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An anatomical study of the lymphatic drainage of the gallbladder

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Summary. Based upon the detailed dissections of the lymphatic system of four adult cadavers, the lymphatic drainage of the gallbladder was divided into three pathways. 1) The cholecysto-retropancreatic pathway, which can be regarded as the main pathway, had two routes, one running spirally and posteriorly from the anterior surface of the common bile duct to the right, and the other running almost straight down from the posterior surface of the common bile duct. At the retroportal segment, these routes converged at a large lymph node, which appeared critical as the main terminal lymph node of this pathway. We designated this node the principal retroportal node. 2) The cholecysto-celiac pathway was the route by which some of the lymphatics from the gallbladder ran to the left through the hepatoduodenal ligament to reach the celiac nodes. 3) The cholecysto-mesenteric pathway was the route by which some of the lymphatics ran to the left in front of the portal vein and connected with the nodes at the superior mesenteric root. These three pathways converged with the abdomino-aortic lymph nodes near the left renal vein; in particular, the nodes in the interaortico-caval space were considered important.

Une étude anatomique du drainage lymphatique de la vésicule biliaire

Résumé. A partir de la dissection fine des lymphatiques de la vésicule effectuée sur 4 sujets adultes, trois voies de drainages ont pu être schématisées. 1) La voie cholécysto-rétro pancréatique qui peut être considérée comme la principale, comporte deux trajets, l'un descendant en spirale de la face antérieure de la voie biliaire principale vers son bord postéro-droit, et l'autre descendant directement à la face postérieure du conduit biliaire. Dans leur segment rétroportal, ces voies convergent vers un important nœud lymphatique qui apparaît comme le principal nœud terminal de cette voie. Nous l'avons dénommé le nœud principal rétroportal. 2) La voie cholécysto-cœliaque est utilisée par quelques lymphatiques de la vésicule biliaire qui se dirigent vers la gauche à travers le ligament hépato-duodénal pour rejoindre les nœuds cœliaques. 3) La voie cholécysto-mésentérique est empruntée par des lymphatiques qui descendent vers la gauche en avant de la veine porte et rejoignant les nœuds situés à l'origine de l'artère mésentérique supérieure. Ces trois voies convergent vers les nœuds lymphatiques abdomino-aortiques situés à proximité de la veine rénale gauche; les nœuds situés dans l'espace inter-aortico-cave seront particulièrement importants.

Key words : Gallbladder — Lymphatic system — Carcinoma — Macroscopic anatomy

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Abbreviations: *Car,* cardia; *Ch,* bile duct; *Dia,* diaphragm; *Dt,* thoracic duct; *duo,* duodenum; *eso,* esophagus; *gre,* celiac ganglion; *grs,* suprarenal gland; *he,* liver; *l,* lumbar vertebrae; *pan,* pancreas; *py,* pylorus; *th,* thoracic vertebra; *tz,* suspensory ligament (Lig of Treitz); *vf,* gall bladder; *ao,* abdominal aorta; *acm,* middle colic a.; *al,* splenic a.; *ams,* superior mesenteric a.; *ard,* right renal a.; *ars,* left renal artery; *at,* testicular a.; *agd,* right gastric a.; *agdu,* gastroduodenal a.; *aged,* right gastroepiploic a.; *ags,* left gastroepiploic a.; *ahc,* common hepatic a.; *ahp,* hepatic artery proper; *apdip,* posterior inferior pancreaticoduodenal a.; *apdsp,* posterior superior pan-

creaticoduodenal a.; *apdsp*, superior posterior pancreaticoduodenal a.; *aphid*, right inferior phrenic a.; *aphis*, left inferior phrenic a.; *rd*, right branch; *rs*, left branch; *tc*, celiac trunk; *tg*, gastrocolic v. (Henle); *vci*, inferior vena cava; *vl*, splenic v.; *vms*, superior mesenteric v.; *vp*, portal v.; *vrd*, right renal v.; *vrs*, left renal v.; *vsrs*, left suprarenal v.; *A*, cystic node; *B*, superior retropancreaticoduodenal node (Rouvière); *C*, node of the foramen of Winslow; *D*, principal retroportal node; *E*, coeliac retropancreatic node (Inoue); *F*, preportal node; *G*, retro-pyloric node (Rouvière); *Ha and Hp*, anterior and posterior common hepatic node; *I*, retroligamentous node (Inoue); *J*, node at the porta hepatis; *K* (Ka, Kd, Ks, Ksp), celiac nodes; *L*, suprapyloric node; *M and N*, celiacomesenteric nodes (Deki); *O*, posterior pancreaticoduodenal nodes; *P*, node at the origin of the inferior pancreaticoduodenal a; *Q*, *R*, *S*, *T*, abdomino-aortic nodes

Abréviations : *Car*, cardia; *Ch*, conduit cholédoque; *Dia*, diaphragme; *Dt*, canal thoracique; *Duo*, duodénum; *Eso*, œsophage; *Gce*, ganglion cœliaque; *Gsr*, ganglion supra-rénal; *He*, foie; *L*, vertèbres lombaires; *Pan*, pancréas; *Py*, pylore; *Th*, vertèbres thoraciques; *Tz*, muscle suspenseur du duodénum (ligaments de Treitz); *Vf*, vésicule biliaire; *Aa*, aorte abdominale; *Acm*, a. colique moyenne; *Al*, a. splénique; *Ams*, a. mésentérique supérieure; *Ard*, a. rénale droite; *Ars*, a. rénale gauche; *At*, a. testiculaire; *Agd*, a. gastrique droite; *Agdu*, a. gastro-duodénale; *Aged*, a. gastro-épiploïque droite; *Ags*, a. gastrique gauche; *Ahc*, a. hépatique commune; *Ahp*, a. hépatique propre; *Apdip*, a. pancréatico-duodénale inférieure et postérieure; *Apds*, a. pancréatico-duodénale supérieure et postérieure; *Aphid*, a. phrénique inférieure droite; *Aphis*, a. phrénique inférieure gauche; *Rd*, rm. droit; *Rs*, rm. gauche ; *Tc*, t. cœliaque; *Tg*, v. gastro-colique (Henlé); *Vci*, v. cave inférieure; *Vi*, v. splénique; *Vms*, v. mésentérique supérieure; *Vp*, v. porte; *Vrd*, v. rénale droite; *Vrs*, v. rénale gauche; *Vsrs*, v. suprarénale gauche; *A*, Ln cystique; *B*, Ln rétro-pancréatico-duodénal supérieur (Rouvière); *C*, Ln du foramen de Winslow; *D*, Ln retroportal principal; *E*, Ln rétro-pancréatico-cœliaque (Inoue); *F*, Ln pré-portal; *G*, Ln rétro-pylorique (Rouvière); *Ha and Hp*, Ln hépatique commun antérieur et postérieur; *I*, Ln rétro-ligamentaire (Inoue); *J*, Ln du hile hépatique; *K*, (Ka, Kd, Ks, Ksp), Lns cœliaques; *L*, Ln suprapylorique; *M and N*, Lns cœliaco-mésentériques (Deki); *O*, Lns pancréatico-duodénaux postérieurs; *P*, Ln de l'origine de l'artère pancréatico-duodénale inférieure; *Q*, *R*, *S*, *T*, Lns abdomino-aortiques

In recent years, various methods of extended radical operations have been performed for digestive cancers. For carcinoma of the gallbladder, large scale lymph node removal combined with partial resection of the liver is the standard procedure [8, 16]. Moreover, pancreaticoduodenectomy is sometimes recommended for advanced cases in order to completely remove the lymph nodes along the superior mesenteric root [8].

Regarding the lymphatic drainage of the gallbladder, excellent studies have been reported by Clermont and others from the end of 19th century [1, 3, 6, 20, 23]. However, these studies were performed by a dye injection method using fetuses, therefore, precise record and analyses of the adult lymphatic system are incomplete.

We analyzed the lymphatic drainage of the gallbladder based on detailled dissections of four adult cadavers. Our purpose was to elucidate the lymphatic pathways extending from the gallbladder to the thoracic duct, as well as their relations to the neighboring organs, blood vessels and autonomic nn., and to provide basic information for more complete treatment of gallbladder cancer.

Materials and methods

Four adult cadavers (three males and one female) were used. According to the macroscopic dissection procedure developed by Deki, Sato and Sato [4, 25], dissection of the lymphatics from the gallbladder to the abdomino-aortic nodes was performed by sequential removal of the related organs.

In a separate related study, the interconnections of the lymph nodes of the area surrounding the gallbladder, the hepatoduodenal ligament and the posterior surface of the head of the pancreas were examined in 46 additional adult cadavers to confirm the findings of the present study.

Results

Specimen 1, No. 1657, male
(Figs. 1-4)

Many lymphatics were found at the left half of the gallbladder and dense lymphatic networks were formed at the neck, but the cystic node was missing. At Calot's triangle, the lymphatic from the gallbladder ran along the cystic a. and v. and anastomosed with the lymphatics from the liver (Figs. 1, 2 and 4).

From the anterior surface of the gallbladder, the collecting lymphatics reached the right margin of the common bile duct, anastomosed with the lymphatics from the porta hepatis, descended spirally to the right rear margin, and terminated at node B. This node was located to the right of the common bile duct in the angle between the first and second portions of the duodenum. Almost all lymphatics from the inferior and posterior surfaces of the gallbladder drained directly to node B. However, some lymphatics reached node B via node C which was located in the front center of the foramen of Winslow (Figs. 1 and 2). The above-mentioned lymphatic route is designated here as the right lymphatic group of the ligament. These lymphatics were connected to the anterior lymphatic group of the ligament which descended from the porta hepatis along the anterior surface of the left half of the hepatoduodenal

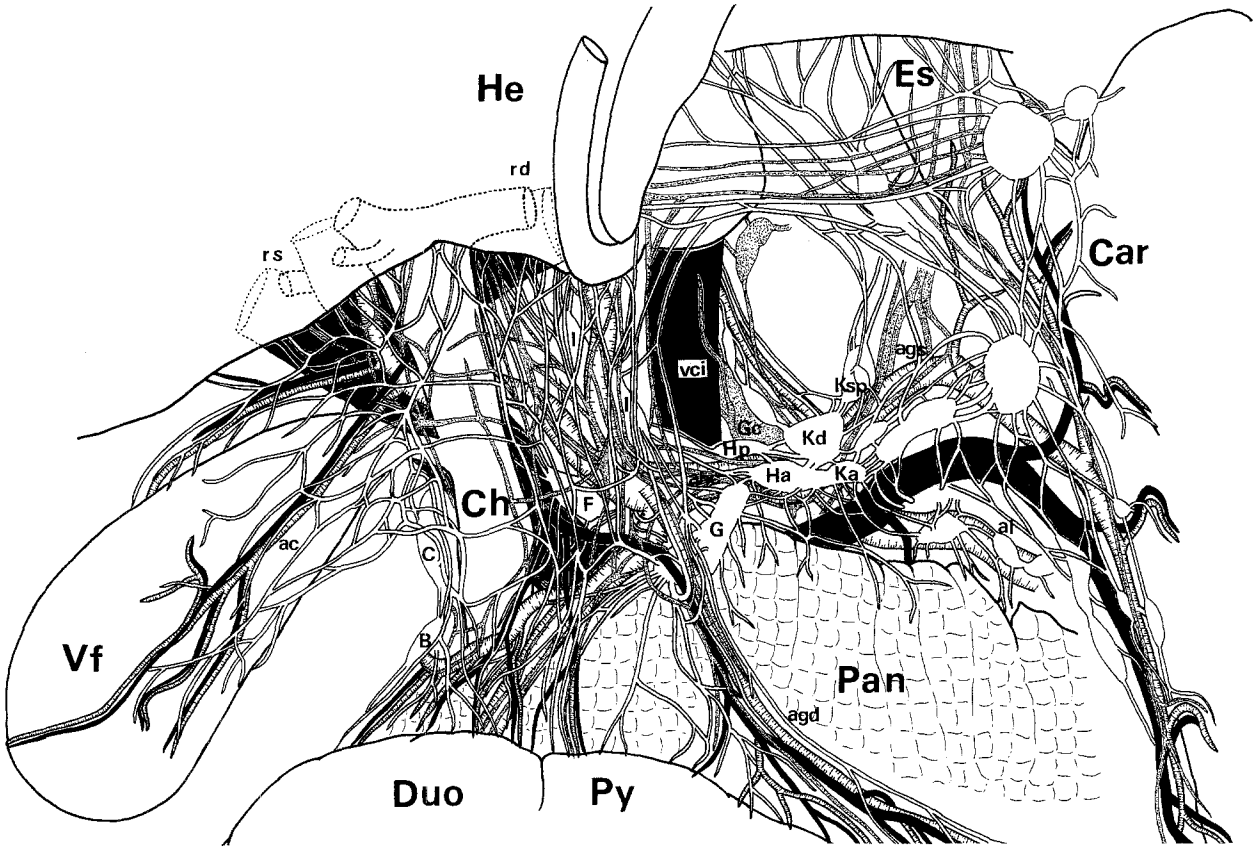


Fig. 1
Anterior view of the lymphatics surrounding the gallbladder in specimen 1
Vue antérieure des lymphatiques entourant la vésicule du spécimen 1

ligament. In this specimen, both groups were more independent than in the other specimens (Fig. 1).

Node D, a large lymph node at the superior border of the head of the pancreas behind the portal v., received the lymphatics of the right lymphatic group. This node was connected with node Kd at the right side of the celiac trunk via node Hp behind the common hepatic a. Node D also connected to the lymphatics along the proper hepatic a. (left lymphatic group of the ligament) and to the lymphatics behind the portal v. (posterior lymphatic group of the ligament) (Fig. 2).

Node E was located below and adjacent to node D, behind the nerve plexus at the head of the pancreas [29]. Node E received some efferent vessels of node B and node P which was located at the superior mesenteric root in the superficial layer of the nerve plexus at the head of the pancreas and the ligament of Treitz (Figs. 2 and 4). The route from the right lymphatic group to the retropancreatic lymphatic group, the cholecysto-retropancreatic pathway can be considered the main pathway of lymphatic drainage of the gallbladder.

At the posterior surface of the hepatoduodenal ligament, the posterior hepatic plexus diverged from the celiac plexus and ran diagonally to the upper right and fanned out behind the portal vein and the bile duct. Part of the right lymphatic group, after crossing the posterior hepatic plexus, anastomosed with node F located between the proper hepatic a. and the common bile duct. The lymphatics from Calot's triangle passed to the left along the right hepatic a. and behind the common bile duct, connected with node F, and anastomosed with the lymphatics from the right lobe of the liver (internal lymphatic group of the ligament) (Figs. 2 and 4). The efferent vessels of node F, partly connecting with nodes G and I, ran to the left behind the gastroduodenal a. and linked with nodes M and N located at the origin of the superior mesenteric a. Nodes M and N received lymphatics from the mesentery and united with the nodes around the celiac trunk. This lymphatic pathway can

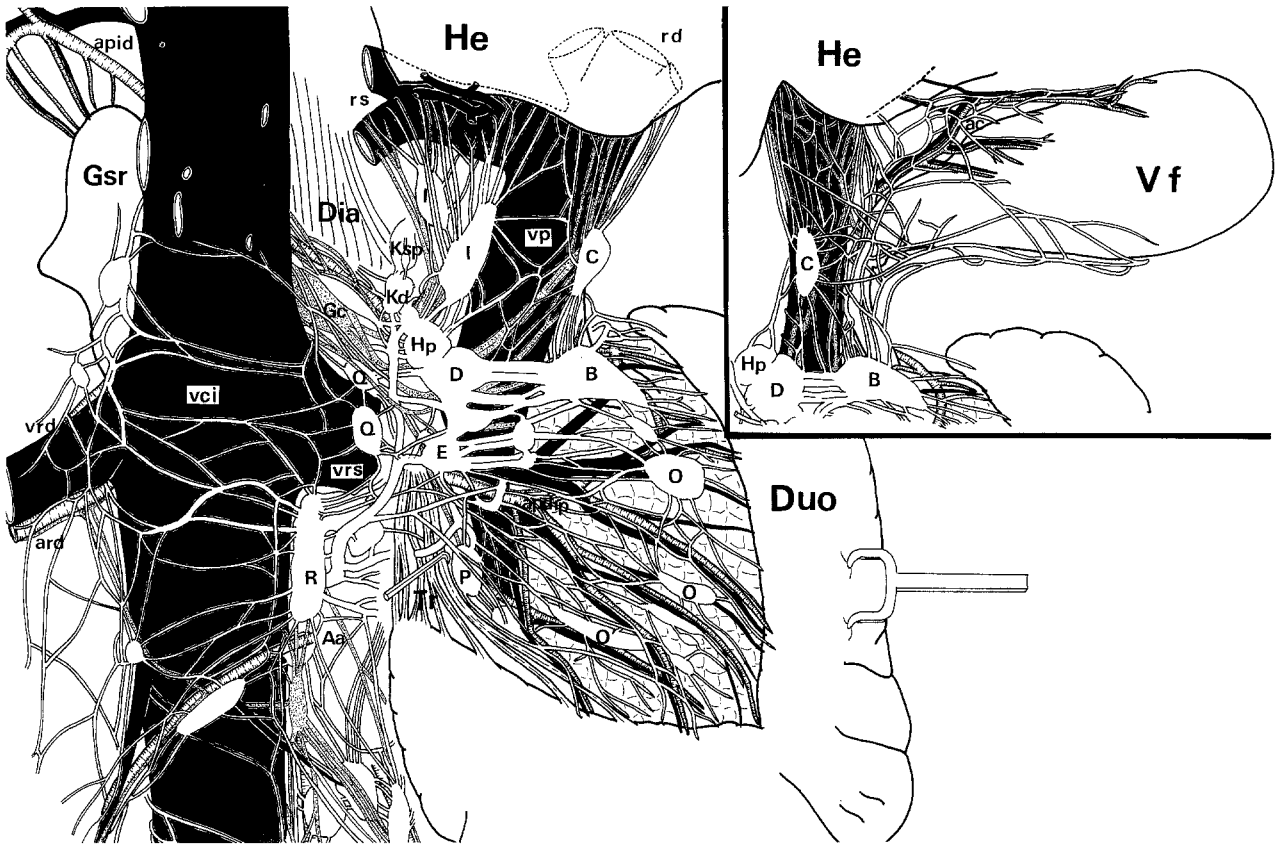


Fig. 2
Posterior view of the lymphatics surrounding the gallbladder in specimen 1. Insert: oblique posterior view
Vue postérieure des lymphatiques entourant la vésicule du spécimen 2. Encadré : Vue oblique postérieure

be considered as one of the lymphatic passages of the gallbladder, designated here as the cholecysto-mesenteric pathway (Figs. 1, 3 and 4).

The efferent vessels of node D linked with nodes Q and R, (primarily R), which were located above and below the left renal vein. The efferent vessels of node M connected to node D; node N drained into nodes S and T on the left margin of the aorta (Figs. 2 and 4).

Specimen 2, No. 1600, Male
(Figs. 5-8)

Well-developed lymphatic networks were found at the neck of the gallbladder and the cystic node was missing. The collecting trunks from the anterior surface of the gallbladder drained into node D after spiralling to the right rear, and the lymphatics from the posterior surface descended vertically and directly drained into node D (the cholecysto-retropancreatic pathway). Nodes B and C, which were found in specimen 1, were missing. Nodes D, E, and Hp were united, forming a large oblong node (Figs. 5 and 6). The lymphatics crossing the posterior hepatic plexus and some lymph vessels of the right lymphatic group connected with the internal lymphatic group which ran to the left and reached nodes M and N (the cholecysto-mesenteric pathway (Figs. 7 and 8).

Unlike specimen 1, some lymphatics of the right lymphatic group ran to the left through the hepatoduodenal ligament and reached node G at the bifurcation of the common hepatic a. The efferent lymphatics from node G joined node Ha located along the common hepatic a. The lymphatics running from Calot's triangle connected with node I via the internal lymphatic group, and nodes I and Ha united to form a large elongated node. The lymphatics from this elongated node converged at the celiac nodes (Figs. 5 and 7), forming the cholecysto-celiac pathway.

The efferent vessels of node D formed thick lymphatics and connected with nodes R and R′, and some of the lymphatics linked with node Q or Q′ deep to the right celiac ganglion. Node M was connected to node D. After anastomosing with the celiac nodes,

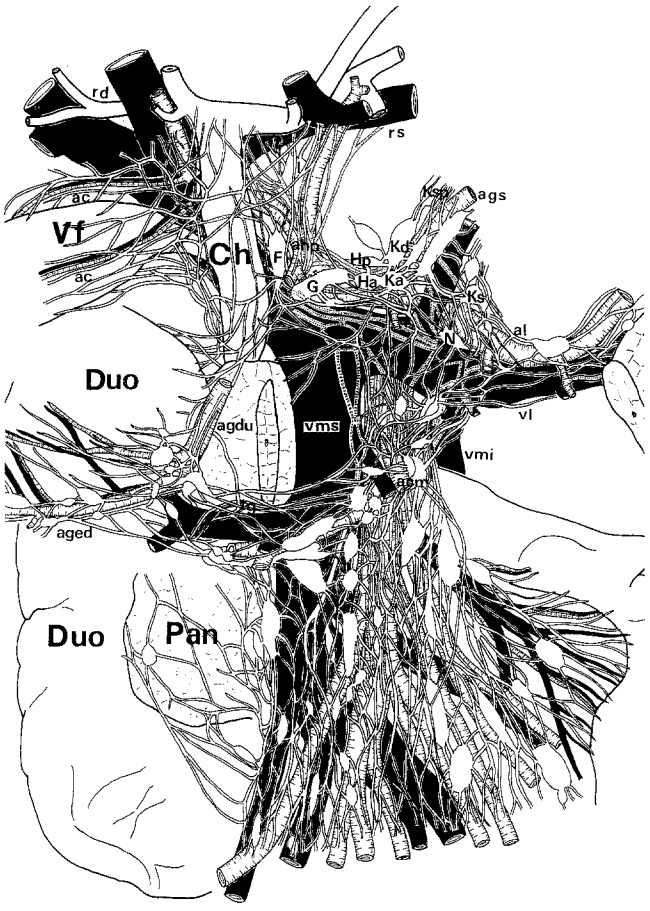


Fig. 3
Communication of the lymphatics from the gallbladder and the lymphatics surrounding the origins of the celiac trunk and the superior mesenteric a. after removal of most of the pancreas in specimen 1

Anastomose entre les lymphatiques de la vésicule et les lymphatiques entourant l'origine du tronc cœliaque et de l'a. mésentérique supérieure après ablation partielle du pancréas sur le spécimen 1

node N connected with nodes S, S′ and T (Figs. 6 and 8).

Specimen 3, No. 1611, male
(Figs. 9-12)

In this specimen, two nodes were found close to the common hepatic duct, one in front (J) and one behind (J′) the duct, although the cystic node was missing. Lymphatics from the gallbladder and the liver united at Calot's triangle and, via node J, connected with the right lymphatic group. The right lymphatic group drained into fused nodes B and D (BD), partly via node C, which was buried in the posterior hepatic plexus, forming the cholecysto-retropancreatic pathway. The efferent vessels of node BD, some of them uniting with node E, connected with node Q (Figs. 9 and 10).

Some lymph vessels of the right lymphatic group ran to the left through the hepatoduodenal ligament and connected with nodes G and Ha (Fig. 9), forming the cholecysto-celiac pathway. Some of the efferent vessels of node C connected with node M via node F, forming the cholecysto-mesenteric pathway (Fig. 12).

Specimen 4, No. 1613, female
(Figs. 13 and 14)

Cystic node (A) was located along the cystic a. at the neck of the gallbladder. Lymphatics on the anterior surface of the gallbladder, some of which passed through node A, reached node B. Some of the lymphatics from the gallbladder linked directly with node D, forming the cholecysto-retropancreatic pathway. Many efferent vessels of node D, some of which passed through node E, reached nodes Q and R. In this specimen, it was difficult to distinguish the internal lymphatic group from the fine nerve fibers.

The afore-mentioned lymphatics from the gallbladder drained into the nodes above and below the left renal v. (nodes Q and R in the interaortico-caval space and nodes S and T located on the left side of the aorta) (Fig. 15). The cholecysto-retropancreatic pathway was predominantly connected to nodes Q and R.

Nodes Q, R, S and T linked with their corresponding nodes Q′, R′, S′ and T′, which were close to the renal a., and united with the lymphatics from the kidneys and with the lymphatics surrounding the abdominal aorta to drain into the thoracic duct behind the aorta.

In a study of the incidence of the lymph nodes surrounding the gallbladder and behind the pancreas using 50 cadavers (including the above-mentioned specimens), node A was observed in 37 cadavers (74%). Nodes B and C were observed in 43 (86%) and 21 (42%) cadavers, respectively. In 5 cadavers (10%), nodes B and C merged, forming an oblong node. Node D was present in all specimens; it existed independently in 26 (52%); in 15 (30%) it united with node B; in 7 (14%) with node E, and in 2 (4%) with both nodes B and E. Node E was found in 48 cadavers (96%) and in 39 (78%) of them it was not fused with any other nodes.

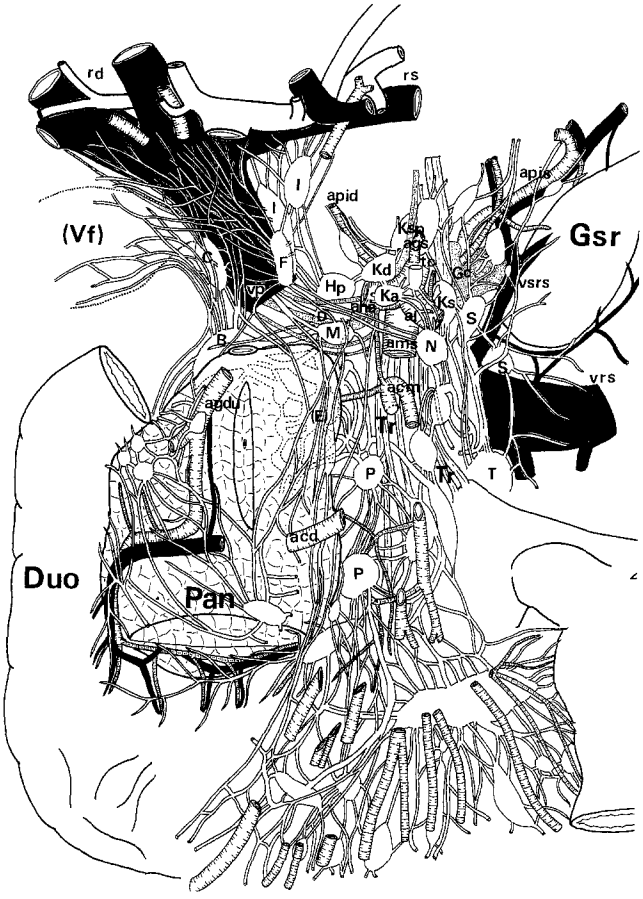


Fig. 4
Deeper dissection of Fig. 3 after removal of the main vessels and the common bile duct. The dotted lines represent the location of the gallbladder

Dissection poussée de la fig. 3 après ablation des vaisseaux principaux et de la voie biliaire principale. Les pointillés correspondent au siège de la vésicule

Discussion

The lymphatics surrounding the gallbladder

Although detailed studies of the lymphatic networks of the gallbladder were reported early in this century by Sudler [28] and Clermont [3], these do not provide enough data necessary for the surgical treatment of cancer.

The cystic node at the neck of the gallbladder has been reported to be rather consistently found, with a frequency of 100% [18], 94% and 89% [22]. Many reports have stated that the lymphatics of the gallbladder converge and drain into the cystic node [1, 20, 23]. Clermont [3] reported that the lymphatics of the gallbladder are in the shape of an « N », and the collecting trunks at the left and the inferior border of the gallbladder gather at the cystic node, while the collecting trunks at the right border run toward the common bile duct.

In the present study, numerous lymphatics were observed to converge and anastomose at the neck of the gallbladder. This does not mean that the entire subserosal lymphatics converged at the cystic node, but, more appropriately it should be considered that this lymph node received lymphatics primarily from the anterior surface of the gallbladder. The cystic node was present in only one of four cadavers, however, in an analysis of incidence, it was present in 37 of 50 cases (74%). This frequency was relatively lower thant that of previous reports [19, 24]. At Calot's triangle, the subserosal lymphatic network and the lymphatics from the liver were densely connected with each other.

The pathway from the gallbladder to the hepatoduodenal ligament

The lymphatics surrounding the gallbladder extend to the hepatoduodenal ligament. In the famous textbook of Rouvière [22], Quénu suggested that the lymphatics from the gallbladder link with the lymph nodes at the porta hepatis. A recently published anatomical textbook has taken the same view [7]. However, Clermont [3] denied the existence of these nodes as well as their relationships to the lympathics of the gallbladder. The lymph nodes at the porta hepatis were confirmed by Hardy et al [9], Nagai et al [17] and Sato and Sato [25]. This was also confirmed in the present study and lymph nodes J and J′ were connected with the lymphatics from the gallbladder in specimen 4. However, this is not a primary pathway.

Two different pathways for the lymphatic drainage of the gallbladder in the hepatoduodenal ligament are known; one runs along the common bile duct to the posterior surface of the head of the pancreas, and the other to the left through the hepatoduodenal ligament. Clermont [3] reported the existence of the former but not the latter; Poirier and Charpy [20], Rouvière [22] and Sato and Sato [25] confirmed his findings. This view is now widely accepted. However, Bartels [1] and

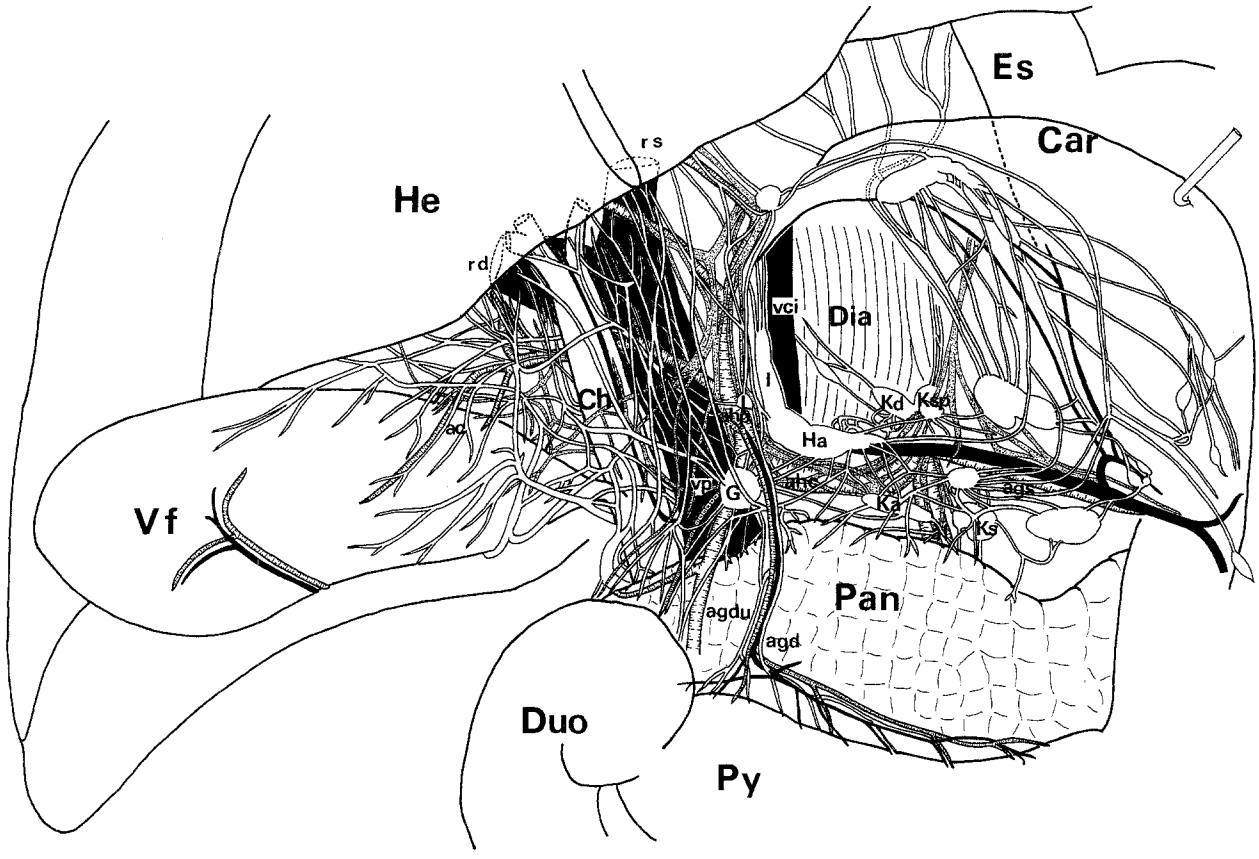


Fig. 5
Anterior view in specimen 2
Vue antérieure du spécimen 2

Sappey [23] reported the existence of only the latter pathway, and Franke [6], Kutuna [13] and Senba [26] suggested the former pathway as primary.

In order to discuss the lymphatic pathways from the gallbladder, the lymphatic routes in the hepatoduodenal ligament can be classified into the following five groups:

1) *Right lymphatic group of the ligament:* This is the route which runs along the common bile duct. From the anterior surface of the gallbladder, the collecting trunks run to the front of the common bile duct and spiral posteriorly to the right terminating at nodes B and D. However, the collecting trunks from the inferior and posterior surfaces tend to directly descend, terminating at nodes B and D.

Node B lies at the angle formed by the first and second portions of the duodenum at the right side of the common bile duct. Node B is typically considered to belong to the retropancreatic lymphatic group. Since numerous lymphatics from the hepatobiliary system converge at node B, it should also be considered to be a critical node of this system, although in specimen 2, this node was not present and the lymphatics drained directly into node D. This node has been called various names, such as the superior pancreatoduodenal node [5], Lgl. paracholedochus [11], and the superior retropancreaticoduodenal node [22].

Node C is typically located along the right rear of the hepatoduodenal ligament on the free border of the foramen of Winslow. In specimens 1 and 4, part of the right lymphatic group of the ligament passed through this node. Clermont [3] and Rouvière [22] reported that this node is consistently present, and designated it the node of the foramen of Winslow (the node of the hiatus); while Inoue [11] named node C, Lgl. paracystica and confirmed it only in one of 104 fetuses. Sato and Sato [25], and Hidden and Hureau [10] suggested that node B corresponds to the node of the hiatus. Nodes B and C are generally identified by retropancreaticoduodenal mobilization (Kocher's maneuver), and fetuses have

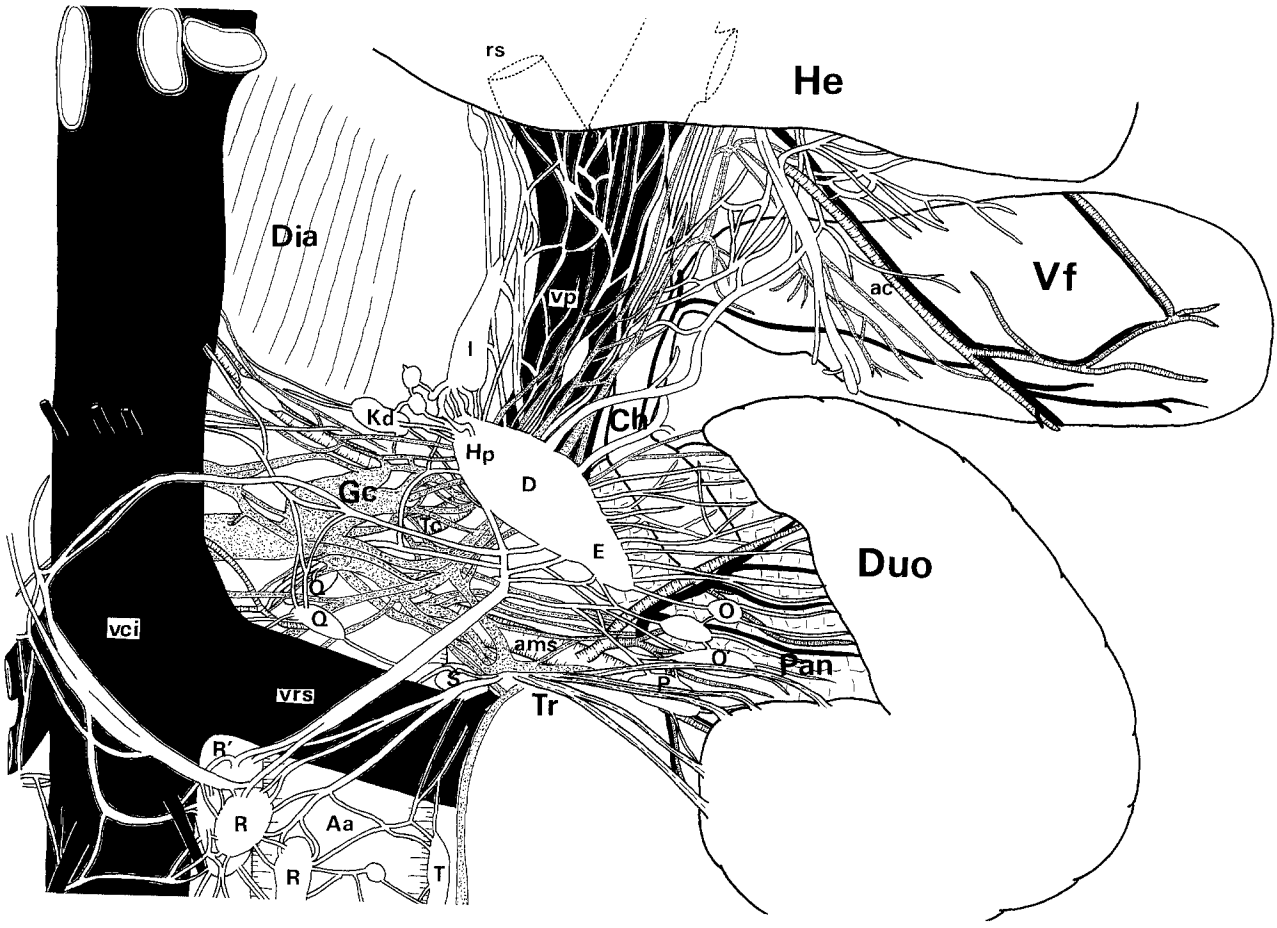


Fig. 6
Posterior view in specimen 2

Vue postérieure du spécimen 2

been typically used as the material for the studies. Consequently, an inaccurate understanding of the topographical relationships led to the discrepancies as mentioned above. Here node B was present in 43 cases (86%), and node C in 21 (42%), out of 50. Nodes B and C occasionally were conglutinous (10%). Interestingly, Fahim et al [5], after confirming the existence of both nodes, suggested that these nodes belong to the pericholedochal node group.

The lymphatic system in general is situated superficial to the nerve plexus. However, in the pathway running along the cystic a. at Calot's triangle to the rear of the common hepatic duct, the lymphatics lie deeper than the nerves originating from the anterior hepatic plexus [27]. Behind the hepatoduodenal ligament, some of the right lymphatic group run to the front of the portal v., crossing the posterior hepatic plexus. In specimen 4, node C was located within the nerve plexus.

2) *Anterior lymphatic group of the ligament:* This is the route which runs along the proper hepatic artery close to the left anterior surface of the hepatoduodenal ligament. This group receives lymphatics from the porta hepatis, the first portion of the duodenum and the supplying area of the right gastric a. In specimens 2 and 4, the suprapyloric node (L) was located along the right gastric a. As this group also communicates with node G or Ha, it appears that it is related to the nodes close to the common hepatic a. Fahim et al [5] and Clermont [3] reported that this group does not have connections with the right lymphatic group. However, in specimens 2 and 3, the lymphatics from the right lymphatic group were found to directly link to the anterior lymphatic group. In the other specimens, the two groups had close anastomoses.

3) *Internal lymphatic group of the ligament:* This is the route in which the lymphatics from the hepatobiliary system run in front of the portal v. and to the left. In specimens 1 and 4, node F was located at the front of the portal v. This group is located deep to the anterior group and is not easily accessible, therefore, few detailed examinations have been reported. This group is composed of the lymphatics extending from Calot's triangle to the back of the common hepatic duct, the lymphatics crossing the posterior hepatic plexus and the lymphatics running from node C. This group continues to the left and reaches the origin of the celiac trunk and the superior mesenteric a.

4) *Left lymphatic group of the ligament:* This route extends from the porta hepatis to the nodes along the common hepatic a. via node I, which lies at the left rear of the proper hepatic a. This group has been called the ascending segment of the hepatic chain [22], or Lgl. retroligamentosae [11]. Node I connects with node F and a part of the internal group.

5) *Posterior lymphatic group of the ligament:* This is the route which runs from the porta hepatis and extends to the retroportal node (D).

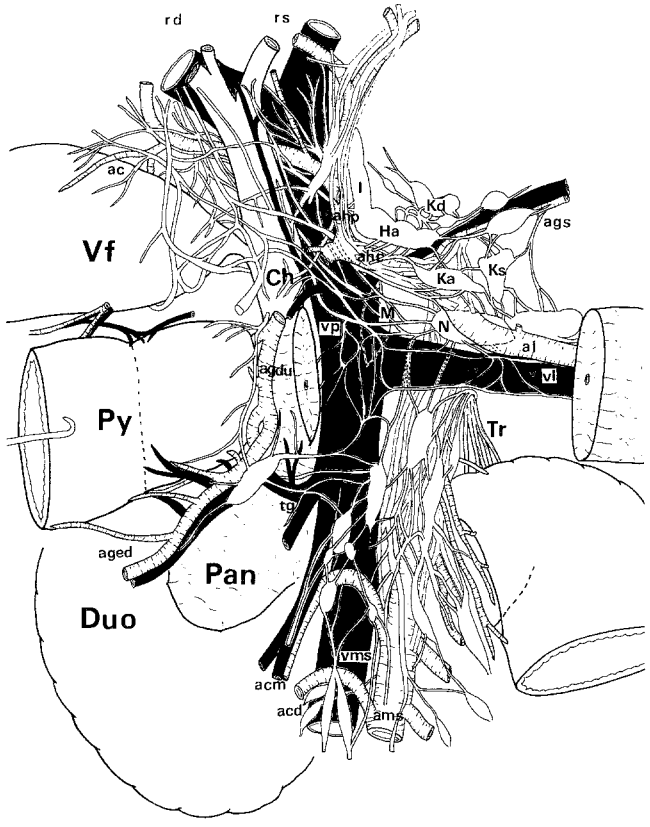


Fig. 7

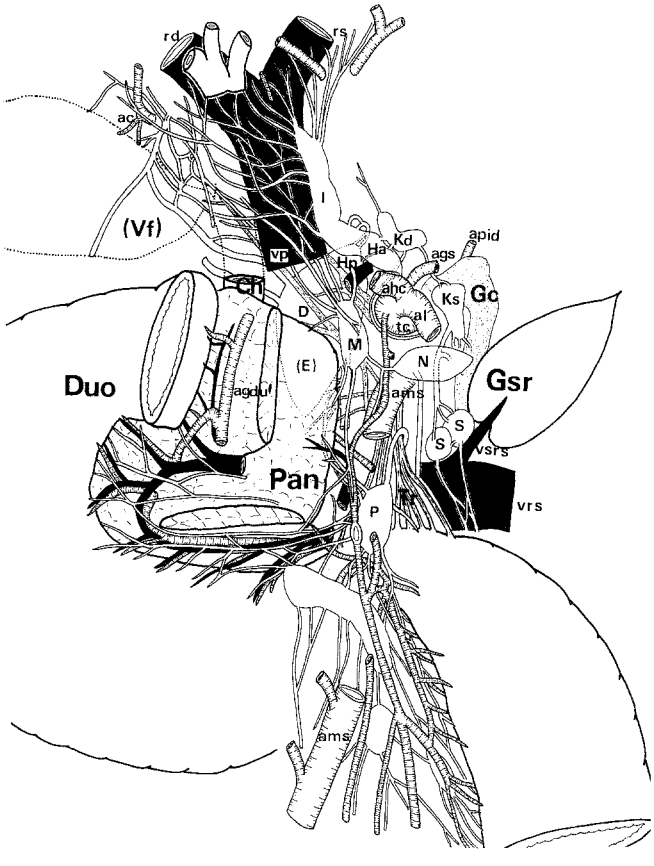


Fig. 8

Figs. 7-8
7 Lymphatics surrounding the origins of the celiac trunk and the superior mesenteric a. in specimen 2 **8** Deeper dissection of Fig. 7

7 Lymphatiques entourant l'origine du tronc cœliaque et de l'a. mésentérique supérieure sur le spécimen 2 **8** Dissection poussée de la fig. 7

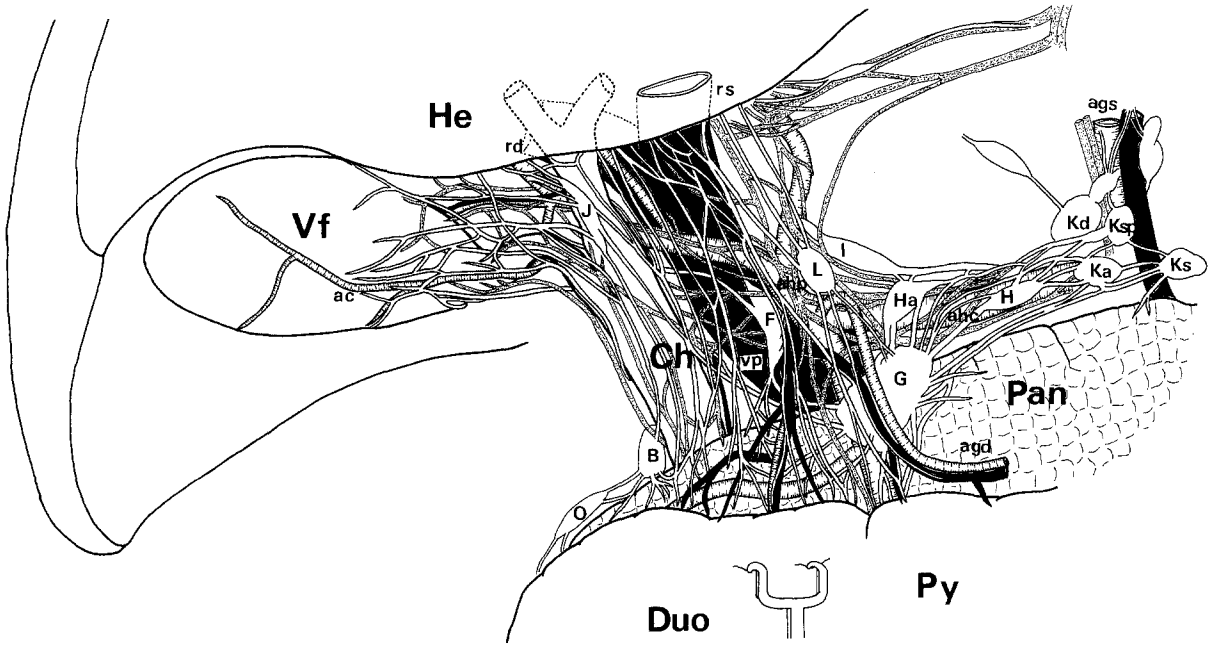


Fig. 9
Anterior view in specimen 3

Vue antérieure du spécimen 3

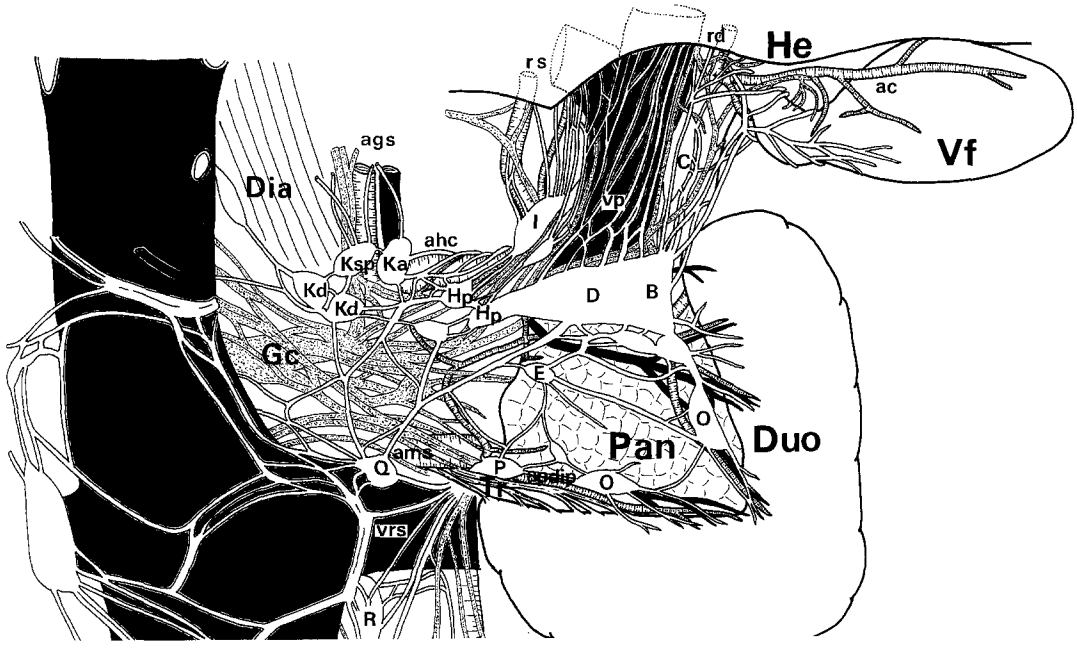


Fig. 10
Posterior view in specimen 3

Vue postérieure du spécimen 3

Based on the findings of the present study, the lymphatics of the gallbladder can be classified into three pathways:

1. Cholecysto-retropancreatic pathway, descends from the right lymphatic group of the ligament to the posterior surface of the head of the pancreas (Fig. 16 a).

2. Cholecysto-celiac pathway, runs to the left through the hepatoduodenal ligament and reaches the common hepatic a. and the celiac trunk (Fig. 16 b). The right, left and internal lymphatic groups are included in this pathway.

3. Cholecysto-mesenteric pathway descends from the internal lymphatic group of the ligament to the origin of the superior mesenteric a. behind the pancreas (Fig. 16 c).

The cholecysto-retropancreatic pathway can be regarded as the main pathway of the lymphatic drainage of the gallbladder as previously reported [3, 6, 13, 22, 25, 26]. Embryologically, the primordium of the gallbladder originated in the primitive ventral mesentery, and due to the roll-over of the intestines, it has moved together with the primordium of the liver and the ventral pancreatic bud to the left and back of the dorsal pancreatic bud. Consequently, the bile duct passes to the rear of the duodenum [14]. These facts are coherent with the characteristics of the cholecysto-retropancreatic pathway and afford a basis for the description as the main pathway of the lymphatic drainage of the gallbladder. The cholecysto-celiac and cholecysto-mesenteric pathways can be regarded as the accessory pathways, although the latter has not been suggested as such in previous reports [6, 13, 26].

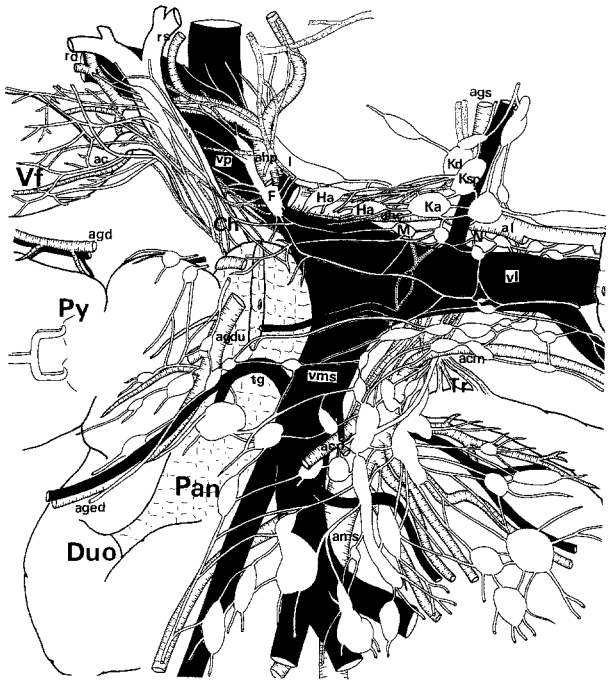


Fig. 11
Lymphatics surrounding the origins of the celiac trunk and the superior mesenteric a. in specimen 3

Lymphatiques entourant l'origine du tronc cœliaque et de l'a. mésentérique supérieure sur le spécimen 3

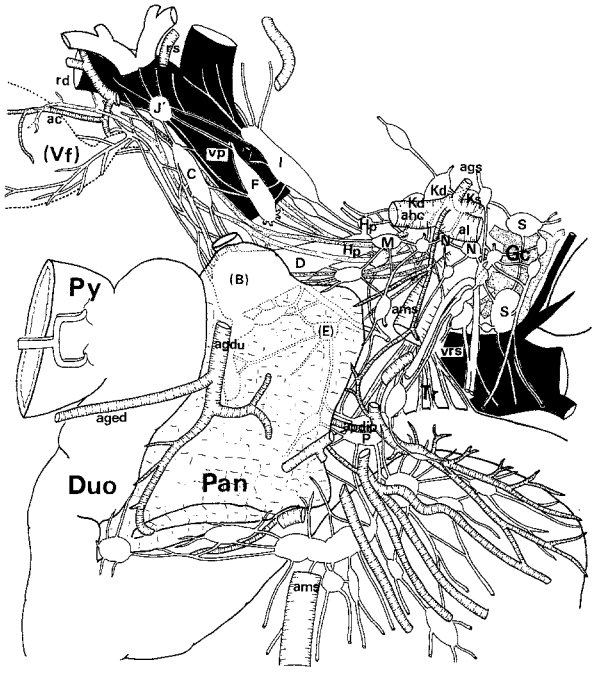


Fig. 12
Deeper dissection of Fig. 11

Dissection poussée de la fig. 11

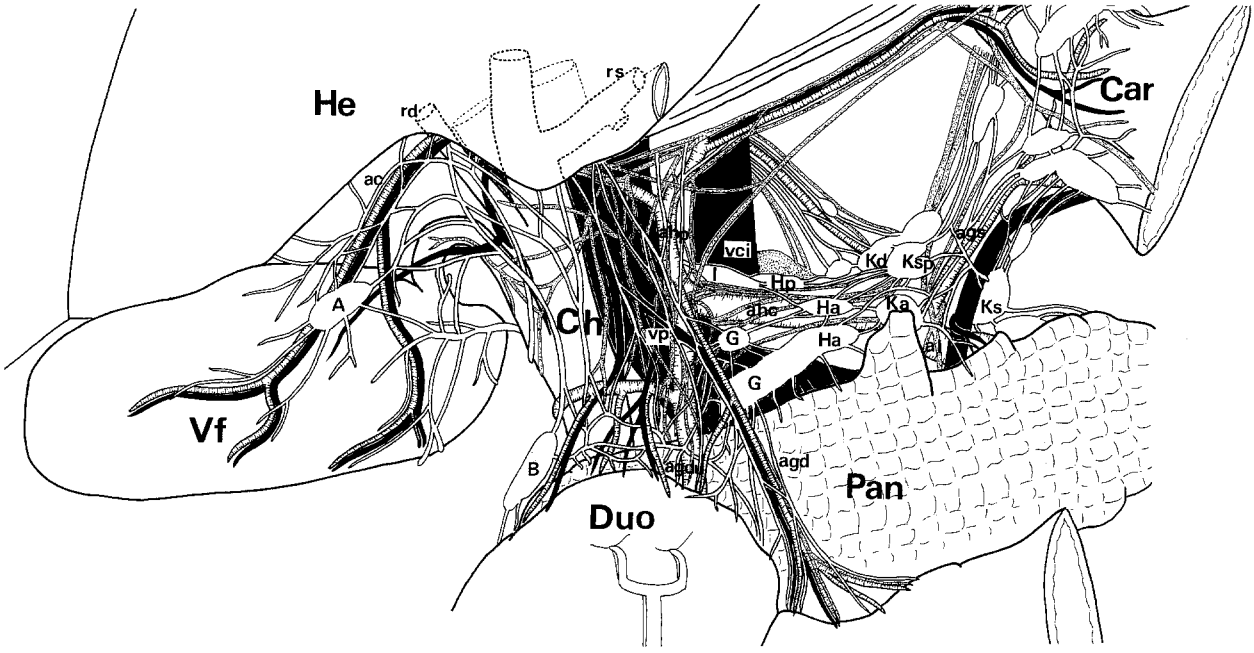


Fig. 13
Anterior view in specimen 4

Vue antérieure du spécimen 4

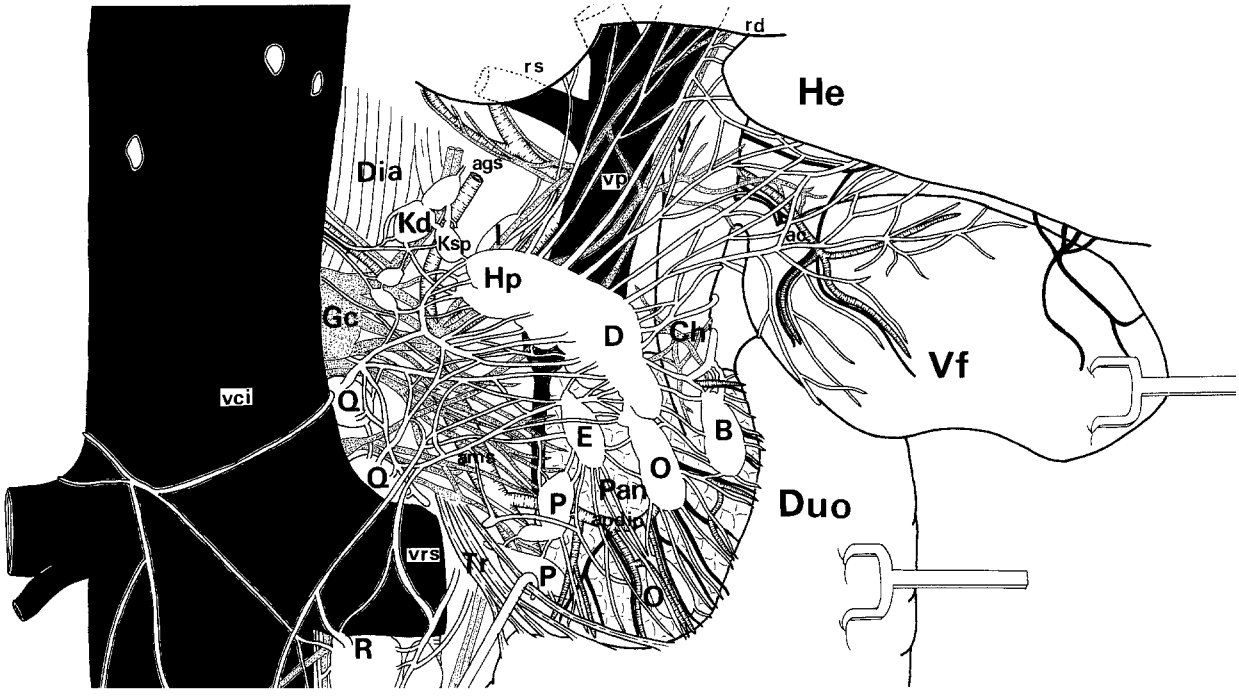


Fig. 14
Posterior view in specimen 4

Vue postérieure du spécimen 4

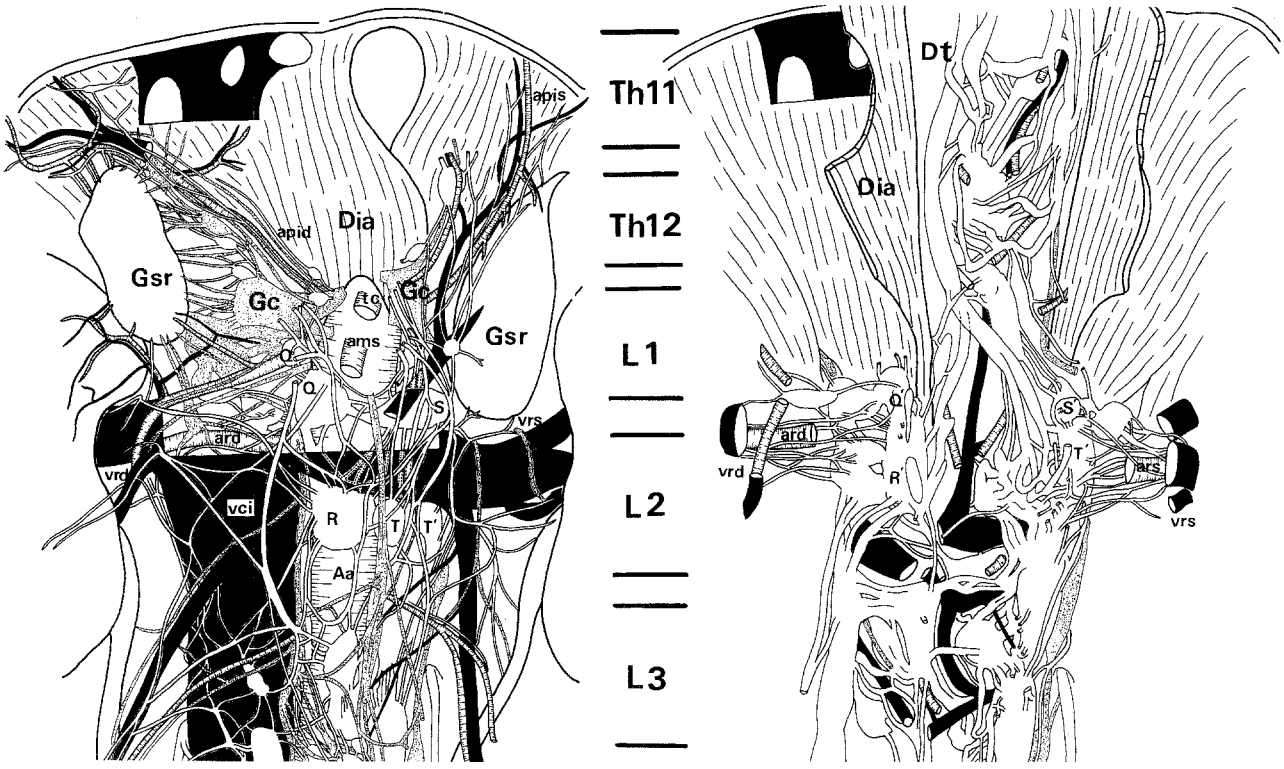


Fig. 15
Left Lymphatics surrounding the abdominal-aorta after removal of the digestive organs **Right** Lymphatics surrounding the abdominal-aorta and forming the thoracic duct after removal of the aorta and the inferior vena cava (specimen 4)

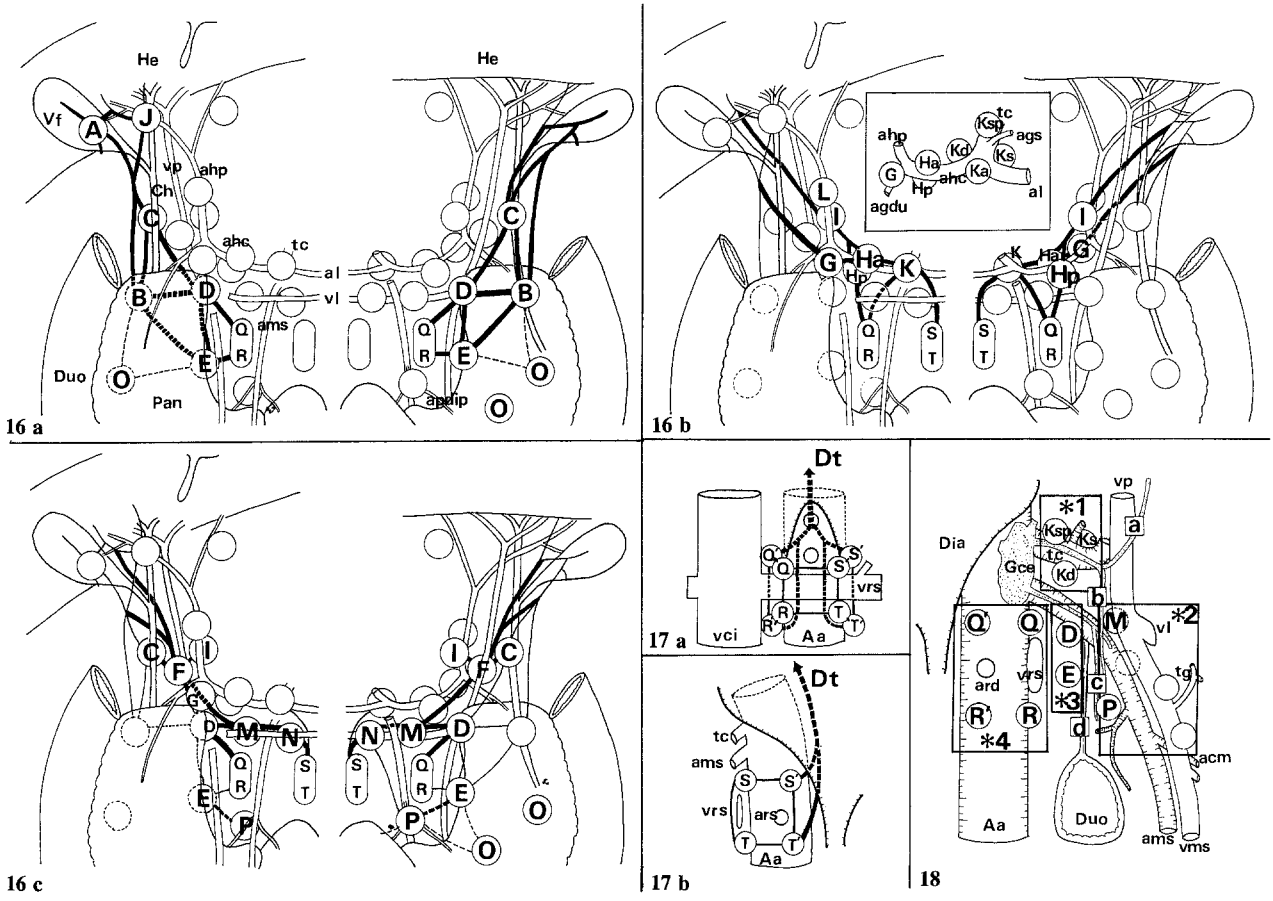
A gauche, lymphatiques entourant l'aorte abdominale après ablation des viscères **A droite,** lymphatiques entourant l'aorte abdominale et origine du canal thoracique après ablation de l'aorte et de la veine cave inférieure (spécimen 4)

The lymphatic system of the posterior surface of the head of the pancreas in the cholecysto-retropancreatic pathway (Fig. 16 a)

The main nodes of this pathway are three retropancreatic nodes: B, D and E. Node B has been previously discussed. Node D is a large node located behind the portal v. at the upper edge of the head of the pancreas (retroportal segment) [2]. This node was present in all four specimens, but in two it was fused with adjacent nodes. This node links with the efferent vessels of nodes B and C and receives lymphatics directly from the gallbladder. Further, this node is united with the retropancreatic lymphatic group and connected with the celiac node (Kd) via node Hp.

Node D is of particular importance as the terminal visceral lymph node of the cholecysto-retropancreatic pathway. In many reports, node D was simply described as one of the posterior pancreaticoduodenal nodes [1, 13, 26]. On the other hand, since nodes D, Hp and Kd send efferent vessels to the parietal lymph nodes, some reports have suggested that these three belong to the same group, Lgl. coeliacae dextrae [11], or the horizontal segment of the hepatic lymph chain [22]. However, due to the topographical significance of node D, the authors consider it as an independent node and have named it the principal retroportal node. The efferent lymphatics link with nodes Q and R, located between the aorta and the inferior vena cava.

Node E, which is located at the retromesenteric segment [2] just below node D, is closely connected with node D and receives the efferent lymphatics of retropancreatic nodes B, O and P. In the present study, node E existed independently in 39 out of 50 adult cadavers (78%), and was fused with node D in 8 (16%). Deki and Sato [4] classified the lymphatic drainage routes from the posterior surface of the head of the pancreas as the upper, middle and lower transverse routes, and the longitudinal route. Node E is considered to be the lymph node located at the crossing point of the middle transverse route and the longitudinal route. There has only been one report which has labelled node E as Lgl. coeliacae retropancreaticae [11]. This node is very important considering the relationship between the lymphatic



Figs. 16-18

16 a-c Schematic drawings of the lymphatic drainage of the gallbladder **a** Cholecysto-retropancreatic pathway **b** Cholecysto-celiac pathway **c** Cholecysto-mesenteric pathway **17 a, b** Schematic drawings showing the relation of the abdomino-aortic nodes immediate to the renal vessels and the formation of the thoracic duct **a** viewed from the front **b** viewed from the left **18** Schematic drawing viewed from the right, showing the depth relationships of the lymph nodes with special reference to the surrounding structures **a** Posterior hepatic plexus **b** First part of the nerve plexus of the head of the pancreas (Yoshioka and Wakabayashi, 1958) **c** Second part of the nerve plexus of the head of the pancreas (Yoshioka and Wakabayashi) **d** Ligament of Treitz (suspensory m. proper) *1* Celiac nodes *2* Nodes of the superior mesenteric root *3* Retropancreatic nodes *4* Abdomino-aortic nodes

16 a-c Représentation schématique des drainages lymphatiques, de la vésicule **a** voie cholécysto-rétropancréatique **b** voie cholécysto-cœliaque **c** voie cholécysto-mésentérique **17 a, b** Représentation schématique des rapports entre les lymphonœuds aortiques et abdominaux juxtarénaux et l'origine du canal thoracique **a** vue antérieure **b** vue du côté gauche **18** Représentation schématique, vue du côté droit, des rapports entre les nœuds lymphatiques et les structures de voisinage **a** Plexus hépatique postérieur **b** Première partie du plexus nerveux de la tête du pancréas (Yoshioka et Wakabayashi, 1958) **c** Deuxième partie du plexus nerveux de la tête du pancréas (Yoshioka et Wakabayashi) **d** M. suspenseur du duodénum (ligament de Treitz) *1* nœuds cœliaques *2* nœuds de l'origine de l'a. mésentérique supérieure *3* nœuds rétropancréatiques *4* nœuds abdomino-artiques

system of the gallbladder and the nodes along the superior mesenteric root, which will be discussed later.

Nodes O and O′ are called posterior pancreaticoduodenal nodes [11, 22, 24], or ganglion retropancreatique [20] and usually lie along the arcade of the posterior pancreaticoduodenal arteries. These nodes are generally believed to belong to the lymphatic group of the duodenum and the pancreas. But the upper of these nodes appear to be bile juice color, and thus these nodes are considered to have critical relationships with the gallbladder [11, 18].

The lymphatic systems along the common hepatic artery and the celiac trunk in the cholecysto-celiac pathway (Fig. 16 b)

The lymphatic systems along the celiac trunk and its three main branches are variously termed. For the celiac nodes, some reports include all the lymph nodes located from the celiac trunk to the divergence points of the three main branches [11, 13, 21] and others limit the description to the nodes lying along the celiac trunk [24, 26]. Here the celiac nodes are classified into four groups: 1. Node Kd, located at the origin of the common hepatic a. along the right side of the celiac trunk. 2. Node Ks, located at the origin of the splenic a. along the left side of the celiac trunk. 3. Node Ka, at the bifurcation of the celiac trunk into the common hepatic a. and the splenic a. 4. Node Ksp, at the origin of the left gastric a. These nodes are intricately fused and occasionally difficult to distinguish.

The lymphatic routes along the common hepatic a. are divided into two groups. The anterior common hepatic group follows the course from nodes G and Ha to celiac nodes Kd and Ka. Node G is located at the origin of the gastroduodenal a. and has been termed the supraduodenal node [24] or the retropyloric node [22]. This node unites with the lymphatics from the anterior and the internal lymphatic groups of the ligament as well as with the subpyloric nodes. Node Ha is located in front of the common hepatic a. The cholecysto-celiac pathway connects with the celiac nodes via G and Ha. The posterior common hepatic group indicates the route from the principal retroportal node to node Kd via node Hp, which is located at the rear of the common hepatic artery. This group is important as the terminal visceral lymph group, which connects to the parietal lymph nodes Q and R.

The lymphatic system along the superior mesenteric root in the cholecysto-mesenteric pathway (Fig. 16 c)

Regarding the mesenteric nodes, previous reports have discussed only up to the level of the lower edge of the pancreas [1, 11, 13, 22], and there have been few reports [4, 19] describing the nodes at the origin of the superior mesenteric a. behind the pancreas.

Topographically, the superior mesenteric root and the posterior surface of the head of the pancreas are close to each other, but the lymphatic systems of both seem to be independent from the embryological viewpoint, as mentioned before. As Pissas [19] reported, the two systems can be divided by the retroportal process of the primitive dorsal mesentery. This process consists of the nerve plexus of the head of the pancreas [29] and the suspensory muscle proper of the ligament of Treitz (m. suspensorius duodeni) [12]. The former is derived from the right celiac ganglion and the superior mesenteric plexus. The latter fans out from the connective tissues surrounding the celiac trunk and the superior mesenteric a., and reaches the duodenum from the duodenojejunal flexure to the center of the third portion of the duodenum. Here, the lymph nodes on the ventral side of the above two systems are defined as the nodes of the superior mesenteric root, located along the trunk of the superior mesenteric root, located along the trunk of the superior mesenteric artery and at the origins of its branches (Fig. 18).

Clinically, the lymph nodes along the superior mesenteric root are resected in extended operation procedures [8, 16]. According to Hanyu et al [8], lymph node metastasis was found in 54 (68%) out of 79 operated gallbladder carcinoma cases. In 12 of these cases (15%) the metastasis was found at the mesenteric root. The pathway from node B to the nodes along the superior mesenteric root via nodes O and O′ has been suggested to be the metastatic route [5, 15].

Concerning the relationships between the gallbladder and the mesenteric nodes, two pathways have been cited. The primary pathway, the cholecysto-mesenteric pathway, includes the internal lymphatic group of the ligament and runs to nodes M and N. These nodes were originally considered to be at the highest point of the superior mesenteric root. But since the origins of the celiac trunk and the superior mesenteric artery are located close together, Deki and Sato [4] named them Ln. celiaco-mesentericus dexter superficialis and Ln. celiaco-mesentericus sinister, respectively. The connection between node M and the principal retroportal node passes through the nerve plexus of the head of the pancreas. Node N anastomoses with the celiac nodes and links with nodes S and T.

The second, and more minor pathway, includes node P which is one of the nodes along the superior mesenteric root and is located behind the origin of the inferior pancreaticoduodenal a.. The efferent lymphatics of node P run cranially and connect with not only nodes M and N but also with node E behind

the nerve plexus of the head of the pancreas beyond the ligament of Treitz. The direction of the lymph flow was not determined here, but it is reasonable to consider that it is from the mesentery to the posterior surface of the head of the pancreas (Figs. 4, 8, 12). In gallbladder cancer, it is thought that the second pathway is developed due to the metastatic diffusion in the lymph nodes.

Abdomino-aortic lymph nodes and the thoracic duct (Figs. 17 a, b)

The pathways from the visceral lymph nodes to the parietal nodes (abdomino-aortic lymph nodes) are classified as two separate pathways. One is the pathway which runs down to the right of the celiaco-mesenteric axis and reaches nodes Q and R (right group), and the other pathway runs down to the left and reaches nodes S and T (left group); these four nodes are in close proximity to the left renal vein. The cholecysto-retropancreatic pathway takes the course of the right group, whereas the cholecysto-celiac pathway and the cholecysto-mesenteric pathway may take either course. Nodes Q, R, S and T correspond to the renal lymphoid aggregation of Rouvière's preaortic group [22]. Nodes Q, R and S, T link with nodes Q′, R′ and S′, T′ in a deeper layer, and join the lymphatics and other abdomino-aortic nodes at the retroaortic space, forming the thoracic duct. Nodes Q′ and R′ correspond to the upper part of inter-aorticovenous nodes, and nodes S′ and T′ correspond to the left latero-aortic nodes [22].

At the level of the origin of the celiac trunk, the aorta is covered by the crura of the diaphragm, and there are no lymphatic paths to the back of the aorta. At the level of the left renal v., the tendon of the crura of the diaphragm is attached to the lumbar vertebra. The lymph vessels from the upper abdominal organs extend downward to this level to reach the back of the aorta. As Deki, Sarrazin et al, and Sato and Sato [4, 24, 25] reported, the abdomino-aortic lymph nodes adjacent to the left renal vein are extremely important as parietal lymph nodes which connect with the lymphatics from the upper abdominal organs.

Conclusion

Based on the detailed dissections of four adult cadavers, the lymphatic drainage of the gallbladder was divided into three pathways: 1) cholecysto-retropancreatic pathway, 2) cholecysto-celiac pathway, and 3) cholecysto-mesenteric pathway. To thoroughly comprehend these pathways, it is necessary to elucidate the overall upper abdominal lymphatic systems including their relations with the blood vessels and the nerves.

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