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Anatomoclinical and anatomosurgical essay on the lymphatic circulation of the pancreas

A Pissas

Centre Hospitalier, Service de Chirurgie Viscérale, 30205 Bagnols sur Cèze Cedex France

To the memory of our Chief and Teacher, Professor Calas, Chirurgien des Hôpitaux

Summary. This essay is based on the injection and dissection of 100 cadaver specimens (fetuses, new borns and infants), the study of 34 case reports of pancreatic carcinoma, the injection of the lymphatic system in 14 living dogs and the reconstruction of the dorsal mesentery of an embryo of 30 mm according to Born's method. The results are as follows : the anatomy of the pancreas and of the lymphatic channels show that there are two distinct portions, one is right-sided and corresponds to the primitive ventral bud, the other is situated on the left and corresponds to the primitive dorsal bud. The primitive dorsal mesentery is formed by a double contingent : one right, for the right pancreas, this is the retroportal process (RPP). The other left, for the left pancreas. This is a formation which up until now, has never been described in the literature, the left lateral portal process (LLPP). While the anterior lymphatic drainage of the pancreas does not seem to hold any surprises, the posterior lymphatic drainage, arising from the posterior and anterior surfaces of the pancreas, is very particular. In the right side (anterior and posterior aspects), the drainage runs to the RPP, while in the left side (anterior and posterior aspects) it courses to the LLPP and here, in an exclusive manner. Only a few borderline regions, those situated precisely in the area of inosculation of the two buds, escape this systematisation. The terminal network of the pancreatic lymphatic channels have a short distance to bridge in order to reach the thoracic duct. The study of the distribution of lymph node metastases in carcinoma of the pancreas seems to confirm the anatomical results in the cadaver, but our series is too short to be of statistical value. Very early spread via the thoracic duct probably greatly reduces the value of supra-enlarged operations whose justification is precisely more complete lymph node removal. It might be useful, however, if proof could be provided that tumor reduction in the case of carcinoma of the pancreas is a necessary prelude to complementary therapeutic measures. The anatomy of the pancreas and of the lymphatic channels in mammals seems to confirm the results found in man, i.e. the division of the pancreas into a right and a left pancreas. The precise knowledge of the anatomy of the lymphatic ducts of the pancreas might be the starting point for progress in the experimental studies concerning the modifications of the lymphatic circulation during acute pancreatitis. Indeed, during acute pancreatitis, the lymphatic system seems to play an important role. Pancreatic edema, rich in enzymes, and therefore in proteins, is essentially a "lymphatic edema". The interstitial and lymphatic diversion during canalar hyperpression have been emphasized. The lymphatic system plays the role of a "buffer system" or a "safety valve" in the fight against pancreatic necrosis. Ligation of the proximal pancreatic lymphatic efferents (within the processes) was followed by fatal acute pancreatic necrosis in the two cases in which this maneuver was performed.

The development or the experimentation of a lymphagogue drug is certainly worth while in the management of acute pancreatitis. A therapeutic regimen is proposed associating a lymphagogue treatment with antienzymes. The former facilitates the uptake of the enzymes by the lymphatic system. The antiproteases should protect against the fatal consequences induced by the afflux of enzymes in the lymphatic system and in the circulatory torrent.

Essai d'anatomie clinique et chirurgicale sur la circulation lymphatique du pancréas

Résumé. Cet essai repose sur l'injection et la dissection de 100 pièces cadavériques (fœtus, nouveau-nés ou enfants); l'examen de 34 dossiers de cancers pancréatiques; l'injection des lymphatiques de 14 chiens vivants; la reconstruction du mésodorsal du pancréas d'un embryon de 30 mm selon la méthode de Born. Les résultats sont les suivants : L'anatomie du pancréas et des voies lymphatiques montre qu'il existe deux portions bien distinctes : une droite correspondant à l'ébauche primitivement ventrale, une gauche correspondant à l'ébauche primitivement dorsale. Le « mésodorsal primitif » du pancréas est composé d'un double contingent : un droit, pour le pancréas droit : c'est la lame rétroportale (LRP); un gauche pour le pancréas gauche, c'est une formation qui n'a fait l'objet d'aucune description à ce jour : la lame latéroportale gauche (LLPG). Si le drainage lymphatique antérieur du pancréas ne semble ménager aucune surprise, le drainage postérieur qui résume les lymphatiques de la face postérieure et ceux de la face antérieure est tout à fait particulier. Il se fait, pour la portion droite (face antérieure et postérieure) dans la LRP; pour la portion gauche (face antérieure et postérieure) dans la LLPG et ce de façon exclusive. Seules quelques régions frontières échappent à la systématisation : celles qui se situent justement dans la zone de fusion des ébauches. Les émonctoires terminaux des lymphatiques pancréatiques n'ont qu'un très court trajet à parcourir pour atteindre le canal thoracique. L'étude de la répartition des métastases ganglionnaires des cancers du pancréas semblerait confirmer les résultats anatomiques cadavériques mais la série est trop courte pour pouvoir être exploitée. L'essaimage très précoce dans le canal thoracique réduit probablement de beaucoup l'intérêt des interventions supra-élargies dont la justification est exclusivement lymphoganglionnaire. Il en serait différemment si la preuve formelle était amenée, que la réduction tumorale, dans le cas du pancréas, doit être le prélude nécessaire à une thérapeutique complémentaire. L'anatomie du pancréas et les lymphatiques des mammifères semble confirmer les résultats chez l'homme, sur la division en pancréas droit et pancréas gauche. La connaissance précise de l'anatomie des lymphatiques du pancréas doit être à l'origine de progrès dans les études expérimentales concernant les modifications de la circulation lymphatique au cours des pancréatites aiguës. Au cours des pancréatites aiguës en effet, le système lymphatique semble jouer un rôle primordial. L'œdème pancréatique, riche en enzymes, donc en protéines, est un œdème essentiellement « lymphatique ». La voie de dérivation interstitielle et lymphatique dans l'hyperpression canalaire est soulignée. Le système lymphatique joue le rôle de « système tampon », de « soupape de sécurité » contre l'évolution vers la nécrose. La ligature des efférents lymphatiques pancréatiques très proximaux (compris dans les lames) a été suivie, les deux fois où la manœuvre a été exécutée d'une pancréatite nécrotique mortelle. La mise au point ou l'expérimentation d'une drogue lymphagogue prend toute sa place dans le traitement de la pancréatite aiguë. Un protocole est proposé associant le traitement lymphagogue aux anti-enzymes. Le premier facilite la prise en charge des enzymes par le système lymphatique. Les antiprotéases mettent à l'abri du choc mortel induit par l'afflux d'enzymes dans le système lymphatique et le torrent circulatoire.

Key words : Pancreas – Lymphatic system – Lymph node metastasis – Cancer – Acute pancreatitis

Historical background

Although recognized long before, the lymphatic system was rediscovered in 1622 by Aselli and his book [4] published in 1637, marks the starting point of a new era in lymphology. It is difficult to ascertain irrefutably who was the first to demonstrate the lymphatic system of the pancreas : Rouvière [79] resumed the situation of the historical progression of knowledge of lymphatic collectors of the pancreas : "According to Cruikshank, they were discovered by Veslingius. Cruikshank made injections into these channels and Sappey described them. Bartels made one of the most complete studies on the subject." This seems to be exact and Servelle [83] certified this situation in this work on the pathological aspects of lymphatic system. The careful examination of the works of Cruikshank [24], Veslingius [85] and Sappey [81] confirms this.

This mesoscopic study was paralleled by two microscopic studies of the lymphatic system of the pancreas, which are still up to date even though great progress has been made in pathology : that of G and F Hoggan in 1881 [51] and that of Klein in 1882 [54]. The latter authour described the periacinous windows communicating with the interlobular lymphatic vessels. These openings can not be considered to be capillaries because they do not have an endothelium, and are the beginning of the intrapancreatic lymphatic system.

Between 1904 and 1907, Bartels published three memoirs on the lymphatic drainage of the pancreas. His results are inscribed in his synthetic work entitled "Das Lymph Gefässystem" published in 1909 [6]. The study was made on 71 cadaver dissections using Gerota's

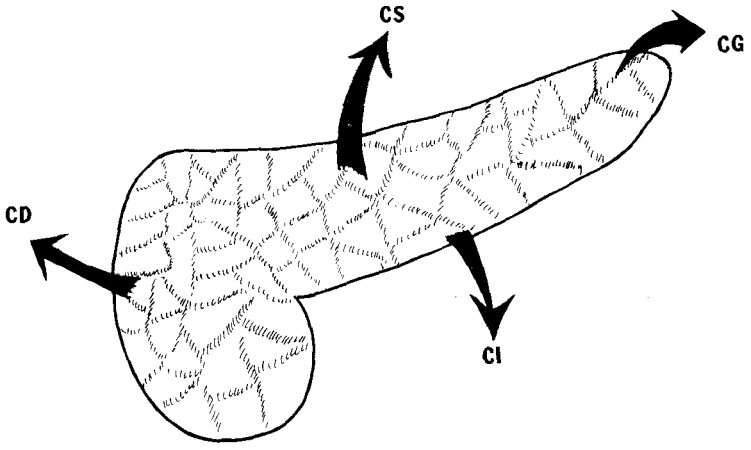


Fig. 1
Bartels (1909) *CS* superior collectors; *CI* inferior collectors; *CG* left collectors; *CD* right collectors

Bartels (1909) *CS* collecteurs supérieurs; *CI* collecteurs inférieurs; *CG* collecteurs gauches; *CD* collecteurs droits

mass injection method (human fetus or still borns, injection of living sacrificed mammals). The efferent collectors run to the regional lymph nodes (Fig. 1) :

The left collectors, arising from the tail of the pancreas, course to the hilum which is situated in the pancreatico-lienal ligament and to the lymph nodes found above and below the tail.

The superior collectors (anterior, posterior and superior borders of the corpus) course to the superior lymph nodes of the pancreas, sometimes to those of the left gastric falx; others arising from the right part of the corpus may drain through the lymph node of the hepatic chain.

The inferior collectors arising from the posterior and inferior parts of the corpus pancreatica, run through the inferior pancreatic, superior mesenteric and left para-aortic lymph nodes.

The right collectors arise from the anterior aspects of the pancreas and join the subpyloric, anterior pancreatico-duodenal and mesenteric lymph nodes. Those which arise from the posterior aspect of the pancreas, run to the posterior pancreaticoduodenal lymph nodes. Others reach the lymph nodes at the origin of the superior mesenteric artery and in the right para-aortic groups.

In 1954, Evans and Ochsner [37], published an anatomical and surgical work, based on the injection of India ink in 30 specimens. They were able to confirm the results of Bartels except that they did not find direct lymphatic anatomoses between the pancreas and the duodenum as did Bartels. Dismayed by the small percentage of five-year survival after resection for pancreatic carcinoma, they became fervent advocates of extended and supra-extended operations : sacrifice of the transverse colon, the portal vein, the superior mesenteric artery which was replaced by a prosthesis. Last in date are the works of Krutikowa [56] who studied the "architecture and the structure of the pancreatic and intrapancreatic lymphatic canals", of Vorobiyeva [86] who presented the "intraorganic anatomy of the pancreatic lymphatic system in man", of Jdanov [52] who, in 1960, published the results he observed in his work on the "functional morphology of the lymphatic systems of endocrine glands", of Sokolowski [84], in 1970, and Godard [43], in 1965 and 1975, who studied the lymphatic microcirculation of the pancreas, and lastly by Hidden [47, 49] for whom the pancreas is the "crossroads of the abdominal lymphatic chains".

Review of the anatomosurgical aspects of the pancreas and the major lymphatic routes of the abdomen

Bibliographic research has aided in the comprehension and in the rationalization of the results of our personal study of the lymphatic drainage of the pancreas. In deed, after 100 dissections, we were convinced that there were two principal emunctories for lymphatic drainage of the viscus; one right and one left, reaching either side of the origin of the superior mesenteric artery. These two global streams resume the lymphatic circulation of the pancreas which may be divided into two relatively distinct portions = a "right pancreas" and a "left pancreas".

Embryology (Fig. 2) and pancreatic ducti (Delmas [28], Cordier [19], Rachail [77])

Initially, there is a bulky dorsal bud and several ventral blocks which fuse together to form the ventral bud. The dorsal pancreas first provides the head which represents the primary formation and then the body and tail which represent the secondary expansion. The ventral pancreas doubles the entire dorsal aspect of the

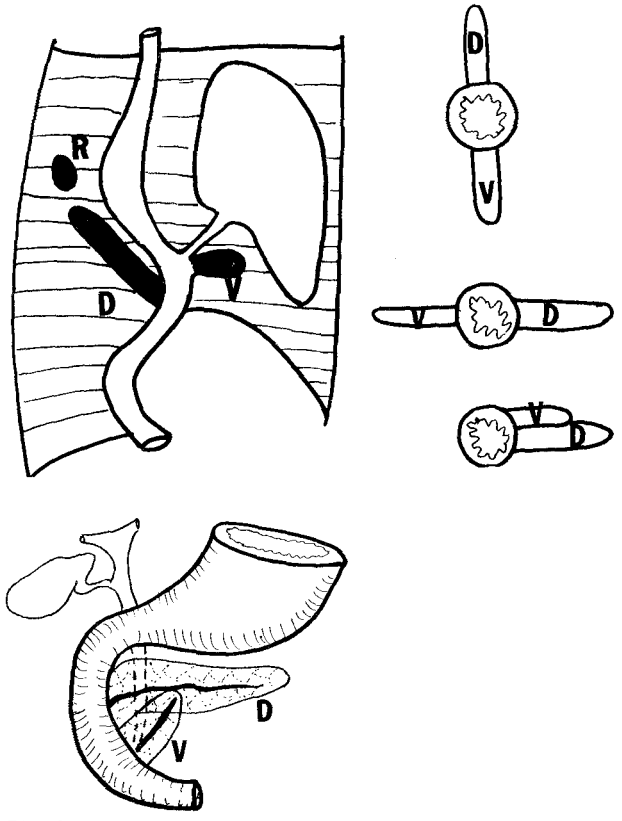


Fig. 2
Embryology of the pancreas; *V* ventral bud; *D* dorsal bud; *R* spleen

Embryologie du pancréas : *V* ébauche ventrale; *D* ébauche dorsale; *R* rate

head, but overlaps the top and the right of its dorsal counterpart to form the preduodenal tubercule, below and on the left to form the uncinate process (of Winslow). Only the ventral pancreas reaches and embraces the duodenum. 2nd order ducts run into the main duct of each bud. The excretor canal of the dorsal pancreas is the "primary duct of Santorini" while that of the ventral pancreas is the "primary duct of Wirsung". At the point where the ventral block meets the dorsal block there is a small communication between the two canalicular systems. This corresponds to the region of the future neck of the definitive pancreas.

The excretory duct of the dorsal pancreas follows a horizontal direction from the tail to the body and then curves as it reaches the region of the cephalic portion, describing a bayonet-like course and ends in the duodenum at the level of what will become the small caruncle. The duct of the ventral pancreas duct has a much simpler course which is oblique, descending as it runs from left to right. At the embryonic stage of 20 mm, the duct changes directions for unknown reasons. Most of the 2nd order canals of the duct of Santorini disappear and this channel becomes an accessory duct, subsisting in the upper part of the cephalic region, inosculated with the duct of Wirsung by the initial anastomosis which has cut it off from all its primary affluents. Variations are frequent but abnormalties are rare : the most characteristic of them is the absence of inosculation between the two canalar systems (pancreas divisum).

Arteries and veins

They have been described elsewhere in such classic works as Michels [62], Calas [15], Mellière [61], Couppie [23] and Martin [59].

Nerves

There are very few studies in the literature on the pancreatic nerves. The works of Debeyre [27] in 1933, of Yoshioka in 1958 [90] and of Ageenko [1] plead in favor of the existence of a plexus formed by :

A right celiac pedicle : the filaments derived from the nervous ganglionic mass situated along the aorta between the celiac axis and the superior mesenteric artery are spread out on the posterior surface of the pancreas. They form a fan-like structure whose superior branches are hepatic, those located in the middle are pancreaticoduodenal and the inferior are mesenteric. The lowest branches course along the right lateral and posterior aspects of the superior mesenteric artery, slip into the pancreatic groove and appear on the anterior aspect, in front of the uncinate process and then in front of the third portion of the duodenum.

A left celiac pedicle : The filaments arising from the left celiac ganglion (g. celiaca) run between those coming from the right vagus nerve and descend to the duodenojejunal flexure. They spread out into two groups : one is superior (pancreaticosplenic filaments) and is directed toward the hilum of the spleen, accompagnying and intertwining with the splenic artery as it courses to the posterior aspect of the pancreas; the other is inferior and reaches the duodenal flexure.

A superior mesenteric pedicle : This structure appears as a dense network between the inferior borders of the pancreatic neck and the third portion of the duodenum. The diagrams of the authors only reinforce the idea of a dual posterior pedicle of the pancreas which is represented as a nervous "crop-like" structure of the viscus (Fig. 3).

The mesentery of the pancreas

The retrovenous segment of the pancreas is known since the works of Wiart [89], Olivier and Debeyre, in Bellocq [12] and was perfectly systematised by Calas

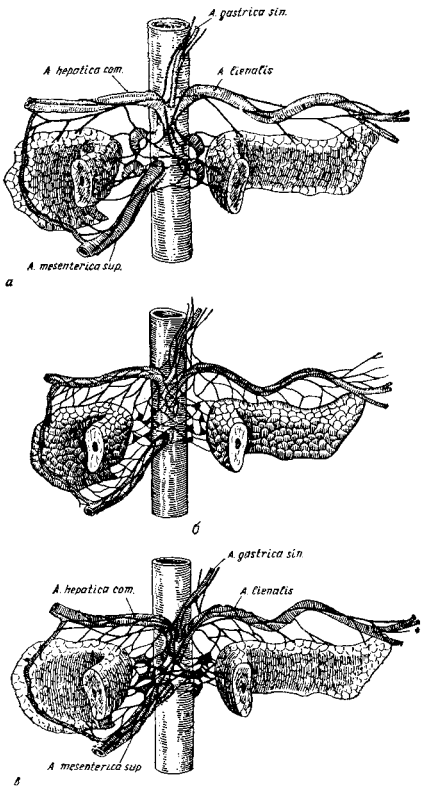


Fig. 3
Nerves of the pancreas : Diagram based on Ageenko and Gvazava's article

Nerfs du pancréas : Schéma extrait de l'article d'Ageenko et Gvazava

and his school [16] (Fig. 4). The retrovenous portion of the gland is constituted of three parts, which are from below to above, a) the uncinate process b) the retromesenteric segment and c) the retroportal segment ("retroportal process"). The works of Yoshioka and Wakabayashi [90], and Prioton and Laux [76] have confirmed these ideas. However, it was Couinaud who first tried to provide an explanation based on embryonic evidence. As he examined a 5 mm embryo, he observed that the primitive digestive tube was connected to the posterior wall by a continuous dorsal mesentery, stretching from the aorta to the viscera, and running from the esophagus to the terminal intestine [22]. This original configuration may be reconstituted by dissection, liberation and mobilization, leaving only the median part of the mesentery attached from behind. These planes of cleavage have been used by generations of surgeons to expose or to remove digestive viscera. The isolation of the dorsal mesentery of the pancreas, which runs from T_{12} to L_3, allows one to demonstrate the hilum of the pancreas. This may be accomplished : a) *on the right,* by incision of the peritoneum, retropancreaticoduodenal mobilization (Kocher's maneuver) through Treitz's fascia. As one progresses toward the midline along the inferior limit of the epiploic foramen (of Winslow), and below the 3rd portion of the duodenum, the hilum and the pedicle of the right kidney, the inferior vena cava and the termination of the left renal vein may be seen. On the midline, progression is stopped by a dense, essentially nervous, structure. Behind this, the pulsations of the aorta may be felt; b) *on the left,* after liberation of the tail and the body of the pancreas, one may easily progress as well to the aorta. Left-to-right splenopancreatectomy and total gastrectomy extended to the mesentery for carcinoma are but two surgical procedures which make use of this concept in everyday surgical practice. The hilum of the pancreas is therefore centered on the superior mesenteric arterial axis. On the right, its limit is constituted by the falx of the common hepatic artery (arteria hepatica commonis), on the left, by the undulations of the splenic artery. The unbelievable denseness of the connective tissue occupying the dorsal mesentery makes the isolation of these elements difficult. All the vascular and nervous elements of the pancreas, be it afferent or efferent, are grouped within this dorsal sagittal attachment. Referring to the works in embryology by Delmas and in surgery by Yoshioka, in which the retroportal process is divided into uncolunar and uncomesenteric processes, Couinaud likens the retroportal process of the pancreas to the primitive dorsal mesentery. However, it seems that the left part of the mesentery has been left out...

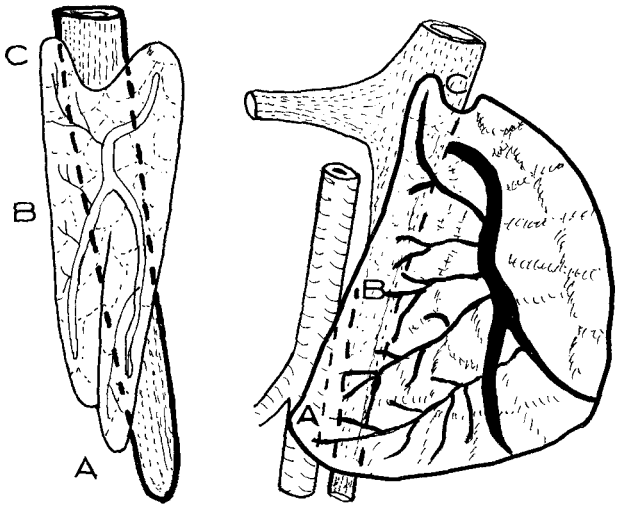


Fig. 4
Retrovenous process : Right lateral and posterior views according to Calas; *A* Uncinate process; *B* retromesenteric segment; *C* retroportal segment

Segment rétro-veineux, vue latérale droite et vue postérieure d'après Calas : *A* processus uncinatus; *B* segment rétro-mésentérique; *C* segment rétro-portal

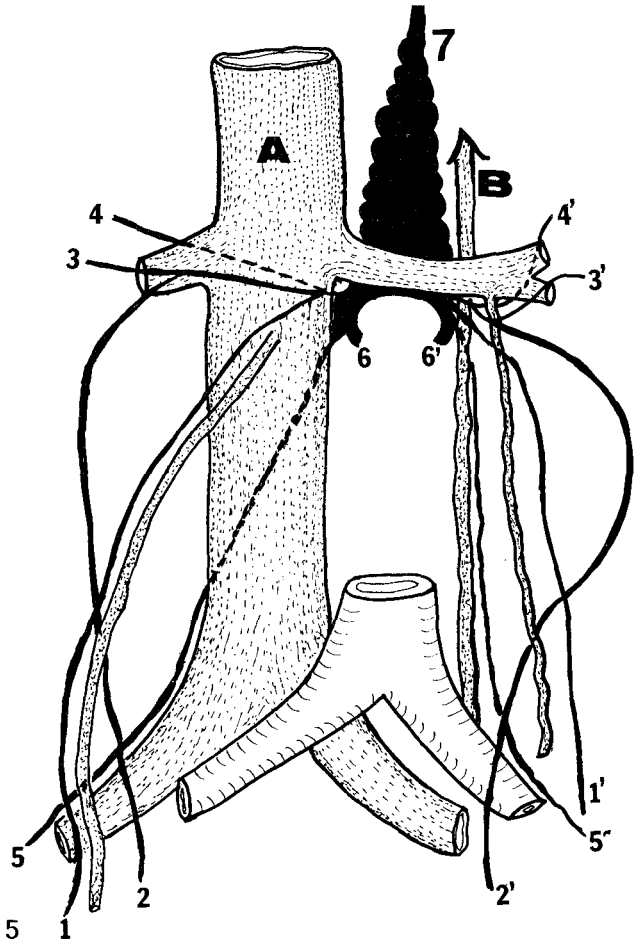


Fig. 5
Course of the great lymphatic streams of the abdomen according to Descomps and Turnesco in relationship to the two "caval systems". *A* inferior vena cava; *B* ascending lumbar vein; *1* right genital current; *2* inferior current (urinary current); *3* anterior current (right urinary current); *4* posterior current (right urinary current); *5* current of the right inferior limb; *6* termination of the right intestinal current; *7* Pequet's cysterna. *1' 2' 3' 4' 5' 6'* left currents

Trajet des grands courants lymphatiques de l'abdomen de Descomps et Turnesco par rapport aux « deux systèmes caves » : *A* Veine cave inférieure; *B* Veine lombaire ascendante; *1* Courant génital droit; *2* Courant inférieur (courant urinaire); *3* Courant antérieur (courant urinaire droit); *4* Courant postérieur (courant urinaire droit); *5* Courant du membre inférieur droit; *6* Terminaison du courant intestinal droit; *7* Citerne de Pecquet. *1' 2' 3' 4' 5' 6'* même courants gauches

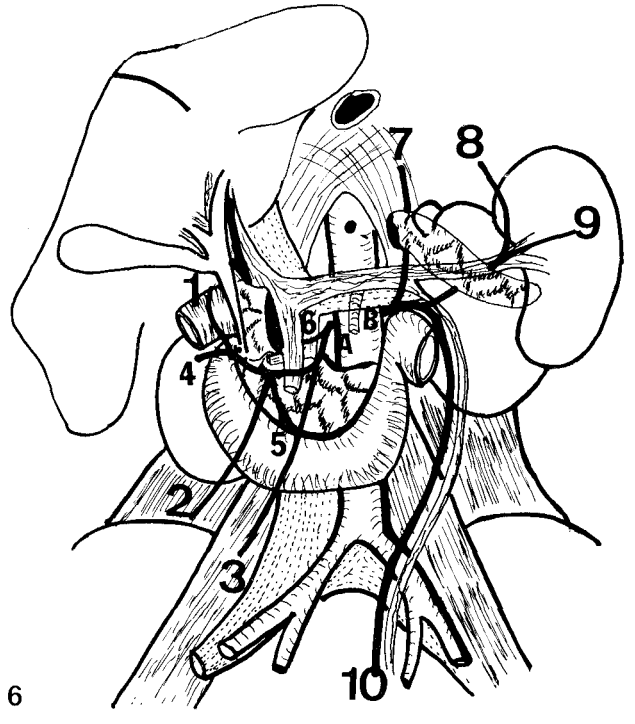


Fig. 6
The two right and left intestinal currents (Descomps and Turnesco); *A* right gastrocoloenteric confluent with its three branches of origin : *1* inferior gastric trunk; *2* right colic trunk; *3* enteric trunk and its three collateral branches; *4, 5* small superior and inferior pancreatic trunks; *6* retropancreaticoduodenal trunk; *B* left gastrosplenocolic confluent and its three roots; *7* superior gastric trunk, satellite of the coronary vein; *9* splenic trunk which receives the collectors following the vasa brevia *(8); 10* the left colic trunk

Les deux courants intestinaux droit et gauche (Descomps et Turnesco) : *A* confluent droit gastro-colo-entérique avec ses trois branches d'origine; *1* Tronc gastrique inférieur; *2* Tronc colique droit; *3* Tronc entérique et ses trois branches collatérales; *4, 5* Petits troncs pancréatiques supérieur et inférieur; *6* Tronc rétro-duodéno-pancréatique; *B* Confluent gauche gastro-spléno-colique et ses trois racines; *7* Tronc gastrique supérieur satellite de la veine coronaire; *9* Tronc splénique recevant les collecteurs qui suivent *(8)* les vaisseaux courts; *10* Tronc colique gauche

The great lymphatic streams of the abdomen

The right efferent lumbar trunk and the left efferent lumbar trunk which receives the intestinal trunk, constitute the beginning of the thoracic duct (ductus thoracicus) at the level of the first lumbar vertebra. At this point, an initial ampullar dilatation (cisterna or receptaculum chyli) was described by Pecquet in the dog; this dilatation does not seem to be common in man. Poirier and Cuneo [74] have described 4 principal lymphatic chains : preaortic, retroartic, left lateral aortic and right lateral aortic, which may be subdivided into the interaortocaval, lateral caval, precaval and retrocaval chains. In fact, this conception is purely descriptive as opposed to the systematisation proposed by Descomps ans Turnesco [29] on one hand, and Hidden [46, 47], on the other. According to these authors, there are four great lymphatic streams, symetrically disposed by pairs on either side of the midline. These efferent channels arise from the lower extremity, the genitalia, the urinary tract and the intestine. Each of them are grouped around two venous trunks, the inferior vena cava on the right, and the ascending lumbar vein (its embryonic equivalent) on the left, arising from the initial segment of the posterior cardinal vein. The intestinal lymphatic stream is represented by two main collecting systems on the right and left.

The right collecting system

The gastrocoloenteric stream is formed by the inferior gastric trunk, satellite of the right gastroepiploic and the gastrocolic (of Henle) veins, coursing between the superior mesenteric artery and vein, the right colic trunk, draining the right colon and the enteric trunk, draining the lymph coming from the ileun and the jejunum, accompagnying the superior mesenteric vein. The right collecting system ends in the inferior and medial corner of the cisterna chyli and before reaching it, the lymphatic channel insinuates itself between the mesenteric artery and vein and then runs through the quadrilateral space limited above by the left renal vein, on the right by the inferior vena cava, on the left, by the aorta, and below, by the uncinate process.

The left collecting system

The gastrosplenocolic stream is formed by the superior gastric trunk, draining the rest of the gastric lymph and satellite of the coronary vein, the splenic trunk, accompagnying the splenic vein and the left colic trunk. This left sided stream arises below the pancreas and the jejunoduodenal flexure and ends in the inferior and medial corner of the cisterna chyli after insinuating between the left renal venal above, the aorta on the right and the third and fourth portions of the duodenum below and on the left. Hidden confirms these results and calls attention to the importance of two nodal groups, the left interaorticocaval subrenal group whose efferents represent the "right stream" and the left pararenal node which lies in front of the renal vein and is therefore left lateral aortic and whose efferents represent the "left stream". The efferents of the left subrenal interaorticocaval node run between the aorta and the vena cava before joining the right branches of the origin of the thoracic duct. The efferents of the left pararenal ganglion run around the left border of the aorta and join the left branches of the origin of the thoracic duct. Often, a preaortic anastomosis unites the two nodes, hence the necessity for the author to replace the concept of nodal chains by that of cellulolymphatic planes.

Conclusion

The viscus may be divided into two : a right duodenopancreas (of ventral origin) and a left splenopancreas (of dorsal origin) whose pivot is the superior mesenteric vessels. Likewise, the primitive dorsal mesentery of the pancreas is divided into two : a right process which contains the right celiac nervous pedicle and the right great lymphatic stream, the "retroportal process"; and a left process which contains the left celiac nervous pedicle and the left great lymphatic stream, the "left lateral portal process".

Personal study

Material and method

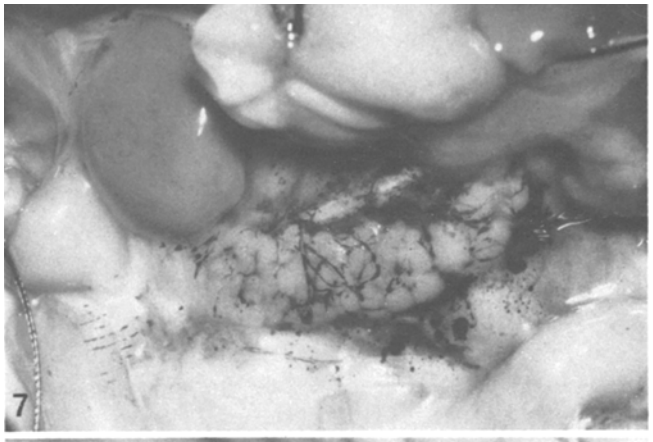
Fetuses, newborns and babies coming from spontaneous and therapeutic abortions as well as still borns were used. Correct exposition as well as an adequate temperature of the specimen were essential. Either colored ceder oil (Paramiltiades'medium) or (author's medium) a colored Chinese wood oil, was used. The injection was always performed indirectly either by infusion or by a syringe. The technical details were given in our previous publications [67, 69, 73] as well as in the memoir of the author [68].

Anatomical results

The lymph contained in the efferent collectors of the pancreas may course through two sorts of drainage systems; anterior and posterior.

The anterior drainage routes

The anterior subserosal lymphatic vessels and the parietal nodes (Fig. 7), present in 65% of cases,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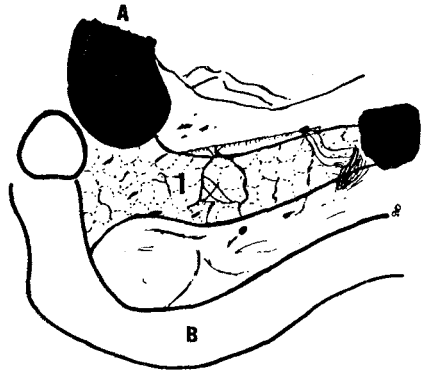
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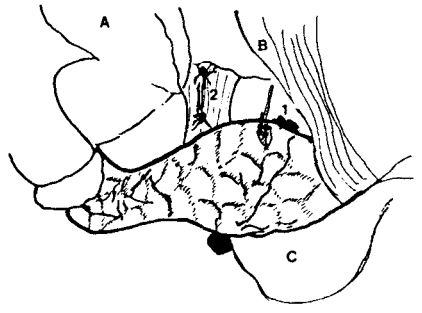
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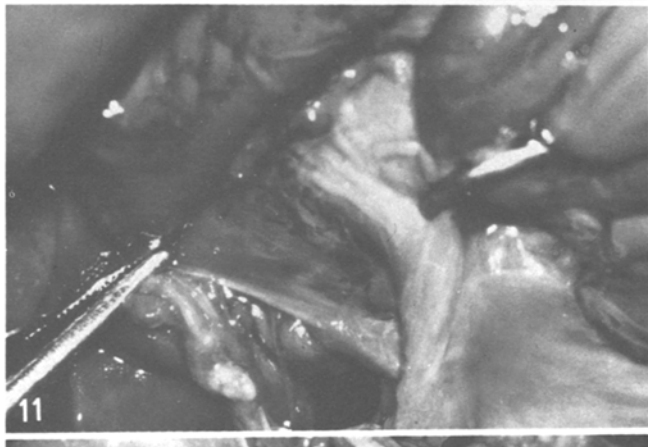
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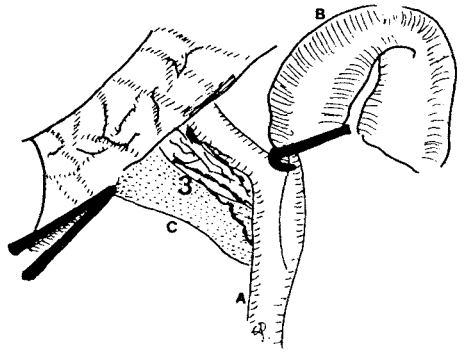
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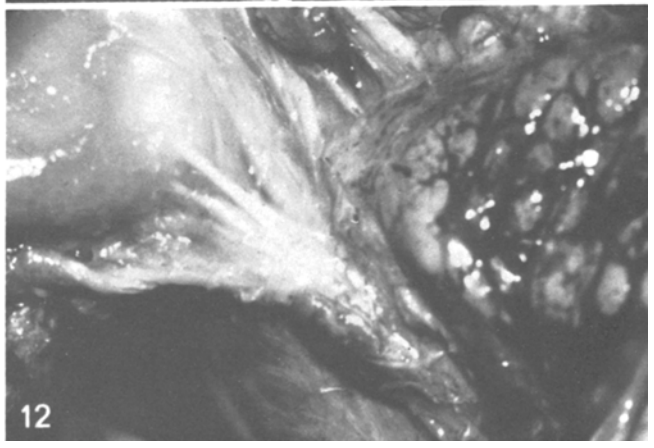
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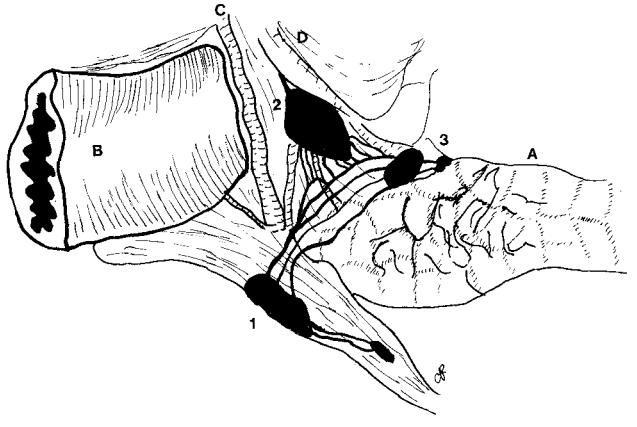
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represent the efferents of the collectors draining the intra- and the perilobular networks.

The splenic chain (Fig. 8) : this route was injected in 44% of cases; it is composed of three to five nodes. However, it is essentially the sub- and prevenous process which receives the collectors and rarely the supra and retroarterial process described in our work on the lymphatic drainage of the stomach [70].

The transverse mesocolon (mesocolon transversalis) and mesocolons (Fig. 9) : 39 specimens out of 100 presented either collectors or lymph nodes filled by the mass injected into the pancreas.

The left gastric reflux (Fig. 10) : injection of the lymph nodes of the left gastric artery occurred in 36 specimens. This was indeed a retrograde injection and this route clearly merits the term "reflux"; exceptionnally, an injection of lymph nodes near the cardiac orifice was seen.

The inferior pancreatic chain : the injection of this chain was noted in 34 out of the 100 specimens. It receives the collectors arising from the neck, the body the tail and from the inferior border of the gland.

The mesentery proper and its root (Fig. 11) : the injection reached the lymphatic collectors in the mesentery proper in only 20 specimens out of 100. This number is paradoxally low when traditional data is considered. The efferent vessels concern the neck, the anterior aspect of the head, but most of all, the uncinate process and the inferior border of the pancreas.

The anterior pancreaticoduodenal lymph nodes : the lymph node group is situated in front of the head of the pancreas and the anterior pancreaticoduodenal arcade. This plexus consists of 3 to 8 lymph nodes. They were described in our work on the lymphatic system of the stomach. These nodes are situated at the same level as the subpyloric (subduodenal) lymph nodes but in a slightly more posterior frontal plane. They were injected 27 times in our series of 100 specimens. The vessels arise from the head, the uncinate process and the neck.

The gastroduodenal chain (Fig. 12) : in our previous publications on the lymphatic vessels of the stomach, we described two territories of drainage of the liver : one follows the accessory hepatic lymphatic route, accompagnying the pyloric artery (of little importance); the other follows the principal hepatic route and includes 2 varieties : one is frequent and lies on the right aspect of the gastroduodenal artery (subpyloric, retroduodenal and supraduodenal nodes); the other is rare and lies on the left aspect of the gastroduodenal artery. It is represented by two lymphatic collectors which cross the anterior aspect of the pancreas. In this study, the gastroduodenal chain (common variety) was colored 17 times when the injection involved the collector channels arising in the anterior and posterior aspects of the head and in the neck. It was the same in the case of

The hepatic chain : which was injected in 17 out of the 100 specimens, essentially when the injection was performed on the anterior or the posterior aspects of the head, sometimes when it was performed on the neck or the body.

The porta hepatis and the hilum : the lymphatic vessels in the porta hepatis were injected 17 times and in the hilum twice. In the great majority of cases, the injection was made in the head or the uncinate process.

The posterior gastric reflux : we have already stressed elsewhere this lymphatic route and its importance in the drainage of the splenic territory of the stomach (67,72). Of the 100 specimens in this essay, a posterior gastric artery was encountered 60 times. However, a lymphatic collector arising from the pancreas accompanied this artery in only 15 cases. Therefore, it seemed that this was not a double channeled route but rather indeed a reflux.

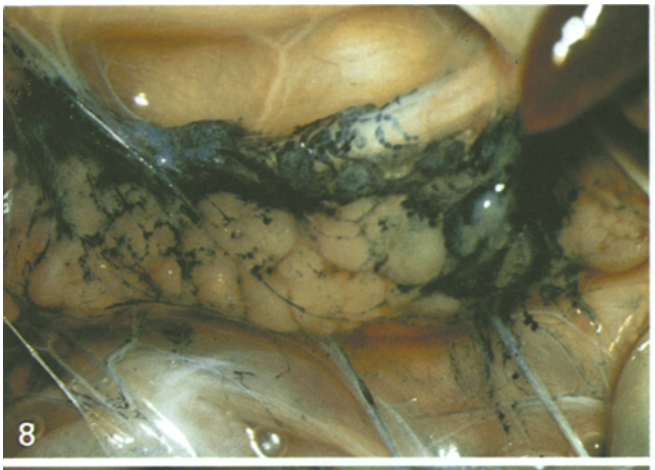
The pancreaticolienal ligament : classically, an important place is alloted to this route of lymphatic drainage

←

Figs. 7, 10-12

7 Anterior drainage. *A* Spiegel's lobe; *B* transverse colon; *1* anterior subserosal collectors. **10** Coronary reflux; *A* stomach turned up; *B* Gastrosplenic ligament; *C* spleen; *1* splenic chain; *2* reflux in the coronary falx. **11** Superior mesenteric chain; *A* superior mesenteric artery pulled by a hook; *B* duodenojejunal flexure; *C* superior mesenteric vein pulled by a forceps; *3* lymphatic channel satellite to the vein, placed between artery and vein. **12** Gastroduodenal chain; *A* pancreas; *B* mobile portion of the first part of the duodenum; *C* gastroduodenal artery; *D* common hepatic artery; *1* subduodenal lymph nodes; *2* supraduodenal lymph nodes; *3* lymph nodes of the hepatic chain "suprapancreatic lymph nodes"

7 Drainage antérieur. *A* Lobe de Spiegel; *B* Côlon transverse; *1* Collecteurs sous-séreux antérieurs. **10** Reflux coronaire stomachique. *A* Estomac relevé; *B* Ligament gastro-splénique; *C* Rate; *1* Chaîne splénique; *2* Reflux dans le faux coronaire stomachique. **11** Chaîne mésentérique supérieure. *A* Artère mésentérique supérieure réclinée par un crochet; *B* Angle duodéno-jéjunal; *C* Veine mésentérique supérieure tirée par une pince; *3* Voie lymphatique satellite de la veine, placée entre artère et veine. **12** Chaîne gastro-duodénale. *A* Pancréas; *B* Portion mobile du premier duodénum; *C* Artère gastro-duodénale; *D* Artère hépatique commune; *1* Ganglions sous-duodénaux; *2* Ganglion sus-duodénal; *3* Ganglion de la chaîne hépatique « ganglion sus-pancréatique »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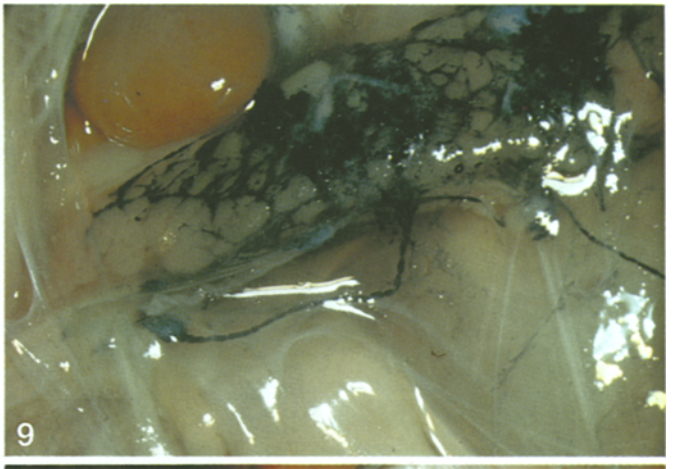
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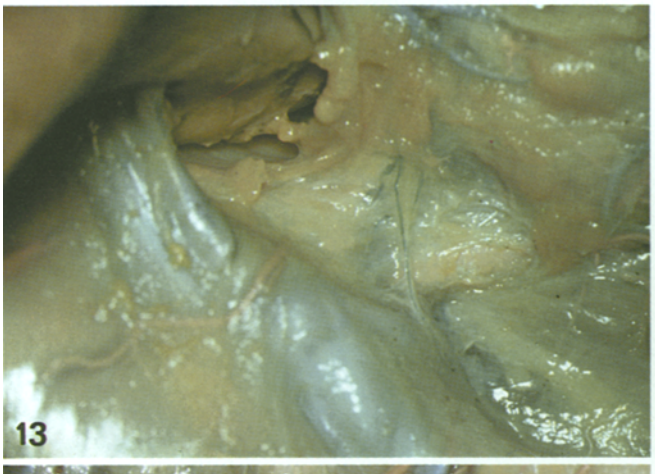
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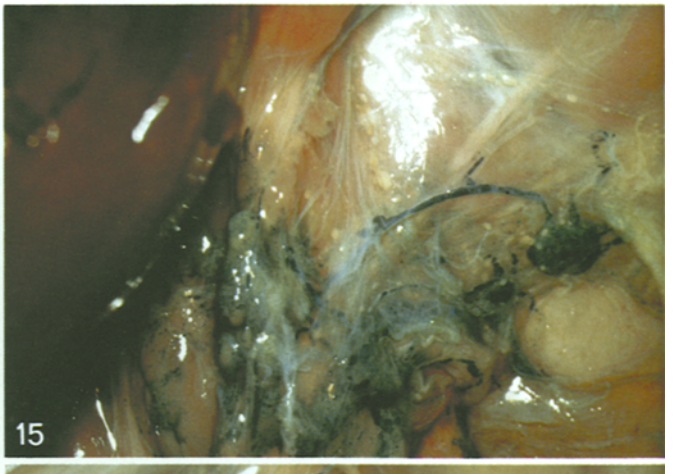
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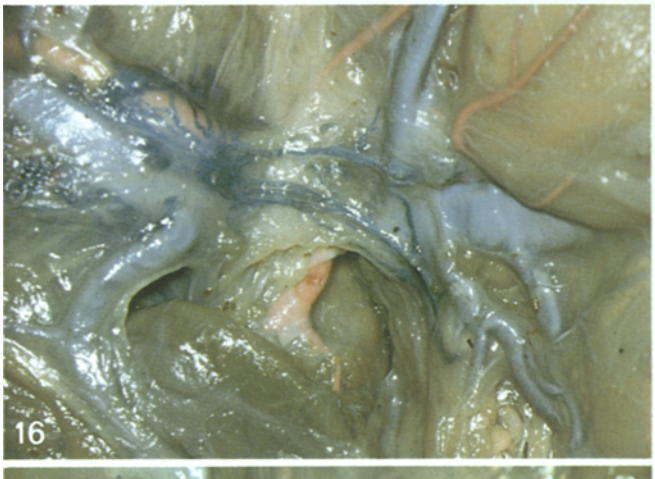
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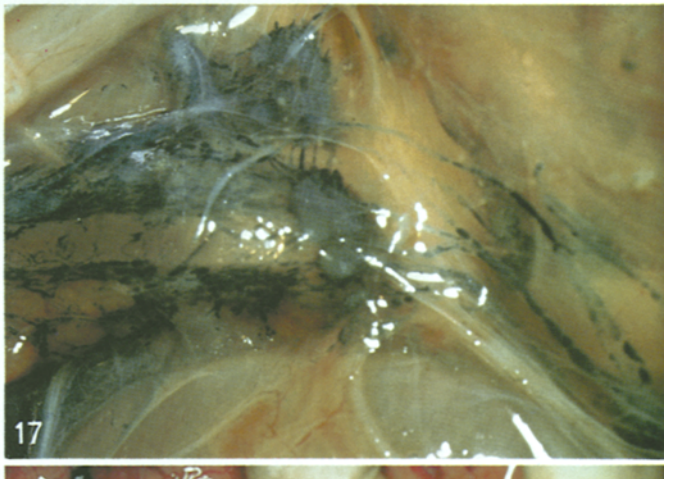
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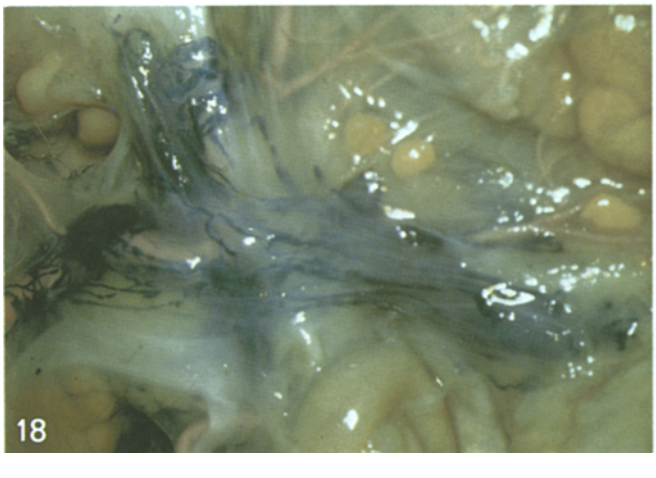
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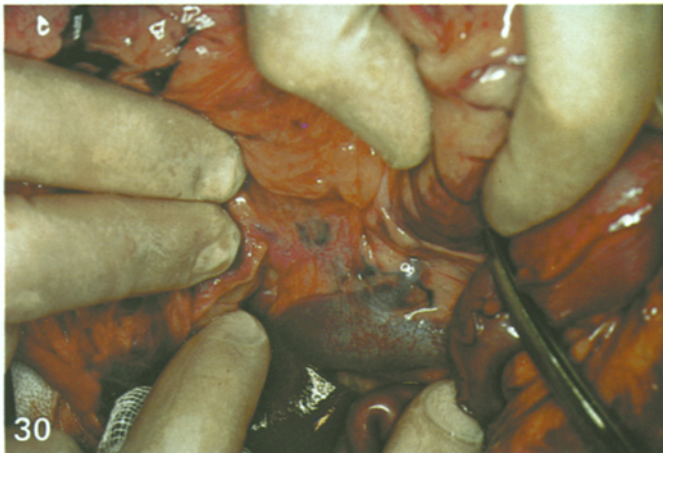
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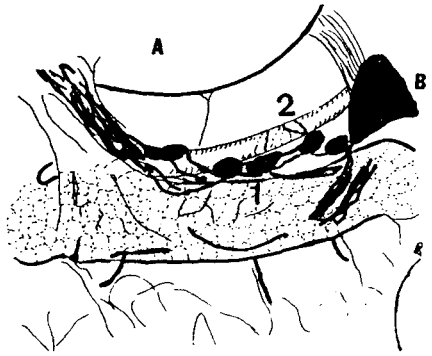

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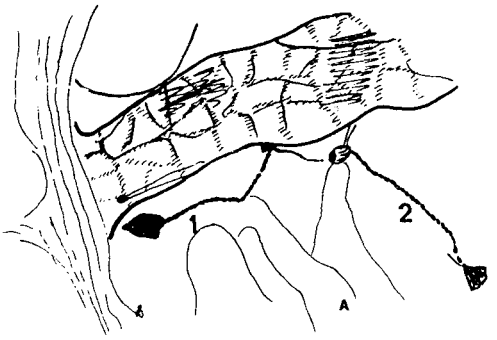

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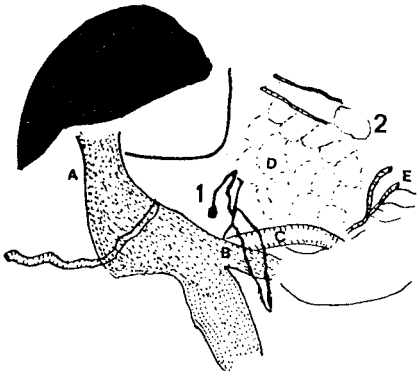

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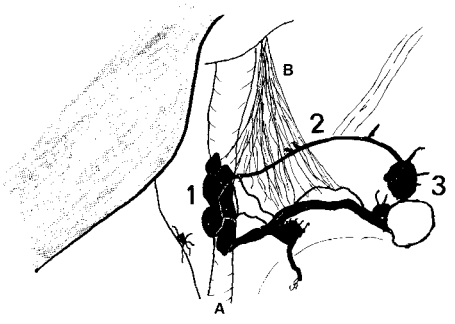

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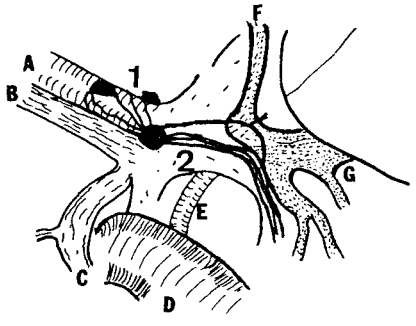

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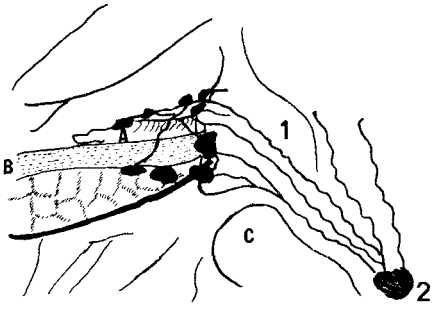

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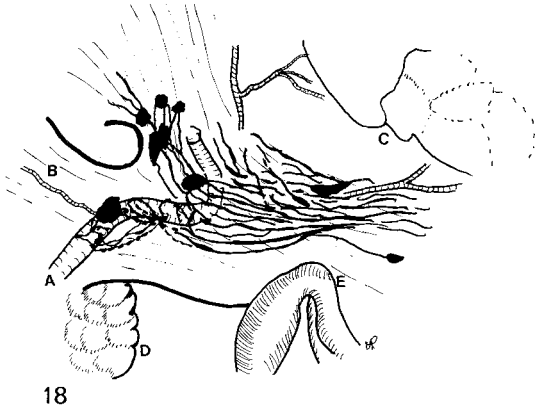

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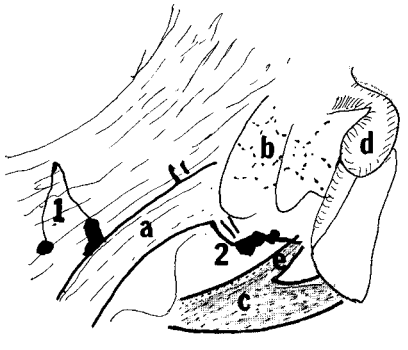

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Figs. 8-9, 13, 15-18, 30 (for legends see p 266)

of the pancreas. This was not the case in our series of 100 specimens, for in only 9 cases was this chain injected (essentially from the body and the tail).

Gastrosplenic reflux : only rarely indicated in the literature, drainage via the gastrosplenic ligament was found in 4 cases out of 100.

The posterior routes of drainage

Strictly speaking this is not a drainage of the posterior aspect of the pancreas because they were only very exceptionally injected. Lymphatic collectors were *observed* on the posterior aspect of the viscus and more generally speaking in a "posterior plane" visualized nearly exclusively by the injection of the anterior surface of the pancreas.

The retroportal process (Fig. 13) : Lymphatic vessels were found to be injected in this process 20 times. The collectors on the right, that is to say posterior, surface of the process, are accessible by the Kocher manuever. The collectors on the left (that is to say anterior) surface become accessible after transsection of the neck of the pancreas (Fig. 14). The direction of the lymphatic vessels in the retroportal process are slightly oblique, below, behing and medially. They end under the distal third of the left renal vein, just a few centimeters before the vein runs into the vena cava. They become "left subvenal and above all interaorticocaval".

The left lateral portal process (Figs. 15, 16, 17, 18) : in our 63 cases (out of 100), the mobilization of the tail of the pancreas from left to right demonstrated sometimes a massively injected formation of lymphatic vessels originating in the pancreas. Its constancy allowed its identification starting from the 30th specimen, at least in the fetus and small infant. Once we had found this process filled with lymphatic channels, but distinct from the retroportal process, we began our search in the books which encouraged us and progressively reinforced our convictions. The afferent collectors of the left lateral portal process arise from practically all the portions of the pancreas (anterior surface of the head, the neck, the body, the tail and the superior and inferior borders). Only the posterior aspect of the head escapes this description. The lymphatics seem to come from the

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Figs. 8-9, 13, 15-18, 30 (preceeding page)
8 Splenic chain injected from the pancreas. *A* stomach; *B* spleen; *1* sub- and prevenous collectors hiding the splenic vein; *2* supra and retroarterial collectors which interlace the artery. **9** Drainage into the transverse mesocolon. *A* transverse mesocolon; *1* (exceptionnal) lymphatic collector parallel to the inferior border; *2* collector descending toward the intestine. The valves may be clearly seen. **13** Retroportal process after mobilization. *A* inferior vena cava; *B* distal third of the left renal vein; *C* superior mesenteric artery; *D* posterior surface of the head (not injected); *E* posterior pancreaticoduodenal arcade; *1* collectors seen by transparency belonging to the left aspect of the RPP; 2=posterior pancreaticoduodenal lymph node (not injected). **15** Afferent collectors included in the LLPP, anterior left view, from the splenic chain. *A* splenic artery; *B* small nervous filaments arising from the left celiac plexus; *1* splenic chain; *2* the "true" passage; *3* left pararenal lymph node. **16** Drainage in the left lateral portal process. Examination after splenopancreatic mobilization from left to right. *A* splenic artery; *B* splenic vein; *C* inferior mesenteric vein; *D* jejunoduodenal flexure; *E* superior mesenteric artery in Rogie's quadrilateral space; *F* left suprarenal vein; *G* left renal vein; *1* splenic chain; *2* lymphatic vessels in the process. The summit of the curve of the lymphatics corresponds to the intersection with the mesenteric artery. **17** Afferent collectors included in the LLPP. Drainage into left lateral portal process and the "true passage" after mobilization. *A* posterior aspect of the splenic artery; *B* posterior aspect of the splenic vein; *C* duodenojejunal flexure seen by transparency; *1* lymphatic vessels of the superior, middle and inferior thirds of the LLPP; *2* left pararenal lymph node in the LLPP. **18** Lymphatic vessels in the LLPP after mobilization. *A* splenic artery; *B* posterior gastric artery and its falx; *C* left suprarenal gland; *D* posterior aspect of the pancreas; *E* duodenojejunal flexure. **30** Intraoperative injection of the pancreas of the dog with PSB 6 BX. *a* portal vein; *b* posterior surface of the pancreas; *c* caudal vena cava; *d* duodenum; *e* left renal vein; *1* anterior lymph node; *2* efferent lymphatic collector descending behind the renal vein

8 Chaîne splénique injectée à partir du pancréas. *A* Estomac; *B* Rate; *1* Collecteurs sous et pré-veineux masquant la veine splénique; *2* Collecteurs sus et rétro-artériels qui enlacent l'artère. **9** Drainage dans le mésocôlon transverse. *A* Mésocôlon transverse; *1* Collecteur lymphatique parallèle au bord inférieur : exceptionnel; *2* Collecteur descendant vers l'intestin. On distingue très nettement les valvules. **13** Lame rétro-portale après décollement. *A* Veine cave inférieure; *B* Veine rénale gauche tiers distal; *C* Artère mésentérique supérieure; *D* Face postérieure de la tête non injectée; *E* Arcade duodéno-pancréatique postérieure; *1* Collecteurs, vus par transparence appartenant à la face gauche de la LRP; *2* Ganglion duodéno-pancréatique postérieur non injecté. **15** Collecteurs afférents inclus dans la LLPG, vue aérienne gauche, de la chaîne splénique. *A* Artère splénique; *B* Petits filets nerveux émanant du plexus cœliaque gauche; *1* Chaîne splénique; *2* Le « vrai passage »; *3* Ganglion pararénal gauche. **16** Drainage dans la lame latéro-portale gauche : examen après décollement splénopancréatique de gauche à droite. *A* Artère splénique; *B* Veine splénique; *C* Veine mésentérique inférieure; *D* Angle duodéno-jéjunal; *E* Artère mésentérique supérieure dans le quadrilatère de Rogie; *F* Veine surrénalienne gauche; *G* Veine rénale gauche; *1* Chaîne splénique; *2* Lymphatiques dans la lame. Le point le plus élevé de la courbure des lymphatiques est le point d'intersection avec l'artère mésentérique. **17** Collecteurs afférents inclus dans la LLPG, drainage dans la lame latéroportale gauche et le « vrai passage » après décollement. *A* Face postérieure de l'artère splénique; *B* Face postérieure de la veine splénique; *C* Angle duodéno-jéjunal vu par transparence; *1* Vaisseaux lymphatiques des tiers supérieur, moyen, inférieur de la LLPG; *2* Ganglion para-rénal gauche de la LLPG. **18** Vaisseaux lymphatiques dans la LLPG après décollement. *A* Artère splénique; *B* Artère gastrique postérieure et sa faux; *C* Glande surrénale gauche; *D* Face postérieure du pancréas; *E* Angle duodéno-jéjunal. **30** Injection per-opératoire du pancréas du chien par PSB 6 BX. *a* Veine porte; *b* Face postérieure du pancréas; *c* Veine cave caudale; *d* Duodénum; *e* Veine rénale gauche; *1* Ganglion antérieur; *2* Collecteurs lymphatiques efférents se dirigeant en bas et en arrière de la veine rénale

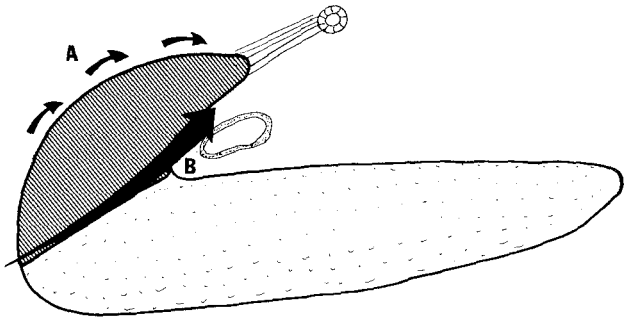


Fig. 14
Direction followed by the lymphatic channels included in the RPP. *A* from the posterior aspect of the head after mobilization; *B* from the posterior aspect of the head situated at the level of the neck (never injected). The collectors are colonized by anterior anastomoses

Chemins suivis par les lymphatiques inclus dans la LRP. *A* De la face postérieure de la tête injectée après décollement; *B* De la face postérieure de la tête située à l'aplomb de l'isthme jamais injectée. Les collecteurs ont colonisé par les anastomoses antérieures

distal portion of the splenic chain and from the lymphatic center surrounding the celiac trunk (at the posterior and superior aspects of the neck) (Fig. 15). In fact, they lie on the left side of the arch of the superior mesenteric artery and reach the anterior aspect and inferior border of the left renal vein at its proximal third-middle third junction (that is to say in general at the level of the termination of the middle suprarenal vein) (Fig. 16). The biggest and most constant is a left pararenal node (Fig. 17). The left lateral portal process is exclusively fibrous, contrary to the retroportal process which is glandular and fibrous. This study concerned only fetuses in whom the left lateral portal process was particularly developed. We have dissected and individualised this process in the adult in whom it remains less important thant the retroportal process.

The thoracic duct

The supradiaphragmatic portion of the thoracic duct was injected only 8 times in the 100 specimens studied. Although they were few in number, it must be remembered that in all cases, the injections were made directly into the parenchyma. Theoretically this is "more physiological", even though lymphatic circulation is not possible in the cadaver. In all cases in which the thoracic duct was individualised above the diaphragm, the retroportal and left lateral portal processes were massively injected. The vessels included in the retroportal process enter the left subrenal interaorticocaval nodes and from there, the efferent collectors first run between the aorta and the vena cava, then along the right border and finally along the posterior border of the aorta. The vessels included in the left lateral portal process run to the left pararenal and subrenal lymph nodes. The efferent channels pass under the left renal vein, insinuate themselves between the artery and vein, and then join the left border of the aorta at the level of the origin of the renal artery. From that point, they direct themselves toward the posterior aspect of the aorta. The aorta is thus "wrapped" within a network of lymphatic collectors, located behind, on the sides but also in front, for the left and right systems communicate between each other often in this manner. This lymphatic network continues up into the posterior mediastinal cavity twining together behind the aorta to form the thoracic duct without any initial dilatation (Fig. 19).

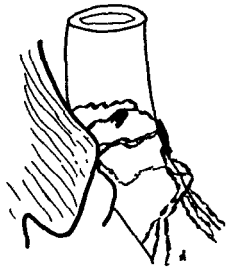


Fig. 19
Constitution of the thoracic duct. The lateral aortic afferents : left lateral view. It may be seen that the thoracic duct is not individualized around the diaphragmatic or in the posterior inframediastinal space portions of the aorta. The thoracic duct appears only on the posterior aspect of the thoracic aorta

Constitution du canal thoracique, les afférents latéro-aortiques vue latérale gauche : on constate qu'il n'existe pas de canal thoracique individualisé autour de l'aorte diaphragmatique ou de l'aorte dans l'espace inframédiastinal postérieur. Le canal thoracique n'apparaît qu'à la face postérieure de l'aorte thoracique

The lymphatic lumbo-aortic reflux

In 14 out of the 15 cases in which the effrents of the process were visible, the lumbo-aortic subpancreatic lymphatic vessels were injected as well. The lymphatics involved were those which reached and slightly overan the inferior mesenteric artery (level of L3 for the average subject). This phenomenon might be considered as an "overflow reflux" when the retroportal left lateral portal process and the thoracic duct have been massively injected.

Lymphatics of the diaphragm

In three specimens, the lymphatic vessels included in the muscle of the diaphragm were found to be injected. These vessels seem to be the anatomical support for pleural effusions associated with pancreatic disease. In these three cases, the thoracic duct was not injected. Could that be a compensatory phenomenon as is the case of the anterior mediastinal routes found for the stomach ? Might they not be the classical pits of Ranvier ?

Pancreaticoduodenal anastomoses

They were affirmed by Bartels and repudiated by Evans and Ochsner; we, ourselves, have seen them in only 4% of cases : they were anastomoses between the head of the pancreas and the second portion of the duodenum.

Synthetic study of the lymphatic drainage of the pancreas

Studying the lymphatic drainage of the pancreas is the equivalent of defining the correspondance between the different territories of the gland and one or another lymph node chain or part of these chains. This calls for an ordered study of the efferents. The lymphatic drainage of the pancreas is regional; that means that one organ may be drained by several chains, and conversely, one chain may receive the lymph coming from several viscera. A "strict topographic application" may never be employed : one must only speak of a probability of right-sided drainage or left-sided drainage, *viz* drainage into the retroportal process and the right border of the origin of the superior mesenteric artery or the left lateral portal process and the left border of the origin of the mesenteric vessel. The game consisted of following the lymph current-afferents, first lymph node relay, efferents, second relay etc, from the pancreas all the way up to the thoracic duct.

The lymphatic drainage of the anterior surface of the pancreas (Fig. 20)

Body-tail upper half (probable left-sided drainage) : the first relays of the subserosal afferents are represented by the lymph nodes in the pancreaticolienal ligament and by

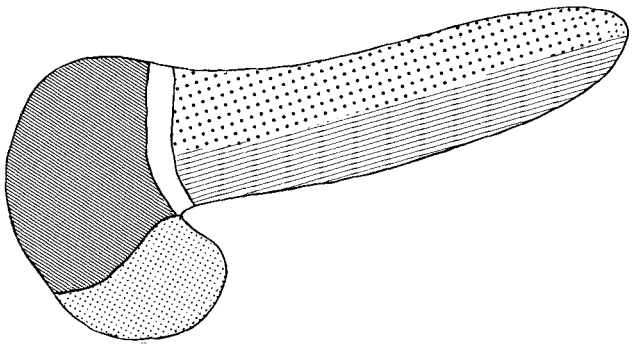


Fig. 20

Drainage of the anterior surface : Superior corporeocaudal segment toward the lienal chain and the LLPP. Inferior corporeocaudal segment toward the inferior pancreatic chain and the LLPP. Anterior aspect of the head, either toward the gastroduodenal chain (LLPP) or toward the anterior pancreaticoduodenal lymph nodes and the RPP. Uncinate process toward the RPP

Drainage de la face antérieure : Segment corporéocaudal supérieur vers la chaîne splénique et la LLPG. Segment corporéocaudal inférieur vers la chaîne pancréatique inférieure et la LLPG. Face antérieure de la tête, soit vers la chaîne gastroduodénale (LLPG) soit vers les ganglions duodénopancréatiques antérieurs et la LRP. Crochet vers la LRP

those of the splenic chain, composed of two cellulolymphatic processes : supra- and retroarterial, sub- and prevenous. The second relay is the celiac mass. The third relay is the left subrenal or pararenal nodes attained by the collectors in the middle third of the left retroportal process. There are several possibilities of reflux : posterior gastric, coronary (and in this case, there is a relay in the superior third of the lateral portal process) as well as gastrosplenic.

Body-tail lower half (probable right-sided drainage) : the first relay is the inferior pancreatic chain. The second is either in the transverse mesocolon and is then a cul-de-sac, or in the root of the mesentery proper and the chain is a satellite of the artery along its left border. The third relay is the left sub and pararenal nodes attained by the lower third of the left lateral portal process.

Anterior surface of the head : the first relay is the gastroduodenal chain (probability of left-sided drainage) or the anterior pancreaticoduodenal lymph nodes (probability of right-sided drainage). The second relays are the hepatic chain (probability of left-sided drainage) or the lymph nodes in the mesentery proper (probability of right-sided drainage) or the posterior pancreaticoduodenal nodes (probability of right-sided drainage). The third relay is the celiac mass (probability of the left-sided drainage) or the left subrenal interaorticocaval node running through the lymphatics of the retroportal process (probability of right-sided drainage). The fourth relay is the left subrenal or pararenal, lymph nodes, running to

the middle third of the lateral portal process (probability of left-sided drainage). There is a possibility of reflux via the lymph nodes of the hepatic pedicle and the hilum.

The uncinate process : the lymphatics of the inferior third of the retrovenous segment of the pancreas enter the left subrenal interaorticocaval lymph node directly, coursing along the superior mesenteric artery (probability of right-sided drainage).

Very infrequently, the efferent lymphatic channels attain the anterior pancreaticoduodenal nodes in the opposite direction and after following a long course, run into the left lateral portal process (probability of left-sided drainage).

The lymphatic drainage of the posterior surface of the pancreas

Very exceptionally injected, the subserosal lymphatics on the posterior surface of the pancreas were observed often only because of the parenchymatous anastomoses.

Body-tail : in 50% of the specimens, lymphatics pass to the splenic or the inferior pancreatic chains and end, finally, in the left sub- and pararenal lymph node via the left lateral portal process (probability of left-sided drainage).

Posterior surface of the head : this portion is composed of two elements : the posterior aspect found after retropancreaticoduodenal mobilization and the posterior aspect of the head situated immediately in front of the mesentericoportal axis and the pre-isthmic region (this portion is very short). The first portion was rarely injected. The vessels run to the inter-aorticocaval node via the right (posterior) border of the retroportal process. The second portion was never injected. However, by the anastomoses, the subserosal collectors of this surface were demonstrated in a few cases. They followed the left (anterior) border of the retroportal process (right-sided drainage) and reached the interaorticocaval node. There is a possibility of reflux via the lymphatics of the hepatic pedicle and the hilum.

Drainage territories

Five territories of drainage can be proposed :

- Superior portion of the corporeocaudal segment (anterior and posterior surfaces).
- Inferior portion of the corporeocaudal segment (anterior and posterior surface).
- Anterior surface of the head.
- Uncinate process.
- Posterior surface of the head.

Conclusions to be drawn from our anatomical study

In order to complete this research, we reconstructed the primitive dorsal mesentery of a 30 mm embryo according to Born's technique with the use of Streeter's 23th horizon (Fig. 21). The aortoceliomesenteric attachment of the dorsal mesentery grossly ressembles a capital Y with a body and 3 branches (Figs. 22, 23). The right superior branch is represented by the falx of the hepatic artery and is the upper limit of the retroportal process. The left superior branch is constituted by the undulations of the splenic artery. The lower branch is formed by the inosculation of the two processes at the level of the implantation of the mesenteric artery. The dorsal

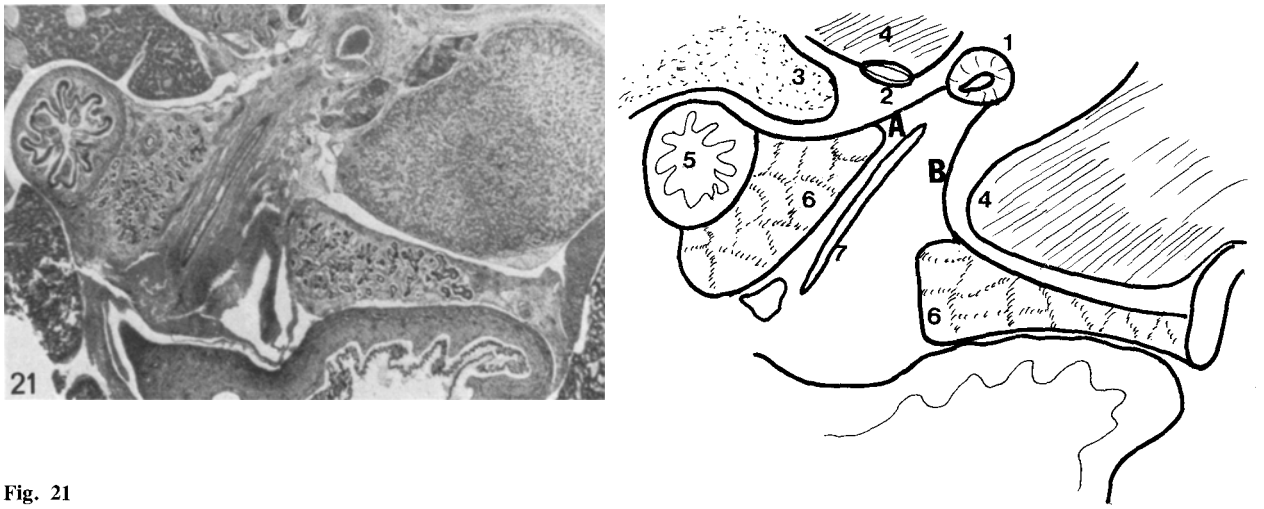
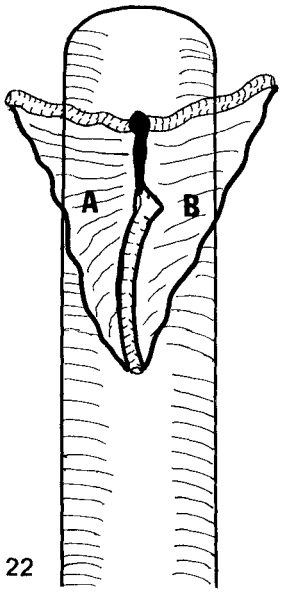


Fig. 21
The primitive dorsal mesentery of the pancreas. Transversal section of a 30 mm embryo (×25). *1* aorta; *2* inferior vena cava; *3* liver; *4* suprarenal gland; *5* duodenum; *6* pancreas; *7* superior mesenteric artery. *A* retroportal process; *B* left lateral portal process

Le méso-dorsal primitif du pancréas coupe transversale d'embryon de 30 mm (×25). *1* Aorte; *2* Veine cave inférieure; *3* Foie; *4* Glande surrénale; *5* Duodénum; *6* Pancréas; *7* Artère mésentérique supérieure. *A* Lame rétro-portale; *B* Lame latéro-portale gauche



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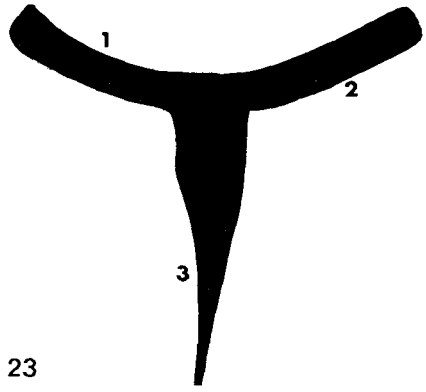

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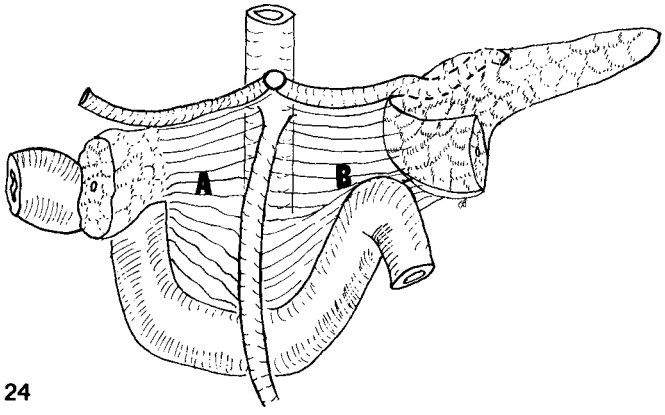

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Figs. 22-24

22 Dorsal mesentery of the pancreas. The two leaves of the mesentery. *A* RPP; *B* LLPP. **23** Posterior parietal projection of the dorsal mesentery. *1* falx of the hepatic artery; *2* falx of the splenic artery; *3* sheath of the superior mesenteric artery. **24** Dorsal mesentery of the pancreas. The viscus is split into two at the level of the neck and the double contingent may be seen. *A* RPP; *B* LLPP

22 Mésodorsal du pancréas. Les deux jupes constitutives du méso. *A* LRP; *B* LLPG. **23** Projection pariétale postérieure du mésodorsal. *1* Faux de l'artère hépatique; *2* Faux de l'artère splénique; *3* Gaine de l'artère mésentérique. **24** Mésodorsal du pancréas : le viscère est fendu au niveau de l'isthme et on peut voir le double contingent. *A* LRP; *B* LLPG

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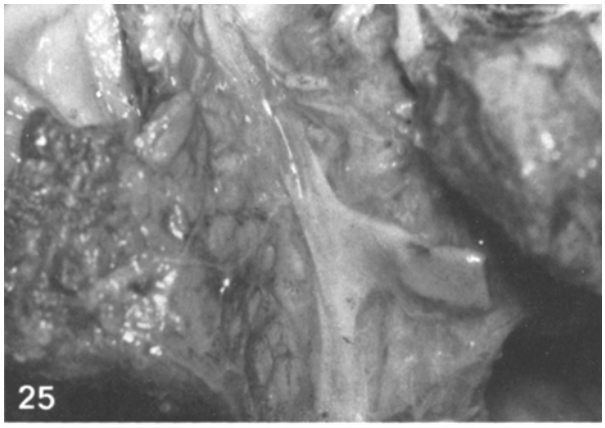
Figs. 25-28

25 First step : section of the neck, the portal confluent is discovered, on either side, the constitutive elements of the dorsal mesentery are seen : RPP and LLPP. **26** Second step : Demonstration of the RPP lifted by the scissors, the portal confluent has been resected. The mesenteric artery and the right hepatic artery may be seen. **27** Third step. Right view of the lateral portal process. The left contingent of the dorsal mesentery arising from the posterior aspect of the neck and attached to the left aspect of the superior mesenteric artery. **28** Fourth step. Right view of the left lateral portal process. The left part of the section is pulled to the left, as well as the LLPP which is reclined by a hook. The mesenteric attachment of the LLPP is clearly seen. *A* origin of the portal vein; *B* retroportal process; *C* left portal process; *D* superior mesenteric artery; *E* right mesenteric artery arising from the superior mesenteric artery and coursing through the RPP. *1* lymph nodes of the RPP; *2* lymphatic collectors satellites of the right hepatic artery; *3* lymph nodes of the LLPP

25 Premier temps : section isthmique, on découvre le confluent portal; de part et d'autre on aperçoit les deux éléments constitutifs du mésodorsal, LRP et LLPG. **26** Deuxième temps : mise en évidence de la LRP, soulevée par les ciseaux le confluent portal a été réséqué. On distingue l'artère mésentérique et l'artère hépatique droite. **27** Troisième temps : la lame latéro-portale gauche vue par la droite. On distingue le contingent gauche du méso-dorsal issu de la face postérieure de l'isthme et s'accrochant sur le bord gauche de l'artère mésentérique. **28** Quatrième temps : la lame latéro-portale gauche vue par la droite. La lèvre gauche de la section isthmique est érignée à gauche, ainsi que la LLPG qu'un crochet récline. On distingue nettement l'amarre mésentérique de la LLPG. *A* Naissance de la veine porte; *B* Lame rétro-portale; *C* Lame latéro-portale gauche; *D* Artère mésentérique supérieure; *E* Artère mésentérique droite née de la mésentérique supérieure et cheminant dans la LRP; *1* Ganglions de la LRP; *2* Collecteurs lymphatiques satellites de l'artère hépatique droite; *3* Ganglions de la LLPG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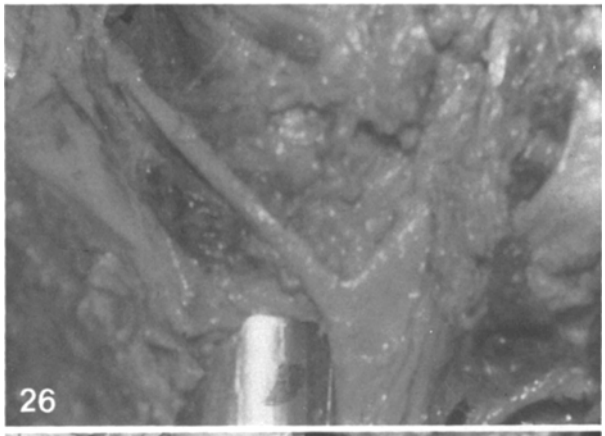
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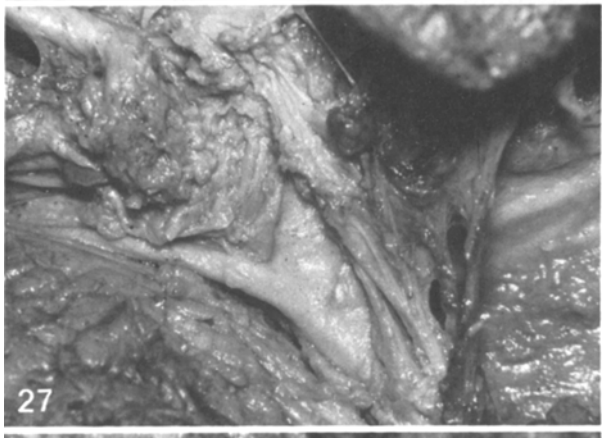
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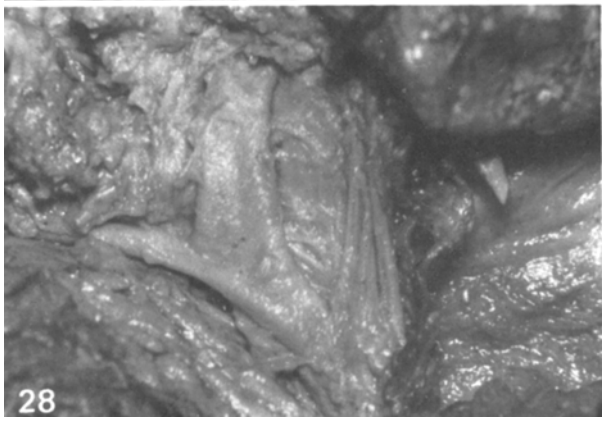
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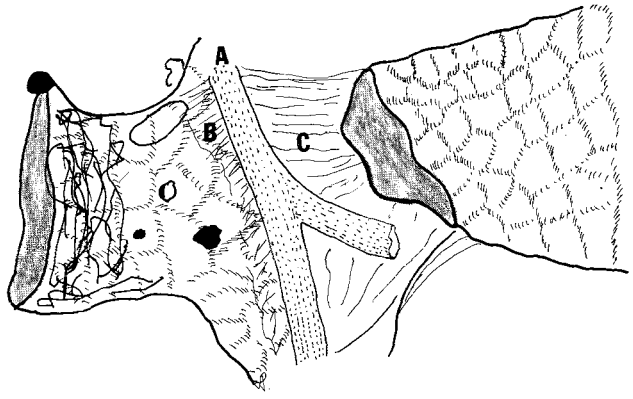
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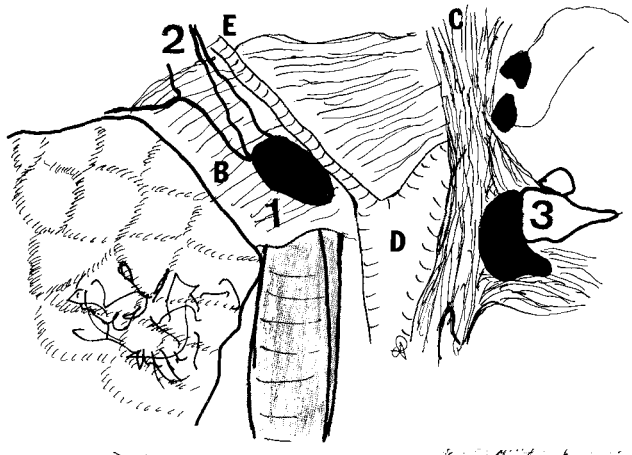
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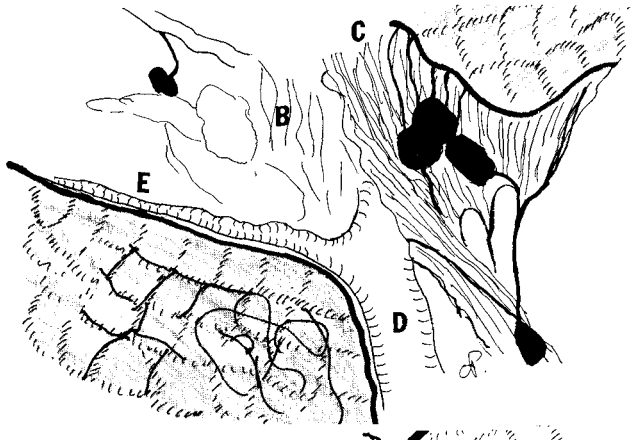
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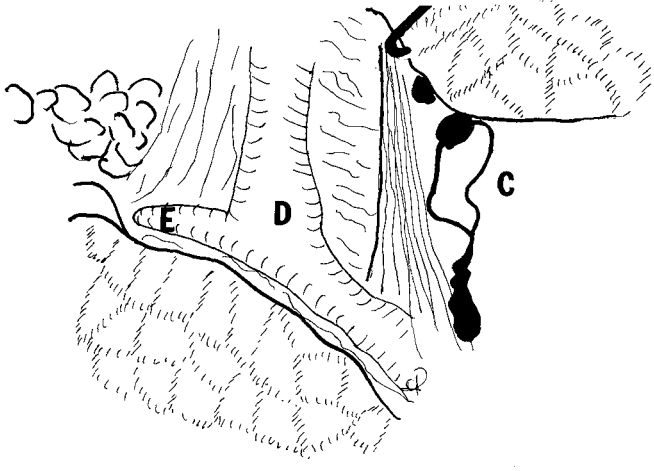
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mesentery is therefore formed by a double skirt, situated on the posterior aspect of the pancreatic neck, the apparent pivot of the organ (Fig. 24). The real pivot of the gland is represented by the sheath of the superior mesenteric artery (Figs. 25, 26, 27, 28). The mammalian pancreas is the result of the inosculation of a dorsal bud, the first to appear, with several ventral blocks fusioned into one or two ventral buds. The important work of Baum on the lymphatic vessels in the dog [11] demonstrated the passage of lymphatic collectors on the right and the left of the portal vein (vena portal) ending on either side of the superior mesenteric artery. This present study was made of 100 fetuses and newly born infants, and even if important, two major obstacles must not be underestimated : a) the extreme richness of parenchymal anastomoses in the cadaver, making it impossible to speak of a territory of drainage, but rather, at the most, of preferential drainage and b) the non existence of lymphatic drainage in the cadaver; therefore to speak of drainage would be a misuse of the term.

Lymph node metastases in carcinoma of the pancreas

Whether they are limited operations (the first cephalic pancreaticoduodenectomy was performed by Codivilla in 1898 [88] or supra-enlarged regional resections according to Fortner (1973) [41], the removal of the pancreas and the peripancreatic tissues is more or less adapted to the needs of modern surgery for carcinoma.

Pancreatic and lymph node resection

According to our anatomical study, there are 15 possible routes of drainage (first relay or efferents of the first relay) *viz.* : lienal, coronary chains and mesocolic posterior gastric reflux, inferior pancreatic chain, nodes in the root of the mesentery proper, gastrosplenic reflux, channels in the pancreaticolienal ligament, anterior pancreaticoduodenal nodes, gastroduodenal, hepatic chains, nodes of the hepatic pedicle and of the retroportal process, of the left lateral portal process and pancreaticoduodenal anastomoses. Which operation is best suited to remove what lymph nodes ?

Partial left pancreatectomies

Corporeocaudal splenopancreatectomy according to Mallet-Guy and to Leger.

Subtotal (95%) left pancreatectomy : resection of nearly all of the head of the pancreas and the uncinate process with the exception of a thin strip of parenchyma left in contact with the duodenal ring.

The first operation removes the splenic chain, the pancreaticolienal ligament, the posterior gastric reflux, the inferior pancreatic chain, the gastrosplenic reflux and a part of the left lateral portal process. The second operation removes the same as the first plus the gastroduodenal chain, a part of the anterior pancreaticoduodenal lymph nodes, a part of the hepatic chain and a part of the retroportal process.

Enlarged left splenopancreatectomy according to Brunschwig : partial gastrectomy, resection of the left colon and its mesentery, removal of the left suprarenal gland. The supplementary lymphatic beds removed are gastric, mesocolic, removal of more of the left lateral portal (suprarenal) process.

Left splenopancreatectomy with lymph node removal proposed by Couinaud (1967) [21] : the goal here is to add celiac, splenic, superior mesenteric and para-aortic (with sacrifice of the left suprarenal gland) lymph node removal to those already mentioned. The removal of the lymph nodes in the renal pedicle and in the aortic group are made easier. This intervention, which is very anatomic, is traced on the schema of lymphatic drainage, and in this manner, the removal of the lymph node beds dependant on the left pancreas (excepting the mesocolic) is complete since all the portal processes are resected as far as possible (with removal of their efferent if possible).

Partial right pancreatectomies

Cephalic pancreaticoduodenectomy for carcinoma, or the Whipple procedure (1935) [88] : this operation removes the anterior pancreaticoduodenal lymph nodes, the gastroduodenal chain, a part of the hepatic chain, the retroportal process, the pancreaticoduodenal anastomoses, a part of the lymph nodes in the hepatic pedicle and eventually the coronary chain.

Cephalic pancreaticoduodenectomy with lymph node removal according to Couinaud [21] : lymph node removal is superior to that of the first type of operation : lymph node removal of the hepatic chain (from the celiac trunk to the mesenteric artery) (theoretically complete), of the entire retroportal process with the first centimeters of its interaorticocaval efferents, most of the hepatic pedicle, and complete removal of the coronary chain. Such an operation, theoretically at least, removes all the lymph node relays of the right pancreas.

Total pancreatectomy

Association of right pancreaticoduodenectomy and the left splenopancreatectomy. Lymph node removal is

made easier and is in nearly all cases, at least as complete as in Couinaud's two operations combined. The advantage (as far as the lymphatics are concerned) is that the entire pancreatic parenchyma and the numerous intrapancreatic anastomoses are removed [20].

Enlarged total pancreatectomies

Regional pancreatectomies according to Brunschwig [14] and above all Fortner [42]. Sacrifice of the portal vein, resection of the branches of the celiac trunk, colectomy (sometimes total), gastrectomy, exceptionally resection of a part of the inferior vena cava with left nephrectomy. This type of operation indeed removes all the lymph node relays of the pancreas and all their efferents. Certainly, there is no better way for complete lymph node removal than to remove the satellite vessel. The adventia of the portal vein, of the superior mesenteric artery, of the celiac artery and of the left renal vein are lymphatic sponges and (as far as the strict anatomy is concerned), the most careful dissection can not be as efficient as complete vascular removal with reimplantation. The sacrifice of the mesocolon opens the door to further complete lymph node removal. After that, the only structures which remain are : a portion of the efferents of the terminal lymph nodes of the pancreas which intertwine around the aorta before piercing the diaphragm to form the thoracic duct and the transdiaphragmatic lymph channels, arising from the terminal lymph nodes of the processes.

The neoplasia : site of injection of the neighboring lymph node chains

The neoplasia may be compared with the site of anatomic injection; the cancer cell, "priviledged biological tracer" with the injected mass. The goal, here as in other proceding works, was to confirm or invalidate the schema of drainage obtained in the cadaver, as compared to the living human being. In order to do that, we have made use of data available in the literature as well as from a personal study.

Data in the literature

To our knowledge, the only work which mentions this problem is that of A Cubilla and Fortner [25] (Fig. 29). Twenty-two adenocarcinomas were reported : 21 involved the head and one the tail. Three Whipple type (cephalic) pancreaticoduodenectomies, 10 total pan-

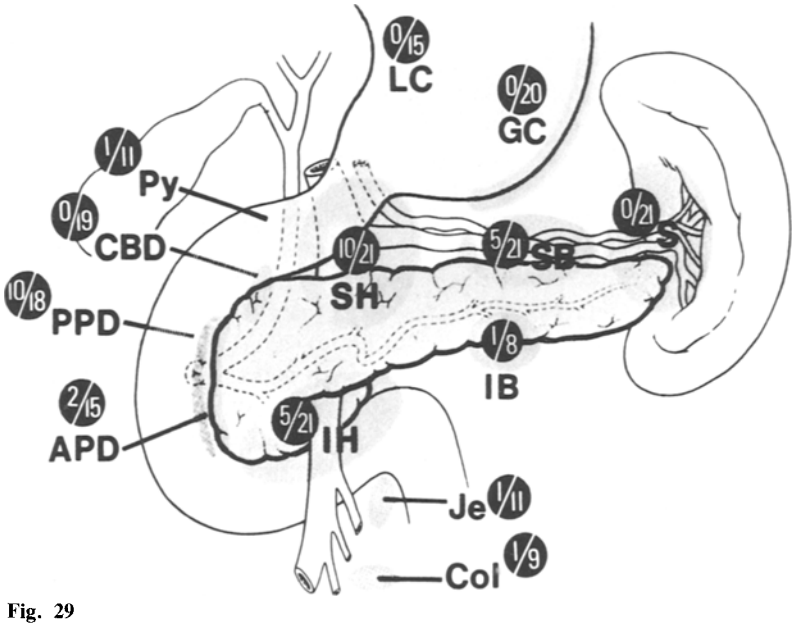

Fig. 29

The neoplasia, site of injection of the neighbouring lymph nodes (Cubilla and Fortner 1978). *SH* suprapancreatic lymph nodes of the head; *SB* suprapancreatic lymph nodes of the body; *IH* lymph nodes of the superior border of the head; *IB* lymph nodes of the superior border of the body; *PPD* posterior pancreaticoduodenal lymph nodes, satellites of the biliary tract; *S* splenic group; *APD* anterior pancreaticoduodenal lymph nodes; *LC* lymph nodes of the lesser curvature; *GC* lymph nodes of the greater curvature; *PY* subpyloric lymph nodes; *Je* root of the mesentery proper; *Col* transverse colon

Le néoplasme site d'injection des chaînes ganglionnaires de voisinage (Cubilla et Fortner 1978). *SH* ganglions supra-pancréatiques de la tête; *SB* ganglions supra-pancréatiques du corps; *IH* ganglions du bord supérieur de la tête; *IB* ganglions du bord supérieur du corps; *PPD* ganglions duodéno-pancréatiques postérieurs; *CBD* ganglions satellites de la voie biliaire; *S* groupe splénique; *APD* ganglions duodéno-pancréatiques antérieurs; *LC* ganglions de la petite courbure; *GC* ganglions de la grande courbure; *PY* ganglions sous-pyloriques; *Je* racine du mésentère; *Col* mésocôlon transverse

createctomies and 13 (regional) enlarged total pancreatectomies were performed. The first type of operation removes 33 lymph nodes; the second, 41 lymph nodes and the third, 70 lymph nodes. The average number of metastatic lymph nodes removed in each case were 1,3 and 5, respectively, for the three groups of operations.

The authors classified the lymph nodes into superior, inferior, anterior cephalic, posterior cephalic and splenic groups.

Carcinoma of the pancreas frequently involves several lymph nodes of different groups. In comparison to tumors of the papilla, the neoplasic dispersion was greater. Regional pancreatectomy removed metastatic mesenteric lymphatics 5 times in this series of 13 (and in none of the 9 total pancreatectomies and Whipple's procedures). The same was true for the retropancreaticoduodenal lymph nodes which were metastatic 8 times in the 13 regional pancreatectomies as compared to 1 time in the 6 total pancreatectomies and 7 times in the 3 Whipple procedures. Regional pancreatectomy is the solution for the superior mesenteric (left lateral portal process) and the retropancreaticoduodenal (retroportal process) lymph nodes.

Personal study

This was possible thanks to the examination of 34 case records (19 primitive malignant tumors of the pancreas and 15 mediastinoscopies) provided by the surgical unit of the Regional Hospital Center of Grenoble (Prof R Sarrazin). This small series was not homogenous and there were relatively few resections. Another fact which leads to lack of precision was that the mean number of lymph nodes found at pathological examination was only 4. No real conclusions may be drawn because of the absence of statistically significant numbers. However it may be inferred that :

In carcinoma of the head, the superior and inferior retropancreaticoduodenal lymph nodes are constantly positive. The retrocholedochal lymph nodes were massively involved as well. Conversely, when they were removed, the mesentery and left subrenal lymph nodes as well as the suprarenal gland, were normal.

In carcinoma of the body, on the other hand, when corporeocaudal splenopancreatectomy had been performed, the surgeon noted a "polycyclic celiac lymphatic mass which filled the retropancreatic space, descended to the renal pedicle passing near the aorta". The suprapancreatic coronary and splenic lymph nodes were involved. Conversely, the removal of the hepatic artery chain and the retrocholedochal lymph nodes was negative for metastasis.

We found 4 cases of mediastinal metastases of pancreatic carcinoma in the reports of the mediastinoscopies available. Positive mediastinal drainage with pulmonary metastasis was found only once in our preceding anatomical study on the lymph nodes of the stomach. In reality, this route is essential for certain lymphologists such as Dos Santos Ferreira [38] who considers this channel to be one of the great abdominothoracocervical lymphatic currents. This is the anterior as opposed to the classic posterior route. This route runs along the anterior aspect of the esophagus and ends in the lymph nodes of the tracheal bifurcation. The thoracic duct is the preferential route but the anterior channel opens up under certain pathological conditions (i.e., metastatic block leading to reflux).

Conclusion

The degree of the extension of the resection and of the lymphatic drainage system bounces up from time to time as an incompletely resolved problem. Although as extensive as possible, resection is anatomically limited by the possibilities of survival of the patient. Fortner seems to have reached these limits. It seems difficult to be able to go any further. Cancer is the local expression of a generalized disease, and catheterisation with cytological studies of the thoracic duct have frequently demonstrated the presence of neoplastic cells even though metastases were not diagnosed clinically. Our anatomical study has shown that the efferent collectors of the initial lymphatic relays of the pancreas to the thoracic duct are involved *very early*. The lymphatic visceral current is double : left and right. The vague term of "retroportal retropancreatic crossroads" which only hides our ignorance, must be dismantled. Pathologically, the metastatic involvement is sometimes double, left-and right-sided and gives the impression of an enormous retropancreatic block. However, in the early stages, at least, only one of these two currents may be involved. One must see there an unfortunate contingency : the fact that the malignant essence of the disease is located only a few millimeters from the beginning of the thoracic duct. In these conditions, the surgical maximum is not always a therapeutic optimum. Although interesting from an anatomical point of view, can these operations be considered to be of value carcinologically ? Is the gain in survival worth more than what is lost by postoperative mortality ?

Lymphatic circulation of the pancreas and pancreatitis

Even though very interesting, the study of the lymphatic drainage of the pancreas is not very useful for the

management of carcinoma, at least not for the moment. Indeed, the limits of cellulonodal removal are often known in advance and the knowledge of the lymphatic drainage loses some of its interest. The decision of resection versus by-pass operation is therefore usually taken independantly of the theoretical concept of the lymphatic drainage of the viscus. Moreover, carcinoma is not the most frequently encountered pathology of the pancreas and its mortality is less than that of acute necrotizing pancreatitis.

The theory of pancreatitis of lymphatic origin

Klippel and Lefas [55], Opie [65], Maugeret and Thiroloix [60] have suggested that the communications between the gall-bladder and the pancreas could explain, for a large part, that acute pancreatitits might be the consequence of biliary disease. Operative demonstration of edema and necrosis of the pancreas associated with multiple turgescent lymph nodes and lymphatic collectors appeared to be an excellent means of confirmation for these authors. This idea prevailed until 1930 when people began to think that the nodal involvement was a consequence and not a cause of acute pancreatitis. However, from time to time, this idea comes back to the scene and the enthusiasm of certain surgical teams for the lymphatic system seems to precede a rediscovery of the lymphatic drainage of viscera (Dalmas and Picaud [26], Kalima [53]).

Role and modification of the lymphatic system during acute pancreatitis

Falloise and Bainbridge [5] in 1905, making use of the discovery of Bayliss and Starling, showed that the intravenous injection of secretine could provoke a significant increase of the flow in the thoracic duct. Blalock [13], in 1937, was able to provoke severe and sometimes fatal pancreatic edema, by isolated ligature of the thoracic duct in the dog. In 1947, after making an intraperitoneal injection of lipase with a suspension of fine particles of graphite, Perry [66] concluded that the lymphatic vessels were the vectors of transmission of lipase in the phenomena of pancreatic fat necrosis.

The American studies

They are the most important :

Dumon [30, 31] : he was the first to report irrefutable proof of the fundamental role of the lymphatic system in the drainage of pancreatic enzymes. After catheterisation of the thoracic duct and injection of secretine and morphine, either alone or in association, he was able to emphasize the relationships between the secretion of the exocrine pancreas and the lymphatic circulation. The lymphatic system plays the role of a "safety valve" or a "buffer system" against canalar hypertension.

Anderson [2, 3] : this author became particularly attached to the alterations of the microcirculation induced by acute pancreatitis. During acute hemorrhagic pancreatitis, the erythrocytes which have escaped from the interlobular spaces, penetrate into the lymphatics and obstruct the lymphatic circulation. This important extravasation removes from the systemic circulation a notable quantity of globules and plasma and may be an explanation for the severe hypovolemia observed in pancreatitis. Canulation of the thoracic canal was presented as a solution for diverting the lymph, conveyor of "toxic substances". However this aggravates the depletion which must be stopped in order to reestablish the volemia.

Reynolds (1970) [78] : this author reported an anatomoclinical and a pathological study of the lymphatic system of the gland during chronic and acute pancreatitis by measuring the rate of the pancreatic lymphatic circulation. This was accomplished by intraoperative injection of Patent Blue, as suggested by the works of injection of lymphatic vessels and viscera by Weinberg [87] and then Servelle [82, 83].

The Belgian studies

Godard, Leduc [44], Duprez [34, 35, 36] Dupont [33] : they deal exclusively with the lymphatic microcirculation and its modifications during the phenomena due to pancreatitis. In order to explain the intraparenchymal diffusion of the activated enzymes, there is no need to turn to canalar rupture. The molecules are collected by the interlobular lymphatic vessels. This lymphatic and interstitial diversion is as important as the venous drainage. Water and cristalloids penetrate easily into the blood capillaries whereas the macromolecules (enzymes for exemple) are drained exclusively by the lymphatic vessels. It is higly probable that pancreatic edema is the result of the insufficient lymphatic drainage in the presence of the sudden flooding due to the exocrine pancreas. However, edema, once formed, creates a vicious circle. The lymphatic vessels are compressed, their function of elimination is greatly reduced and then suppressed. This is the beginning of necrosis.

The other studies

They are from the Hungarian (Foldi and Szabo) [80], and the Czechoslovakian schools (Bartos and Malek) [7, 57]. They arrived at the same conclusions as the

preceding authors. That was not the case of Murat and Barbier [64] who performed ligatures of the efferent lymphatic collectors. However, the authors from Strasbourg (Grenier and Gillet) [45] have emphasized the importance of the lymphatic vessels in the pleural effusions in which the level of amylase is higher than that of the blood during lesions of fat necrosis. By her studies of anatomy and lymphology, Hidden was able to show that the ligature of the thoracic duct in the rat was all the more fatal by acute pancreatitis if the animal had been fed on a fatty diet. In order to explain the survival of certain rats, the problem of lymphaticovenous anastomoses may be raised [48, 50].

Personal study

In order to break the vicious circle which irreversibly leads to necrosis, one must act in the beginning hours just after the onset of pancreatitis. If the slowing down of the lymphatic system is one of the causes of necrosis, it should be interesting to use a drug which is considered to be a lymphagogue : a) increase in the rate of circulation and therefore in the rate of flow; b) increase in the permeability of the lymphatic capillaries and therefore in reabsorption. It may be that these mechanisms allow the patient to survive the initial stages of the disease and thus provide the possibility of successful treatment of the causative disease. For instance, in the case of the migration of a choledochal stone (the causative disease) with acute edematous pancreatitis (the complication), the chronology of management might be as follows emergency traditional treatment of pancreatitis associated with a lymphagogue drug, once the diagnosis of acute pancreatitis has been made; biliary surgery (within the first 12 h) which might be cholecystectomy, choledocotomy and drainage of the principal biliary duct, once the diagnosis of biliary lithiasis has been made.

Nevertheless, before proposing a therapeutic schema in human clinical practice, it was advisable to first undertake the following experimental study in order to : appreciate the lymphatic circulation in the dog, induce acute pancreatitis, appreciate the anatomical lymphatic modifications, apply the lymphagogue treatment, and follow the clinical and anatomical courses.

Experimental procedure

Fourteen mongrel dogs were used for the experiment. Anesthesia by Nesdonal. The dogs were not given any food for at least 12 hours before the operation. A midline puboxiphoid incision was the approach used in all cases. Blood was drawn for electrolyte, amylase, creatine, nitrogen, bilirubin and glucose determinations preoperatively and postoperatively during 7 days.

Posterior lymphatic drainage : rate of the lymphatic circulation of the pancreas : after laparotomy, the pancreas was exposed. The site of injection was chosen (right lobe, body, left lobe) and the injection was performed with a lymphography injection needle which was then connected to an automatic pump-driven syringe. The product used was a 4% solution of Pontamine Sky Blue 6 Bx, the same as we used in our preceding study of the stomach [71]. The output of the pump was calculated to be 1 ml/mn. The chronometer was then started. The delay of appearance of the dye in the posterior lymphatic vessels was noted. The posterior drainage was visible on the right side by bending the duodenum over to the left, and on the left side by exteriorisation of the splenopancreas which is very easy, without any surgical mobilization, in the dog. Posterior drainage was constant; it was found in every case and photographs were taken (Fig. 30). The drainage system was included in the dorsal attachment of the pancreas and was much easier to demonstrate in the dog than in the human. This dorsal attachment may be considered to be the "hilum of the pancreas", a vestige of the primitive dorsal mesentery. The collectors arising from the posterior surface of the pancreas always reach the inferior border of the renal vein before disappearing behind it. The time elapsed between the injection of the pancreas (with a solution whose concentration is known and whose rate of infusion is constant), and the appearance of the dye in the posterior lymphatic vessels, terminal network, seemed to be the only contingent variable whose distribution could be studied. The average rate of circulation was 95 ± 26 seconds.

Incidence of the pucture site and the parenchymal injection : could the puncture and the subsequent injection of dye be responsible for acute pancreatitis ? The two criteria chosen (clinical course of the animals and determination of amylasemia) are in favor of a "pancreatic reaction" (i.e. a mild pancreatic edema evaluated by an increased amylasemia) which is probably due to the manipulation, puncture and injection of dye. On the other hand no fatal cases of pancreatitis were observed.

Effects of the ligature of the efferent lymphatic vessels of the pancreas : in two dogs, a ligature of what was considered to be the efferent lymphatic vessels of the pancreas was performed. Based on human anatomy, a bibliographic study of comparative anatomy and the observations of the anatomy of the 14 dogs, we tend to believe that the efferents of the entire pancreas are concentrated on the posterior surface of the pancreas at the level of the dorsal attachment. A double ligature of the collectors was relatively easily performed with a 0000 green nylon suture. This ligature was made near the gland. During the postoperative period, amylasemia

increased to significant levels fairly rapidly. Both dogs had a similar postoperative course : critical state within a few hours postoperatively and death at the 24th h. An autopsy was performed on the second day and a total pancreaticoduodenectomy was made. The specimen was referred to our pathology department.

Dog n° 6 (GR80 H 01) : "Demonstration of lesions of acute necrotizing pancreatitis with foci of exocrine parenchymal necrosis and coagulation, areas of fat necrosis. The greater omentum was streaked with congestive vessels, mottled with hemorrhagic areas and fibrino-leucocytic and necrotic exudates. Areas of fat necrosis were also noted".

Dog n° 7 (GR80 H 02) : "Demonstration of lesions of acute hemorrhagic and necrotizing pancreatitis characterized by foci of coagulative necrosis of the exocrine pancreas, areas of fat necrosis and hemorrhagic suffusion in the connective tissue septa and in the juxtaduodenal portion of the parenchyma".

Conclusions. Criticisms

Anatomic : the posterior drainage seems to represent the terminal network of the lymphatic system of the pancreas.

Lymphatics : the rate of lymphatic circulation in the pancreas (as determined by the lapse of time necessary for the appearance of dye in the lymphatic channels of the pancreas) using Pontamine Sky Blue dye was one minute and 35 seconds on the average. The interval of confidence was 26 seconds.

Pathology : the puncture and the injection of dye were never responsible for fatal pancreatitis, although they provoked mild edematous pancreatitis as demonstrated by a slight increase in the levels of amylasemia. The ligation of the efferent lymphatic collectors of the gland considered to be as distal, anatomically speaking, as possible (i.e. preceeding the intestinal trunk or the thoracic duct) provoked the death of the two animals in which the procedure was carried out, within 24 hours. The pathological examination certified the existence of necrotizing and hemorrhagic pancreatitis with fat necrosis in the peripancreatic peritoneal tissues.

Statistically, the series is too short in order to be able to draw any scientific conclusions.

Lymphatic circulation and therapeutic management of pancreatitis

Physiopathology of edema

The lymphatic circulation plays a double role : drainage of excessive water and electrolytes from the tissues, resorption of macromolecules, especially of the proteins which are conveyed from the intestinal medium to the systemic circulation. Most of the proteins of the interstite are derived from the plasma which is responsible for the turnover of the extravascular proteic pool. The other proteins are endogenous : hormones, enzymes, antibodies...

Origin of the lymph (Starling's law) : the lymph originates in the initial avalvular lymphatic capillary, network whose meshes are rather wide and situated in the interstitium. The fluid is derived from the blood within the capillaries in which the liquid is permanently renewed. The passive diffusion results from the hydrostatic and osmotic pressure gradients between the different compartments, *viz :* capillary blood, tissues, lymphatic capillaries. The content of protein varies from one region to another and depends on the permeability of the lymphatic capillary. The ratio :

$$\frac{\text{content of protein in the lymph}}{\text{content of protein in the plasma}}$$

is the reflection of the permeability. The initial postcapillary lymphatic channels collect the lymph by a pump mechanism (of Casley Smith) [17], due to successive contractions of the lymphatics. Thus, the lymphatic drainage is assured.

Drinker's law : circulatory return is assured by the lymphovenous couple and edema only appears when this couple has failed. Venous return plays an essential role for water and electrolytes, whereas the lymphatic circulation plays the leading role for proteins. Drinker's hypothesis is still true : the proteins conveyed to the interstitial tissues by the systemic circulation regain the general circulation only after passing through the lymphatic system. Lymphatic edema is rich in protein.

Physiopathological applications : the greater part of the lymph in the thoracic duct is derived from the digestive viscera, especially the liver. Portal hypertension, due to intra- or posthepatic block, greatly increases the rate of lymph flow in the thoracic duct. Edema and its final expression, ascites, only appear when the efferent collectors have become saturated and the lymphovenous couple has been overrun. Ligation of the lymphatic channels of the kidney will provoke edema, polyuria with a decrease in osmolarity and transient proteinuria. Conversely, ligation of the ureter will provoke a very important increase in the lymph flow-rate. Postoperative lymphocele after kidney transplantation represents the price that it is sometimes necessary to pay because it is not possible to avoid the consequences of the severance of the "lymphatic circulation" of the organ.

Therapeutic consequences on the lymphatic system

A great deal of drugs will act, to various degres, on the lymphatic circulation. However, all or nearly all of them

act indirectly by modifying the capillary pressure and their filtration. Presently, it seems difficult to affirm that a truly specific lymphotrope treatment has been found.

Drainage of the thoracic duct : developing further the results of Dumont, Bartels and Malek have proposed to treat pancreatitis by catheterization of the thoracic duct. However, it is above all in chronic disease that this technique seems to provide best results. This method has been widely used in the palliative treatment of cirrhosis with edematous and ascitic decompensation. Success with this treatment has been variable [9, 32, 58].

Melilot's extract : Foldi and Zoltan have studied the pharmacodynamic effects of benzopyrones on the lymphatic circulation system [39, 40]. Vitaminic factors, the most commonly utilized being coumarin (5,6 benzopyrone), is associated with another benzopyrone, troxerutin, in two commercialized preparations, one in France, the other in the Federal Republic of Germany. The works of Foldi, Bartos, Mislin, Collard and Preisich [8, 10, 18, 63, 75] have demonstrated the dilatation and the direct spasmolytic action of Melilot's extract on the thoracic duct and the great lymphatic channels. This treatment has been proposed for edema of lymphatic origin, i.e. rich in proteins.

Proposition of a medicosurgical therapeutic schema

Whatever else, the lymphatic system has never been incriminated in the genesis of acute pancreatitis. Its role is nonetheless important during the short lapse of time in which it is involved in the pathophysiological process. Edema is the first manifestation of pancreatitis. Necrosis appears secondly. Canalar hypertension, the passage of liquid through the excretory duct walls containing activated enzymes which rush out into the interstitial tissues, creates edema which in turn, dissociates the acinous patterns. This type of edema, rich in protein, should be assimilated to inflammatory edema, because it is secondary to increased vascular permeability. Resolution depends on its drainage by the lymphatic system. The more the acinous walls are compressed by edema and the lymphatic drainage is inefficient, the more the lesions of necrosis are marked. In these circumstances, the utilisation of very high doses of Melilot's extract may be considered. The recourse to lymphogoguous drugs must mandatorily be associated with protease inhibitors, even though there is no patent necrosis. By definition, the role of the protease inhibitors is only biochemical : that of opposing the action of the activated protein enzymes. Most surgical teams have shown their complete ineficiency in preventing the progression to necrosis, not any more than any other drug is capable of restoring a gangrenous lower limb, at least up until present times. Lymphagogue therapeutic measures increase the capacity of drainage of the interstitial space by the lymphatic system. In this manner, they provoke an important afflux of activated enzymes into the circulatory stream (through the left subclavian vein). If coumarin is administered at very high doses never yet employed in human beings, the risk of fatal shock will probably never be avoided if the drug is to be really efficient against these enzymes. A pragmatic type of therapeutic essay conducted in man was described in my thesis. A strict selection of patients has led to the choice as well as to the limitation of the study to, for example, only acute biliary edematous pancreatitis. The association of a lymphotrope antienzyme treatment must never delay biliary surgery when indicated.

Conclusion

The cadaveric study of the lymphatic drainage of the pancreas seems to show that there are 2 portions of the gland. Their embryonic origin, innervation, surgical approach, pathology and lymphatic drainage have been individualized.

Right pancreas	*Left pancreas*
Ventral pancreas	Dorsal pancreas
Right celiac nervous plexus	Left celiac nervous plexus
Retropancreaticoduodenal mobilization (Kocher's maneuver)	Corporeocaudal splenopancreatic mobilization
Biliary pancreatitis	Non biliary pancreatitis
Retroportal process	Left lateral portal process
Gastrocoloenteric confluent of the right great lymphatic stream	Gastrosplenocolic confluent of the left great lymphatic stream

One pathological condition is shared by both portions, precisely that which may separate them anatomically, "the pancreas divisum". The terminal lymphatic networks seem to be represented by the efferent collectors included in the retroportal process on the right, and the lateral portal process on the left. In the dog, the ligation of these efferents, close to the pancreas in order to avoid any possible shunts, was followed by hemorrhagic and necrotizing pancreatitis. It is permitted to imagine that in these conditions a lymphagogue treatment may be an useful adjuvant in the treatment of acute pancreatitis in its edematous stage, allowing one to wait until the danger point has been turned.

Work from the Anatomy Laboratories of the Medical and Human Biologic Units of Teaching and Research of Bobigny (Professor JP Chevrel), of the Faculty of Medicine of Grenoble (Professor Y Bouchet) of the Faculty of Medicine of Montpellier (Professor P Rabischong) and from the Service of General Surgery of Bagnols sur Ceze (Dr A Pissas).

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