage of the mammary glands during lactation. A. Accessory axillary l. n. B. Superficial inguinal l. n. 1. mammary glands.

Drainage from the Mammary Glands

Three to five afferent vessels of the accessory axillary lymph node drain the first, second, and third mammary glands (Fig. 5). Three to five afferent vessels of the superficial inguinal lymph nodes (Figs. 1, 5 and 7), located along the external pudic blood vessels near the posterior margin of the *m. obliquus externus abdominis*, receive lymph from the third, fourth, and fifth mammary glands (Fig. 5).

Drainage from the Ventral and Lateral Surfaces

The ventral and lateral surfaces of the thorax and abdomen are drained by three to six afferent vessels of the accessory axillary lymph node and three to seven afferent vessels of the superficial inguinal lymph node (Fig. 1). The scrotum, testis, prepuce, and penis are drained by two or three afferent vessels of the superficial inguinal lymph nodes (Fig. 7).

Lymph Nodes and Vessels of the Hindlimb

The popliteal lymph node (Figs. 1 and 6) is located in the popliteal space medial to the *m. biceps femoris*, lateral to the *m. semitendinosus* and dorsal to the *m. gastrocnemius*. It receives two or three afferent vessels from the distal part and one or two afferent vessels from the proximal area of the lateral surface of the hindlimb (Fig. 6). They do not drain the anterior parts of the lateral femoral area. The efferent vessels of the popliteal lymph node course along the dorsal margin of the *m. gastrocnemius*, pass to the medial surface, run across the femoral triangle, and pierce the abdominal wall to drain into the external iliac lymph node (Fig. 8). Infrequently, an afferent vessel from the lower lateral surface of the hindlimb unites with the efferent vessel thereby bypassing the popliteal lymph node. Occasionally an afferent vessel of the popliteal lymph node branches to send a single small afferent vessel to the lateral sacral lymph node. The proximal portions of the lateral femoral area may be drained by an afferent vessel of the lateral sacral lymph node.

Afferent vessels of the superficial inguinal lymph node drain the anterior parts of the lateral femoral region (Figs. 1 and 8). One to three afferent vessels of this node drain the entire medial surface of the hindlimb (Fig. 7).

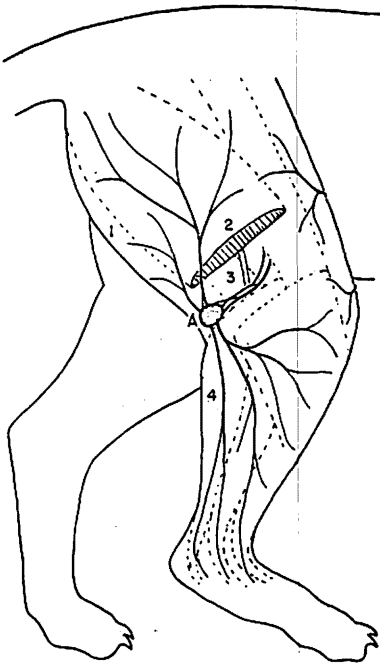


Fig. 6

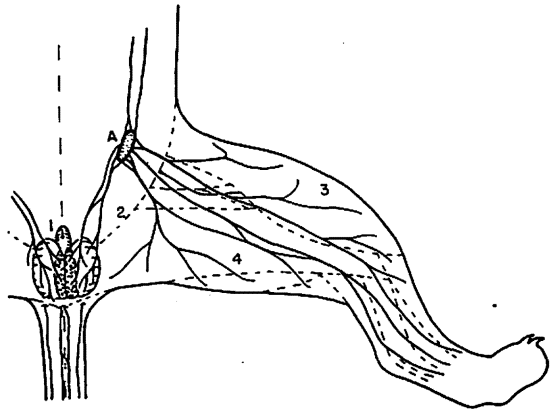


Fig. 7

Fig. 6 The lymph node and vessels of the lateral aspect of the hindlimb. A. Popliteal l. n. 1. *m. semitendinosus*. 2. *m. biceps femoris*. 3. *m. semimembranosus*. 4. *m. gastrocnemius*.

Fig. 7 The lymph node and vessels of the medial aspect of the hindlimb and male genitalia. A. Superficial inguinal l. n. 1. penis. 2. *m. obliquus externus abdominis*. 3. *m. sartorius*. 4. *m. gracilis*.

Lymph Vessels of the Tail

The lymph vessels from the tail drain into the lymph nodes of the pelvic cavity (Figs. 1 and 8). One or two vessels course in the furrow formed by the *Mm. sacrococcygei ventrales* and drain into internal iliac lymph nodes. A single vessel runs along the lateral surface of the tail, divides, and empties into the lateral sacral, deep inguinal, and internal iliac lymph nodes (Fig. 8). This vessel lies in the groove formed by the *m. sacrococcygeus ventralis lateralis* and *m. intertransversarius ventralis coccygeus*.

Lymph Nodes and Vessels of the Abdominal and Pelvic Cavities

The lymph nodes discussed in this section are only those which were revealed by injections in the superficial regions of the body. It is assumed that these lymph nodes receive vessels from the deep structures lying within these regions. A description of these vessels was beyond the scope of this work. The lymph nodes of the mesenteries are not included.

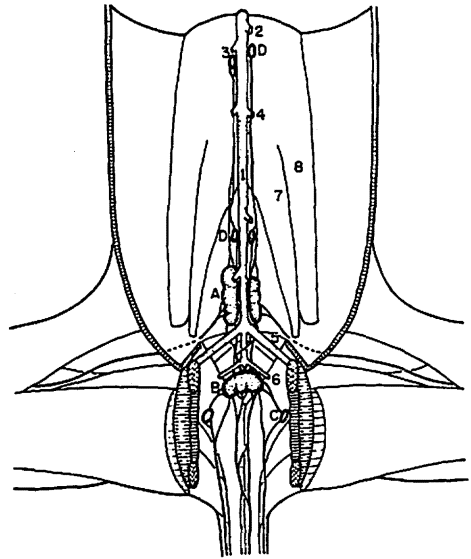


Fig. 8 The lymph nodes and vessels of the pelvic and abdominal cavities involved in the drainage of lymph from the superficial areas. A. External iliac l. n. B. Internal iliac l. n. C. Lateral sacral l. n. D. Lumbar l. n. 1. aorta. 2. celiac art. 3. anterior mesenteric art. 4. renal art. 5. external iliac art. 6. internal iliac art. 7. *m. psoas minor*. 8. *m. iliopsoas*.

The internal iliac lymph node is located adjacent to the internal iliac artery and is bounded dorsally by the *m. sacrococcygeus ventralis lateralis*. It receives afferent vessels from the tail and the efferent vessels from the lateral sacral lymph node. The efferent vessels of the internal iliac lymph node course to the external iliac lymph nodes (Fig. 8).

The deep inguinal lymph node, which occurred in four animals, is located in the angle formed by the bifurcation of the external iliac artery into the femoral and deep femoral arteries. It receives those afferent vessels from the lateral surface of the distal hindlimb which bypassed the popliteal lymph node and the efferent vessels of the lateral sacral lymph nodes. The efferent vessels of the deep inguinal lymph node course to the external iliac lymph node.

The lateral sacral lymph nodes receive afferent vessels from the tail and lateral surface of the hindlimb. The efferent vessels course to the deep inguinal, internal iliac, and external iliac lymph nodes (Fig. 8).

The external iliac lymph node is located along the aorta between the deep circumflex iliac and external iliac arteries. It receives the efferent vessels of the popliteal, superficial inguinal, lateral sacral, internal iliac, and deep inguinal lymph nodes. The efferent vessels of the external iliac lymph node course anteriorly along the aorta to the lumbar lymph nodes (Fig. 8).

The lumbar lymph nodes are located along the aorta between the anterior mesenteric and deep circumflex iliac arteries. These nodes receive the efferent vessels of the external iliac lymph node. The efferent vessels from the lumbar lymph nodes drain into the next anterior node of the group (Fig. 8), ultimately emptying into the thoracic duct.

Discussion

The drainage areas of the superficial lymph nodes is constant and, in general, is restricted to the immediately surrounding regions (Fig. 1). The exceptions to this are the axillary or accessory axillary and the superficial cervical lymph nodes. A small degree of variability occurs in the regions of overlap of the adjacent drainage areas.

The pattern of the superficial lymph vessels is highly variable. For example, the anterior portion of the lateral surface of the forelimb may be served by one or two major vessels. The pattern is further complicated by numerous anastomoses between lymph vessels. Therefore, it is difficult to describe the precise pathways of the lymph vessels. The lymph nodes also exhibit some variability in presence, location, and number.

The conspicuous absence of the medial femoral lymph node in the cat is noteworthy. This node, which is located in the distal portion of the femoral triangle, is present in the Beagle dog and drains a limited part of the medial surface of the hindlimb (*Ratzlaff 9*). In the cat, this area is drained by the superficial inguinal lymph nodes.

The data of this study disagrees in many areas with the data presented by *Ottaviani* and *Cavalli* (8) with respect to the location, number and occurrence of lymph nodes, the pathways of the afferent and efferent vessels, and the drainage areas of certain lymph node groups. The following comparisons illustrate some of the differences between this study and that of *Ottaviani* and *Cavalli*. *Ottaviani* and *Cavalli* stated that the efferent vessels of the parotid lymph nodes coursed to the mandibular lymph nodes; this was not the case in the animals examined in this study. They also described a much more limited drainage area for the parotid lymph nodes than was found to be the case in the specimens used in the current study. In addition to the superficial inguinal lymph node group, they described a subpubic lymph node located at the posterior margin of the abdominal muscles several centimeters from the superficial inguinal nodes. This node was never observed in my specimens. Lastly, *Ottaviani* and *Cavalli* stated that the main efferent vessel from the popliteal lymph node coursed dorsally over the superficial femoral region. The main efferent vessels that were identified in the current study coursed deep to the biceps femoris muscle and emerged on the medial surface of the hindlimb to course to the external iliac lymph node.

Sugimura, Kudo and *Takahata* (5) described the lymph nodes of the body surfaces and thoracic and pelvic limbs. They described two lymph nodes which were never observed in my investigations. These are the prefemoral and lateral femoral lymph nodes. *Ottaviani* and *Cavalli* did not observe either of these nodes in any of the cats they examined.

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A Simplified Method for Cannulation of the Normal Canine Cervical Thoracic Duct

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In view of the reawakened interest in the lymph circulation, a description of a simplified technique for cannulation of the thoracic duct in the neck of the dog is timely. *Markowitz* states (1) that the anatomy of the cervical thoracic duct in the normal dog varies, that the duct often subdivides into multiple channels, and that successful cannulation is often difficult or even impossible. He suggests obstruction of internal, external jugular and subclavian veins, or isolation of these veins into a closed pouch at the entry of the thoracic duct - inconvenient or indirect methods for exposure of the thoracic duct and for collection of lymph. Using the position shown in Fig. 1 we have been uniformly successful in isolating and cannulating the thoracic duct with ease in the neck of normal dogs.