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The Lymph Nodes and the Lymph Vessels of the Abdominal Wall, Pelvic Wall and the Pelvic Limb of Swine

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I. INTRODUCTION

This article is the continuation of previously published papers (11, 12, 13, 14) regarding the lymph nodes of swine and their drainage areas. The details of the "material and methods" have been described and discussed previously (13, 14).

II. THE TERMINOLOGY OF THE LYMPH NODES

A review of the anatomy and the meat-inspection textbooks and other publications showed that in the past a variety of terms were used to group the lymph nodes of the abdominal and the pelvic wall and the pelvic limb regions. In reference to the correspondence and personal communications with Prof. Dr. H. Grau (1962–63), chairman of the revisory committee of the proposed new international anatomical nomenclature of the lymph apparatus, the general guidelines for the future terminology are basically those which were introduced by Baum (1912 thru 1932), for the domestic animals.

Due to changes made in terminology, by reorganizing the lymph node groups into lymphocenters, the authors prefer for the sake of brevity to discuss only the terms used at present in Sisson-Grossman (1953, 4th edition) and compare them with the new nomenclature to be used.

In agreement with Grau and Boessneck (7) and Spira (16), the lymph nodes of the abdominal wall are grouped into four lymphocenters (Lcc), of which two of the lymphocenters, the lumbar and the iliac lymphocenter are found in association with the trunks and the main branches of the abdominal aorta and the posterior vena cava. These lymphocenters are situated subperitoneal on the dorso-medial...
side of the abdominal wall, being located ventral to the lumbar vertebrae. The other two lymphocenters, the subiliac and the superficial inguinal lymphocenter are situated subcutaneously (embedded in fat) on the lateral and on the ventral side of the abdominal wall.

In swine the lumbar lymphocenter (Lc. lumbale) includes the lumbar aortic, the renal, the phrenico-abdominal, the uterine and the testis lymph nodes, which in Sisson-Grossman (15) are designated as the lumbar nodes.

The iliac lymphocenter (Lc. ilium (commune)) comprises the lateral and the medial iliac lymph nodes of which the lateral iliacs are synonymous with the external iliacs (Sisson-Grossman), while the medial iliacs include according to Sisson-Grossman’s terminology the anterior portion of the internal iliacs and the deep inguinal lymph nodes situated along the course of the external iliac vessels. The posterior portion of the internal iliacs (Sisson-Grossman), located in the angle of divergence of the internal iliac arteries, are called according to the new terminology—the anterior sacral lnn. (Lnn. sacrales (hypogastrici)).

According to the new terminology the deep inguinal lymph nodes, which form the deep inguinal lymphocenter of the pelvic limb, are in swine found to be absent. In man, the latter lymphocenter is located in the fossa iliopectinea, and in the horse, the cow, the dog, the cat, and the guineapig, it is associated in close proximity to the femoral vessels, distal to the origin of the deep femoral artery.

The subiliac lymphocenter includes in swine, the subiliac lymph nodes only. In Sisson-Grossman (15) they are called the

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**Figure 1—Subcutaneous lymph vessels.** The arrows indicate the direction of the lymph flow. Transverse planes are drawn through the middle of the 11th and the 14th spine of the thoracic vertebrae.

*Muscles:* A-masseter; B-brachiocephalicus; C-trapezius; D-domotransversarius; E-deep pectoral (prescapular portion); H-sternohyoideus.

*Veins:* a-external maxillary; b-internal maxillary; c-external jugular; d-internal jugular; e-cephalic-humeral; f-axillary; g-ascending cervical.

*Lymph Nodes:* 1-mandibular; 2-parotid; 3-accessory mandibular; 4-lateral retropharyngeal; 5.5-ventral superficial cervical; 7-dorsal superficial cervical; 8,8-medial superficial cervical; 10-axillares primeae costae (costoaxillary); 12-subiliac ("prefemoral"); 13-superficial inguinal; 14-superficial popliteal; 14-deep popliteal.

*Other Structures:* G-mandibular gland; the numbers from 5r through 16r refer to the position of the ribs.
Figure 2: Subcutaneous lymph vessels on the medial and lateral side of the pelvic limb. The arrows indicate the direction of the lymph flow.

Lymph Nodes—12-subiliac; 13-superficial inguinal; 14-superficial popliteal; 14'-deep popliteal.
prefemoral lymph nodes. The term “prefemoral” is considered by the authors as somewhat unfortunate since the lymph nodes drain largely the subcutaneous dorso-lateral lumbar area of the trunk. In fact, the subiliac lymph nodes appear to be rather closely associated with the common iliac lymphocenter. The medial iliac lymph nodes are found near the origin of the deep circumflex iliac vessels. The lateral iliacs are situated on the anterior branches of the deep circumflex iliac vessels and the subiliac lymph nodes are located on the ventral branches.

The superficial inguinal and the accessory superficial inguinal lymph nodes of the male are preferably called in the female, the supramammary lymph nodes. They represent the superficial inguinal lymphocenter (Lc. inguinale superficiale) located on the ventral part of the abdominal wall.

The lymphocenters of the pelvic wall (Lc. sacrale) are associated in general with the internal iliac vessels and their branches. They will be described as the anterior, the internal and the external sacral lymph nodes.

The anterior sacral lymph nodes (Lnn. sacrales (hypogastrici)) correspond in part with Sisson-Grossman’s internal iliac lymph nodes, namely with those lymph nodes which are situated in the angle of divergence of the internal iliac arteries.

The internal sacral lymph nodes (Lnn. sacrales interni) are not present in swine, although in the cow, the sheep and the dog they may be found on the medial side of the sacro-sciatic ligament.

The external sacral lymph nodes (Lnn. sacrales externi) are situated lateral to the sacro-sciatic ligament and they include the anal and the ischiadic lymph nodes of swine as described by Sisson-Grossman (15). The deep inguinal and the popliteal lymphocenters, of which in swine only the latter one is present are associated with the pelvic limb. The popliteal lymphocenter includes the deep and the superficial popliteal lymph nodes. In Sisson-Grossman (15) the popliteal and the tarsal lymph nodes are actually synonymous with the superficial popliteal lymph nodes. The deep popliteal lymph nodes, however, are not described by the latter author (15).

III. THE LOCATION OF THE LYMPH NODES

A. The Lymphocenters of the Abdominal Wall

1. The lumbar lymphocenter (Lc. lumbale)
   a. The lumbar aortic Inn. (Lnn. lumbales aortici) (Fig. 7 and 9) comprise a dozen or more small lymph nodes scattered along the ventral and lateral (often dorsal) side of the abdominal aorta and the posterior vena cava. They extend posteriorly from near the renal vessels to the caudal mesenteric artery. Anteriorly, these lymph nodes are often not clearly distinguished from the renal lymph nodes and posteriorly it may be difficult to differentiate them from the medial iliac lymph nodes. The size of the lymph nodes varied from a few millimeters up to 2.0 cm. in length.
   b. The renal Inn. (Lnn. renales) (Fig. 7) are found in association with the renal vessels. Usually there are 1–4 lymph nodes of approximately 0.25–1.5 cm. in size.
   c. The phrenico-abdominal Inn. (Ln. phrenico-abdominalis) (Fig. 7) is located posterior to the caudal branch of the phrenico-abdominal vessels on the lateral side of the iliopsoas muscle embedded in fat. Occasionally, in three out of 16 cases, this lymph node was present on the right side only and in one female it was considered to be absent. The size of the lymph node varied from a few millimeters up to approximately 1.0 cm. in length.
   d. The uterine Inn. (Ln. uterini) are found in the anterior part of the broad ligament of the uterus, associated with the utero-ovarian vessels. Usually there are one or two lymph nodes of approximately 0.25 to 2.0 cm. in size. Occasionally the lymph nodes were found to be present on one side only, or they were completely absent, or occasionally difficult to distinguish from the lumbar aortic lymph nodes.
   e. The testis Inn. (Ln. testis proprius) is found in the male along the
spermatic cord, in association with the internal spermatic vessels. The number, size and location of the lymph nodes varied, although one of the lymph nodes was found in 4 out of 12 cases near the origin of the internal spermatic artery when the latter vessel crosses the ureter. (Size varied from 0.25 cm. up to 1.5 cm. in length.) Some of the testis lymph nodes were situated on the proximal part of the pampiniform plexus (2 out of 12 cases) of variable size from 0.2 cm up to approximately 1.0 cm. in length. Furthermore, in 2 out of 12 cases, a few minute lymph nodes were present along the course of the internal spermatic artery. The lymph nodes were found to be absent in 4 out of 12 cases examined.

2. The common iliac lymphocenter (Lc. ilium [commune])

a. The medial iliac Lnn. (Lnn. ilici mediales) (Fig. 3, 5, 6, 7, 8, 9) are situated anterior and posterior to the origin of the deep circumflex iliac artery along the lateral and medial side of the external iliac vessels. Anteriorly the lymph nodes extend up to the posterior mesenteric artery. Often, they are not distinguished clearly from the lumbar aortic lymph nodes. The lymph nodes situated posterior to the deep circumflex iliac vessels were usually somewhat larger. They formed a conglomerate, comprised of 3–7 lymph nodes of approximately 0.5–3.0 cm. in length. Occasionally some of the lymph nodes of the latter group extended antero-laterally into the close vicinity of the lateral iliac Lnn. by crossing over the deep circumflex iliac vessels. Thus, it was difficult to distinguish clearly both of these groups. The anterior group of the medial iliac Lnn. included 3–8 lymph nodes of variable size from a few millimeters up to approximately 2.0 cm. in length.

The division of the medial iliac Lnn. into an anterior and a posterior group is empirical, although on occasion it may be helpful to describe the lymph flow.

b. The lateral iliac Lnn. (Lnn. ilici laterales) (Fig. 3, 5, 6, 7, 8, 9) are found anterior to the cranial branches of the deep circumflex iliac vessels. They are situated near the caudal edge of the transversus abdominis muscle, embedded in fat on the ventro-lateral surface of the iliopsoas muscle. Usually there are found 1–3 small lymph nodes of variable size from several millimeters up to approximately 1.5 cm. in length. Occasionally, these lymph nodes were found to be absent on the left side (2 out of 16 cases) and on the right side (1 out of 16 cases). In the cases listed above, the lateral iliac Lnn. appeared to be fused with the medial iliac lymph nodes.

3. The subiliac lymphocenter (Lc. subilicum)

In swine, this lymphocenter includes only one lymph node group. The subiliac Lnn. (Lnn. subilici) (Fig. 1, 2, 3, 4, 5, 6, 7) form a larger sized elongated conglomerate of smaller lymph nodes on the midline between the tuber coxae and the patella. These lymph nodes are situated anterior to the tensor fasciae latae muscle, embedded in fatty subcutaneous tissue along the ventral branches of the deep circumflex iliac vessels. Usually the conglomerate of lymph nodes is 2–5 cm. in length and 1–2 cm. in width, or sometimes there are present two or three smaller sized conglomerates of lymph nodes.

4. The superficial inguinal lymphocenter (Lc. inguinale superfici-ale)

In swine, this lymphocenter includes two lymph node groups of which in the male they are referred to as the superficial inguinal Lnn. and the accessory superficial inguinal lymph nodes. In the female, however, they are preferably called the supramammary Lnn. and the accessory supramammary lymph nodes.

a. The superficial inguinal Lnn. (Lnn inguinales superficiales) (Fig. 2, 3, 4, 5, 6, 7 and 10) in the male are located on the ventral side of the abdominal wall, situated laterally to the penis. They form an elongated conglomerate of approximately 3–7 cm. in length and 1–2 cm. in width. They are associated mainly with the anterior branches of the external pudendal vessels which they cover ventrally. These lymph nodes are located mainly antero-lateral to the spermatic cord and to a lesser extent they extend...
Figure 3: Subcutaneous lymph vessels of the medial and lateral side of the pelvic limb. The arrows indicate the directions of the lymph flow.

Lymph Nodes: 12-subiliac; 13-superficial inguinal; 13'-accessory superficial inguinal; 14-superficial popliteal; 14'-deep popliteal; 15, 15'-external sacral; 16-anterior sacral; 17, 17'-medial iliacs; 18-lateral iliacs.

Blood Vessels: h-abdominal aorta; k-external iliac; m-internal iliac; n-middle sacral; o-deep femoral; p-femoral; q-deep circumflex iliac.
Figure 8: Ventral view of the lumbo-sacral region including the superficial inguinal lymphocenter. The arteries are injected with red latex, the veins with yellow latex, and the lymph vessels are blue. (See legend on Figures 6 and 7).

Figure 9: Ventral view of lumbo-sacral region. (See legends on Figure 6 and 7).

Figure 10: Ventral (abdominal) view of the boar. Observe the afferents from the prepuce and medial surface of pelvic limb terminating into the superficial inguinal lymphocenter.
posterio-medially. The caudal portion of the lymph node groups of the right and left side lie in close proximity one to the other, forming a v-shaped conglomerate of lymph nodes.

In the female, the superficial inguinal lnn. are called the supramammary lnn. (Lnn. supramammari). They represent an elongated, loosely arranged conglomerate of lymph nodes of 3–8 cm. in length and 1–2.5 cm. in width, situated ventral to the anterior branches of the external pudendal vessels along the lateral and the posterior border of the caudal half of the last mammary gland.

b. The accessory superficial inguinal lnn. (Lnn. inguinales superficiales accessorii) of the male (Fig. 3) and the accessory supramammary lnn. (Lnn. supramammari accessorii) of the female (Fig. 1) may be considered as the “split-off” lymph nodes of the superficial inguinal lymph nodes. In both sexes, the accessory lymph nodes are found at a variable distance of approximately 5–15 cm. anterior to the main group of lymph nodes along the subcutaneous abdominal vein.

In seven castrated males, these lymph nodes were found to be present on both sides in two cases. In 2 animals on the right side only, and in 3 additional cases, they were absent. The number (1–3), the size (approximately 0.5–1.5 cm.) and the distance (5–15 cm.) of the lymph nodes from the superficial inguinal lymph nodes varied on each castrated animal. In three boars, the accessory lymph nodes were present on both sides. In one case, they were found on the left side only, and in one boar, the latter lymph nodes were absent.

The accessory supramammary lymph nodes of the female were found in four out of eleven cases examined. In three animals, the lymph nodes were present on both sides situated along the subcutaneous abdominal vein approximately 3–5 cm. anterior to the main group. The number of the lymph nodes varied from 1–4 and the size was found to be approximately 0.5–1.5 cm. in length. In one case, the lymph nodes were present on the left side only, and in four more cases it was difficult to distinguish clearly the accessory lymph nodes from the supramammary lymph nodes because of the loose arrangement of the conglomerate.

B. The Lymphocenters of the Pelvic Wall

The sacral lymphocenter

a. The anterior sacral lnn. (Lnn. sacrales (hypogastrici)) (Fig. 3, 5, 6, 7) are situated in the angle formed at the left and the right internal iliac arteries, located near the origin of the medial sacral artery. Usually, there are 1–3 lymph nodes approximately 0.25 cm. up to 1.0 cm. in size, which appear to form an unpaired group of lymph nodes.

b. The internal sacral lnn. (Lnn. sacrales interni) include the lymph nodes found medial to the sacro-sciatic ligament along the internal iliac and the medial sacral vessels and their branches. However, in swine, there are no true internal sacral lnn. present, although occasionally there are found in both sexes small lymph nodes (Lnn. urogenitales) in the urogenital fold (plica urogenitalis) in association with the umbilical artery.

In the female, the latter lymph nodes were located in 2 out of 9 cases on one side, and in 1 out of 9 cases on both sides of the broad ligament of the uterus, associated with the proximal part of the umbilical artery.

In the male, small urogenital lymph nodes of less than 0.5 cm. in diameter were located in 3 out of 7 cases on the dorso-lateral side of the seminal vesicle in the urogenital fold.

c. The external sacral lnn. (Lnn. sacrales externi) (Fig. 3, 4, and 5) are located on the lateral side of the sacro-sciatic ligament, covered by the gluteus medius and the biceps femoris muscles. The lymph nodes, 1–5 in number, are found along the course of the internal iliac vessels in region between the great ischiadic foramen (spatium ischiadicum majus) and the posterior border of the sacro-sciatic ligament. Usually, two groups of lymph nodes may be distinguished according to their position whether anterior or posterior to the ischiadic spine.

The anterior group is found 2–3 cm.
posterior to the great ischiadic foramen. The size of the lymph nodes varied from 0.25 cm. to 0.75 cm. in length.

The posterior group is located 2–3 cm. anterior to the posterior edge of the sacrosciatic ligament, dorsal to the origin of the caudal haemorrhoidal vessels. The size varied from 0.25 cm. up to 1.5 cm. in length.

Occasionally, the external sacral ln. formed a chain of 4–5 small lymph nodes (approximately 0.5 cm. in length) along the internal iliac vessels. Furthermore, in 2 out of 20 cases, the lymph nodes were found to be absent on the left side, and in 4 out of 20 cases they were not present on the right side.

Egehoj (3) described the presence of the Ln. gluteus in 10% of the cases he examined near the tuber ischiadicum on the medial side of the biceps femoris. This lymph node was not found to be present in 40 limbs examined by the authors.

C. The Lymphocenters of the Pelvic Limb

The deep inguinal lymphocenter (deep inguinal lymph nodes) are absent in swine. Only the popliteal lymphocenter can be located on the pelvic limb of swine.

The popliteal lymphocenter (Lc. popliteum) includes in swine the superficial (subcutaneous) and the deep (intermuscular) popliteal lymph nodes.

a. The superficial popliteal ln. (Ln. popliteus superficialis) (Fig. 1, 2, 3, 4, 5) is located on the dorso-caudal surface of the gastrocnemius muscle, in a groove between the biceps femoris and the semitendinosus muscle. Usually, it is present 2–3 cm. from the skin being embedded in fat on the saphena parva vein. The size of the lymph node varied from 0.5 cm. up to 3.0 cm. in length and occasionally a second smaller lymph node was found to be present. However, in 2 out of 40 pelvic limbs examined, they were absent.

b. The deep popliteal ln. (Ln. popliteus profundus) (Fig. 1, 2, 3, 4, 5) is located approximately 3–6 cm. cranio-dorsal to the superficial popliteal ln. along the course of the saphena parva vein, situated between the biceps femoris and the semitendinosus muscle. The latter lymph node is embedded in fat and often, because of its small size (usually less than 0.5 cm. up to 0.75 cm.) it may be easily overlooked. Occasionally there were present 2 or 3 small lymph nodes of less than 0.5 cm. in size. In 17 out of 40 pelvic limbs examined the deep popliteal ln. was found to be absent. Furthermore, in 1 out of 40 limbs examined, both the superficial and the deep popliteal lymph nodes were not found to be present.

IV. THE LYMPH VESSELS AND THE LYMPH DUCTS

1. General Observations

The lymph vessels are closely associated with the connective tissue in which the lymph capillaries join to form three-dimensional lymph vessel plexuses and networks. In general, the size of the lymph vessels increase in the direction of the lymph flow, although the lymph vessels may branch and join again and form numerous collaterals before entering the lymph nodes.

For descriptive purposes, the lymph vessel networks are described as the "superficial lymph vessels," confined to the skin and the subcutis and as the "deep lymph vessels," which follow the route of the intermuscular connective tissue sheets. This classification is rather empirical, because of the difficulties to distinguish clearly the borderlines of the latter networks. In general, however, the direction of the lymph flow of the skin and the subcutis differs from that of the underlying muscles and the fasciae. The superficial lymph vessels are found to flow together along broad connective tissue sheets towards the subcutaneous lymphocenters, usually independent of the pattern of the blood vessels.

The deep lymph vessels, on the contrary, appear to be closely associated with the route of distribution of the blood vessels. Although this observation may be solely coincidental due to the fact that this may be the easiest way of passage along the intermuscular connective tissue sheets.

In general, the lymph vessels of the skin and the subcutis of the posterior half of the body, including the pelvic limb, enter the subiliac and the superficial inguinal (supramammary) lymphocenters,
Figures 4 and 5: The routes of the lymph flow from the dorsal (anterior) area of the metatarso-phalangeal articulation (fetlock joint). The arrows indicate the direction of the lymph flow.

*Lymph nodes:* 12-subiliac; 13-superficial inguinal; 14-superficial popliteal; 14'-deep popliteal; 15, 15'-external sacral; 16-anterior sacral; 17, 17'-medial iliacs; 18-lateral iliacs.

*Blood vessels:* h-abdominal aorta; m-internal iliac; n-middle sacral; o-deep femoral; p-femoral; q, q'-ventral and anterior branches of the deep circumflex iliac; r-external pudendal.
**Figure 5**

*Directions of lymph flow:* M-efferents of the external sacral lnn. follow the internal iliac vessels. They come from the popliteal lymphocenter (M) via the route of the ischiadic nerve; O-efferents of the popliteal lymphocenter which follow the medial circumflex femoral to the deep femoral vessels. The popliteal lnn., receive afferents from the lateral side of the limb; P-efferents coming from the medial side of the limb along the saphena magna. They follow the course of the femoral vessels. Q-efferents of the subiliac lnn. passing along the deep circumflex iliac vessels to the medial and lateral iliac lymph nodes; R-efferents of the external pudendal vessels.
while these of the anterior half of the body terminate into the dorsal and the ventral superficial cervical lymph nodes (the superficial cervical lymphocenter).

The line of the division of the subcutaneous lymph flow, into anterior and posterior direction, was established in eight animals. It was found that by placing imaginary transverse planes through the middle of the spines of the 11th and the 14th or 15th thoracic vertebrae (Fig. 1) and by connecting them with an oblique line drawn from anterior (dorsal) to posterior (ventral) along the lateral side of the body, it was possible to approximate the directions of the subcutaneous lymph flow (Fig. 1). The terms “posterior half” and “anterior half” of the body will be used as cranial or caudal to this oblique line described.

2. The lymph drainage areas of the lymphocenters

a. The subiliac lymphocenter (Fig. 1 and 2) is the main gathering place of the lymph vessels of the skin, the subcutis and the cutaneous trunci muscles of the dorsal border line of the drainage area extending from the root of the tail up to the spine of the 11th thoracic vertebrae. It then turns caudo-ventrally, along the course of the 11th or 12th rib, close to the costochondral junction and follows approximately a line drawn posteriorly in the direction of the “knee fold” (patella). Posteriorly, the drainage area of the subiliac lymphocenter covers approximately two-thirds of the skin and the subcutis of the thigh and the pelvic region. This area of drainage is thus anterior to the line drawn from the root of the tail cranio-ventrally towards the proximal ⅔ of the tibia and it includes also a skin area a few inches wide, along the cranio-medial border of the thigh and the medial side of the stifle joint. In a few cases, afferents are received also from the femoro-patellar joint capsule. The efferent lymph vessels (Fig. 3, 5, 6, 7, 8) follow the course of the external pudendal vessels (pudendo-epigastric trunk) to the deep femoral vessels and continue anteriorly along the external iliac vessels to the common iliac lymphocenter.

b. The superficial inguinal (supramammary) lymphocenter (Fig. 1, 2, 3, 4, 5) receives mainly the subcutaneous lymph vessels from the posterior half of the body, including the pelvic limb, which are not drained by the subiliac lymphocenter. The afferent lymph vessels originate from the skin, the subcutis and the cutaneous trunci muscles of the latero-ventral half and the ventral part of the posterior half of the body, and from the lateral (caudal) ⅓ of the thigh and the skin of the tail. Furthermore, lymph vessels are received from the skin areas of the lateral side of the pelvic limb (distal to the stifle joint) and from the entire medial side of the pelvic limb including the deeper structures of the digits, accessory digits and the bulbs of the claws.

The superficial inguinal lymph nodes receive lymph vessels also from the rectus abdominis muscle and in the male from the skin and the subcutis of the penis and preputium (Fig. 10) and the cranial and caudal preputial muscles and from the subcutis of the scrotum. In the female, the supramammary (superficial inguinal) lymph nodes drain the subcutis of the vulva and the posterior four or five (out of six) mammary glands. Occasionally, afferents may be received from the femoro-patellar joint capsule.

The efferent lymph vessels (Fig. 3, 5, 6, 7, 8) follow the course of the external pudendal vessels (pudendo-epigastric trunk) to the deep femoral vessels and continue anteriorly along the external iliac vessels to the common iliac lymphocenter.

c. The popliteal lymphocenter (Fig. 1, 2, 3, 4, 5) situated along the saphena parva vein, appears to be intercalated along one of the routes of the lymph flow from the areas of the tarsus, metatarsus and the digits. In general, this lymphocenter receives the superficial and the deep lymph vessels from regions associated with the distribution of the branches of the saphena parva vein. The afferent lymph vessels originate from the skin and the subcutis of the posterior-lateral and the posterior (plantar) areas of the leg, distal to the tarsus, and it includes also the subcutis of the bulbs of the calws. Lymph vessels are also received from the skin of the anterior (dorsal) surface of the
digits, which follow the course of the dorsal ramus of the saphena parva vein. The popliteal lymphocenter receives the deep lymph vessels of the posterior (plantar) portion of the leg (distal to the tarsus). These afferent lymph vessels originate from the muscles, the tendons, the ligaments and the joint capsules of the digits and the tarsus.

The efferent lymph vessels of the popliteal lymphocenter follow two routes (Fig. 3, 4, and 5), one along the course of the saphena parva vein (Fig. 3, 4, and 5:0) along the medial circumflex femoral vessels to the deep femoral vessels to terminate finally into the medial and lateral iliac lymph nodes. Secondly, some of the lymph vessels, however, follow the route of the ischiadic nerve (Fig. 3, 4, and 5:M) to the caudal gluteal vein. Usually the later lymph vessels enter the external sacral lymph nodes, although they may skip one of these lymph nodes and follow the course of the internal iliac vessels (Fig. 5:M') to terminate into the medial iliac or sometimes also into the anterior sacral lymph nodes.

d. The sacral lymphocenter of swine includes mainly the anterior and the external sacral lymph nodes. The urogenital lymph nodes (internal sacrals) are usually absent.

The external sacral lymph nodes (Fig. 3, 4, 5) receive lymph vessels from the skin and the subcutis of the caudo-dorsal areas of the pelvic region including the skin areas in the vicinity of the anus. The deep lymph vessels arrive mainly along the course of the branches of the caudal and cranial gluteal and the caudal haemorrhoidal vessels.

Thus, afferents are received in part from the deep, the middle and the superficial gluteal and from the proximal third of the biceps femoris and the semitendinosus muscles. The lymph vessels of the gemelli, the quadratus femoris and the internal obturator muscles enter also the external sacral lymph nodes. Furthermore, as described previously, the latter lymph nodes receive also in part some of the efferents of the popliteal lymphocenter.

The efferents of the external sacral lymph nodes follow the course of the internal iliac vessels and terminate into the medial iliaca and the anterior sacral lymph nodes.

The anterior sacral lymph nodes may receive the lymph vessels from all of the areas described for the external sacral lymph nodes. Furthermore, lymph vessels are received also from the urinary and the genital organs and from the urogenital lymph nodes (internal sacrals). The lymph vessels of the muscles of the tail and those of the vulva and the vagina terminate also in the anterior sacral lymph nodes. Occasionally, some of the lymph vessels, which follow the course of the external iliac vessels, by-pass the posterior group of the medial iliac lymph nodes and go to the anterior sacral lymph nodes.

The efferents of the anterior sacral lymph nodes terminate into the medial iliac lymph nodes.

e. The common iliac lymphocenter (Fig. 3, 5, 6, 7, 8, 9) which includes the medial and the lateral iliac lymph nodes, appears to be the main gathering place for the lymph vessels of the posterior part of the body. The medial iliac lymph nodes are the most prominent ones.

First, they receive the efferents from the other lymphocenters and the lymph nodes in that area. The efferents of the subiliac lymphocenter follow the ventral branch of the deep circumflex iliac vessels to the medial and the lateral iliac lymph nodes. The efferents of the superficial inguinal (supramammary) lymphocenter take the route to the iliac lymphocenter via the external pudendal (pudendo-epigastric trunk) and the deep femoral vessels. The latter efferents are joined by the lymph vessels, which come from the popliteal lymphocenter along the saphena parva and the medial circumflex femoral vessels and follow the deep femoral vessels to the medial iliac lymph nodes. The efferents of the sacral lymphocenter reach the medial iliac lymph nodes via the internal iliac vessels. The lymph vessels of the caudal mesenteric lymphocenter (Lnn. mesenterici caudals) follow the course of the branches of the caudal mesenteric
artery and enter, the medial iliac or the lumbar aortic lymph nodes.

Secondly, the common iliac lympho-center receives afferents directly from the deeper structures of the abdominal and the pelvic wall, from the pelvic viscera and from the pelvic limb along the route of the blood vessels, nerves, and the connective tissue sheets.

The lateral iliac lymph nodes (Fig. 3, 5, 6, 7, 8, 9) receive afferents via the anterior branches of the deep circumflex iliac vessels from the dorsal and dorso-lateral areas of the external and the internal oblique muscles and from the distal and caudal portions of the transversus abdominis muscle, including the caudodorsal regions of the peritoneum. Furthermore, afferents are also received from the posterior parts of the iliopsoas and the psoas minor muscles.

The medial iliacs receive lymph vessels from the urinary bladder, the urethra and the accessory genital glands. Some of these vessels may also go to the anterior sacral lymph nodes. In cases, in which the urogenital lymph nodes are present, some of the lymph vessels may pass first to these lymph nodes. In the female the urogenital lymph nodes receive afferents from the cervix uteri and from the vagina. The lymph vessels of the ovaries, the uterine tubes, the uterus, the cervix, the vagina and the vulva terminate, in general, directly into the medial iliac lymph nodes. However, some of the lymph vessels of the ovaries and the uterine tubes may go to the lumbar aortic or to the uterine lymph nodes, whereby the latter lymph nodes (when present) receive lymph vessels also from the anterior half of the horns of the uterus. Their afferents enter the medial iliac lymph nodes.

The lymph vessels of the testicles follow the course of the internal spermatic vessels. They enter the medial iliacs or the lumbar aortic lymph nodes. In cases in which the testis lymph nodes are present, they go first to the latter lymph nodes.

Finally, the medial iliac lymph nodes receive lymph vessels directly from all the deep structures of the pelvic limb which

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**Figure 6**

Figures 6 and 7: Ventral view of the lumbo-sacral area. The subiliac lymph nodes are seen by dissecting a portion of the external and interal oblique muscles.

**Lymph nodes:** 1, l-renal; 2-phrenico-abdominal; 3-lumbar aortic; 4-lateral iliac; 5-anterior sacral; 6-medial iliac (In Fig. 7 they are enclosed into an area surrounded by a dotted line); 12-subiliac; 13-superficial inguinal (supramammary).

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Other Structures: A-posterior vena cava; B-abdominal aorta; C.C'-right and left kidney; D-iliopectineus m.; E-transversus abdominis m.; F-rectus abdominis m.; H-adductor m.; J-symphysis pelvis; k-internal oblique m.; L-tensor fasciae latae m.; a-splenic lymph duct; b-hepatic lymph duct: (a and b form the coeliac lymph trunk); c-cranial mesenteric lymph trunk; e-renal vessels; f-lumbar lymph ducts (trunks); g-caudal mesenteric artery; h-anterior branches of the deep circumflex iliac; i-ventral branch of the deep circumflex iliac; j-internal iliac vessels; k-middle sacral artery; l-external pudendal a.; m-femoral a.; n-deep femoral a.; o-continuation of the cisterna chyli (thoracic duct); y-coeliac a.; q-deep circumflex iliac vessels; r-cranial mesenteric a.; s-cisterna chyli; t-efferents from subiliac ln.; u-efferents from superficial inguinal ln.; v-efferents from deep structures of the pelvic limb; w-efferents from the popliteal lympho-center; x-efferents from the external sacral ln.; y-efferents from the tail, the anus and the vulva.
include the muscles of the hip, the thigh, the leg and the foot, and from the tendons, the ligaments, the fasciae and from the joint capsules. Although the lymph vessels of the bones (periosteum) were not demonstrated in this investigation, it must be assumed that they too terminate into the medial iliac lymph nodes. These lymph nodes also received afference from the posterior portions of the sublumbar muscles (psoas minor, iliopsoas, quadratus lumbrorum) and from the longissimus dorsi muscle.

The lymph vessels of the medial and the plantar side of the digits choose usually the course along the saphena magna vein to the femoral vessels (Fig. 4 and 5). The lymph vessels of the dorsal, the lateral and the plantar side of the digits follow the route of the saphena parva vein along the lateral side of the leg to the popliteal lymphocenter (Fig. 4 and 5), while other deep lymph vessels of the digits join the course of the branches of the anterior and posterior tibial vessels up to the popliteal artery and vein (Fig. 4 and 5). These lymph vessels continue their course along the femoral vessels to the medial iliac lymph nodes. Furthermore, the deep and the superficial lymph vessels of the digits may join also, as discussed previously, the superficial lymph vessel network on the medial side of the pelvic limb (Fig. 2, 3, 4, 5, and 10) and terminate into the superficial inguinal lymphocenter (superficial inguinal lymph nodes).

The lymph vessels of the hip joint follow the course of the latero-proximal ramus of the lateral circumflex femoral vessels to the femoral artery and continue along the external iliac vessels to the medial iliac lymph nodes.

The efferents of the stifle joint (the femoro-tibial and the femoro-patellar joints) are associated mainly with the middle genicular artery and vein, which are the branches of the popliteal vessels. However, the lymph vessels may follow also the routes of the proximal medial and lateral and the distal medial and lateral genicular vessels to the popliteal artery and vein. Some of the lymph vessels of the femoro-patellar joint take the route along the subcutaneous lymph vessel networks on the medial side of the limb to the superficial inguinal lymph nodes (Fig. 10), or in two cases the latter efferents joined the superficial lymph vessels on the cranio-lateral side of the limb and entered the subiliac lymphocenter.

The large number of lymph vessels which enter the common iliac lymphocenter form an extensive network in the region of the divergence of the abdominal aorta and the posterior vena cava. The efferents of this lymphocenter continue anteriorly as a plexus of lymph vessels and they incorporate the lumbar aortic lymph nodes located dorsal and ventral to the large blood vessels. From this lymph vessel network may arise one to three larger sized lymph vessels or ducts ("lumbar trunks") which may branch and join again and form collaterals (Fig. 7). One of these lumbar ducts are usually found on the left dorso-lateral side of the aorta, and as it widens gradually it continues anteriorly as the “cisterna chyli.” Another "lumbar duct" may be found on the right lateral side of the posterior vena cava. This duct turns usually dorso-cranially to the posterior vena cava and it joins eventually the left lumbar duct a few centimeters posterior to the left renal artery. Sometimes, a third “lumbar duct” may be identified along the right ventro-lateral border of the abdominal aorta, as being the “ventral branch” of the right lumbar duct. This duct terminates into the large visceral lymph trunks which are formed by the confluence of the coeliac and the cranial mesenteric lymph trunks. This common lymph trunk takes a sharp turn dorsally through a slit (space) found between the diverting abdominal aorta and the posterior vena cava to enter the cisterna chyli (Fig. 7 and 9).

Some of the efferents of the common iliac lymphocenter, namely these of the lateral iliac lymph nodes course anteriorly to the phrenico-abdominal lymph nodes (Fig. 7 and 9), which they may enter or by-pass to terminate into the renal or the lumbar aortic lymph nodes, or they may terminate into the cisterna chyli.

The cisterna chyli (Fig. 7) represents a very irregularly shaped and greatly enlarged and bulged common lymph trunk.
for the visceral and the lumbar lymph vessels. It is situated mainly along the left dorso-lateral border of the abdominal aorta, extending from a few centimeters posterior to the renal artery up to the aortic hiatus. The largest diameters estimated on the lymph filled posterior part of the cisterna chyli varied from 0.25 cm. up to 1.25 cm. The cisterna chyli continues anteriorly through the diaphragm into the thoracic cavity as the "thoracic duct." The course of the latter duct and its relationship to the large blood vessels including the variations of termination into the left brachiocephalic vein (vena anonyma) will be described in an article to follow.

f. The lumbar lymphocenter (lumbar aortic, renal and phrenico-abdominal lymph nodes) and their remaining afferents will be included in a publication in preparation about the coeliac and the cranial and caudal mesenteric lymphocenters of the abdominal cavity.

V. DISCUSSION AND SUMMARY

The findings reported in this study on living (anesthetized) swine on the directions of the lymph flow in the abdominal and the pelvic wall and the pelvic limb with "Evans-Blue" (T-1824)* are in basic agreement with the results achieved on the non-living animals by other investigators.

The common iliac lymphocenter appears to be the main area of confluence of the lymph vessels of the posterior portion of the body. It receives afferents from the sacral, the subiliac, the superficial inguinal (supramammary) and the popliteal lymphocenters. The subiliac and the superficial inguinal (supramammary) lymphocenters are confined mainly to the drainage of the skin and the subcutis. Furthermore, in the female, the supramammary lymphocenter receives lymph vessels from all but the first two (anterior) mammary glands.

The lymph nodes of the sacral and the popliteal lymphocenters are relatively small and inconsistent. The afferent lymph vessels of these lymphocenters represent often only one of the several routes taken from the lymph drainage area. The medial iliac lymph nodes receive lymph vessels from all the deep structures of the pelvic limb, which includes the muscles, the tendons, the ligaments, the joint capsules and the connective tissue sheets. These lymph vessels follow mainly the course of the branches of the femoral and the deep femoral vessels and continue along the external iliac artery and vein to the medial and the lateral iliac lymph nodes.

The deep inguinal lymphocenter is found to be absent in swine. In man, the horse, and occasionally also in the cow and the dog the latter lymphocenter is found in association with the femoral vessels, distal to the origin of the deep femoral vein and artery.

REFERENCES


* T-1824 ("Evans-Blue") ; Allied Chemical Co., New York, New York.