# BLOOD VESSELS DISTRIBUTION IN BODY AND TAIL OF PANCREAS- A COMPARATIVE STUDY OF AGE RELATED VARIATION

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## Abstract

Arterial vascularization of the pancreas has been investigated, as well as variation in vascularization of this organ with regard to the existence of age differences. Aim of the investigation was to establish differences, if any, in newborns pancreas vascularization since diseases invading this organ in newborns have increased recently at this particular age. Injection-corrosion method was used on pancreas arteries and their variations. Twenty-four human pancreas specimens were used for this purpose consisting of 24 cadaver organs aged between 45 and 65, and 12 pancreases of still-born babies. Comparison of the findings has shown that there was no difference in the number, ramification pattern and arterial course between the two experimental groups of organs; all possible blood vessel variations were most probably the result of developmental processes which occur during early stages of intrauterine development.

KEY WORDS: arteries, pancreas

## Introduction

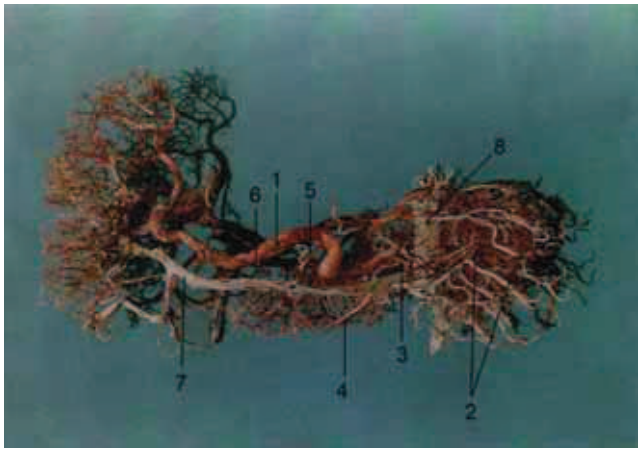
Corporocaudal segment of human pancreas is supplied with blood by splenic artery. Branches of splenic artery, which extend to the body and to the tail of the gland include: dorsal pancreatic artery, inferior pancreatic artery, greater pancreatic artery, artery to tail of pancreas, and pancreatic branches. These branches frequently anastomose among themselves and make rich anastomotic loops of different forms and sizes. Arterial vascularization of the pancreas has been studied, as well as variations in vascularization of this organ in various age groups. The aim of the investigation was to explore possible differences in pancreas vascularization of newborns, since diseases invading this organ at this particular age have recently increased in frequency.

## Material and Methods

In this study, we used 24 human pancreas harvested from cadavers 45 to 65 years of age, and 12 pancreases of still-born babies. All research described in submitted publication involving human subjects and material derived from human subjects complied with ethical principles outlined in Helsinki Declaration. Since preserved blood vessels were critical factor for successful preparation, the preparation started within 36 hours from the moment of death. Period longer than 36 hours considerably reduces value of the preparation. Therefore, we removed duodenum, pancreas and spleen with a portion of abdominal aorta. The ends of arteries were prepared by careful dissection. During the preparation we took care to preserve venous elements. In several preparations, we injected plastic mass into the celiac trunk and superior mesenteric artery. The method consists of two phases, injection and corrosion. After arteries were accessed, a ligature was made in blood vessels that were not necessary for stuffing. Injection needles with a rounded point were inserted into the arterial lumen, which was subsequently fixed. Injection mass consisted of 12% vinyl chloride acetonic solution dyed with acid-resisting dyes. The stuffed preparations were placed into wide glass containers with cold water in order to allow hardening of plastic mass. Preparations were immersed in technical HC1 after 24 hours. While acid degraded soft tissues, plastic casts remained in place of blood vessels. After 7 - 10 days, the preparations were washed in mildly running water in order to remove soft tissue residues. Such obtained preparations were analyzed for developmental changes, flow and position of pancreas arteries.

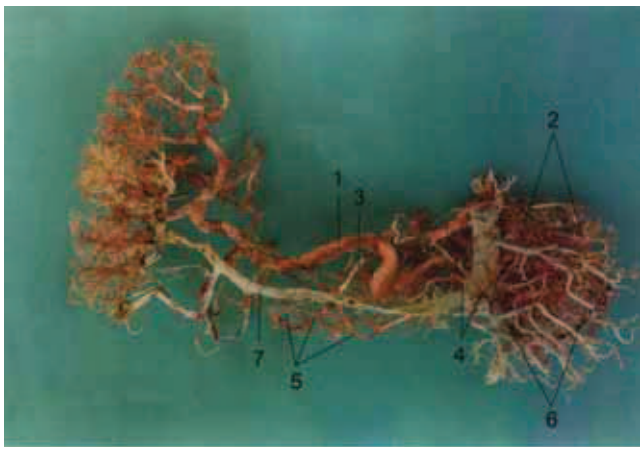
## Results

The system of blood vessels that branch off splenic artery towards pancreas and blood vessel that enter splenic vein as well as the system of blood vessels that branch off gastroduodenalis and upper mesenteric arteries towards the head of pancreas and duodenum were investigated by injection of plastic mass into the blood vessels of the models 45 to 65 years of age. The arteries which branch off the spleen artery towards the body and the tail of pancreas are distributed in classical manner with




1. splenic artery
2. posterior duodenopancreatic arcade
3. dorsal pancreatic artery
4. inferior pancreatic artery
5. greater pancreatic artery
6. rami pancreatici
7. splenic vein
8. superior mesenteric vein

FIGURE 1. Blood vessels of pancreas obtained by injection-corrosion method. Dorsal view



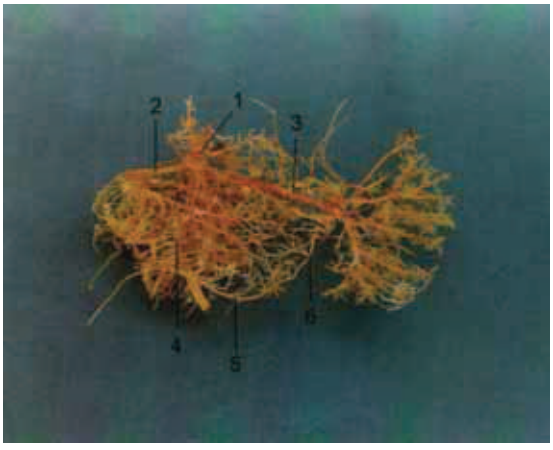

1. splenic artery
2. posterior duodenopancreatic arcade
3. greater pancreatic artery
4. anastomotic loops between body and head
5. anastomotic loops on body
6. dorsal pancreaticoduodenalis veins
7. splenic vein

FIGURE 2. Arteries vascular net and veins of pancreas. Dorsal view

well expressed greater pancreatic artery, dorsal pancreatic artery, inferior pancreatic artery and artery to tail of pancreas. Blood vessels in the area of pancreatic head and duodenum form anterior and posterior duodenopancreatic arcades, which form smaller branches that participate in forming secondary arcades (Figure 1).

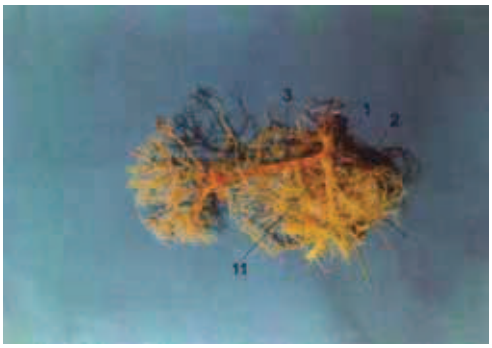
In the body and the tail of the gland, the branches of all arteries form rich anastomoses. Anastomotic network is formed of loops of various form and size (Figure 2).

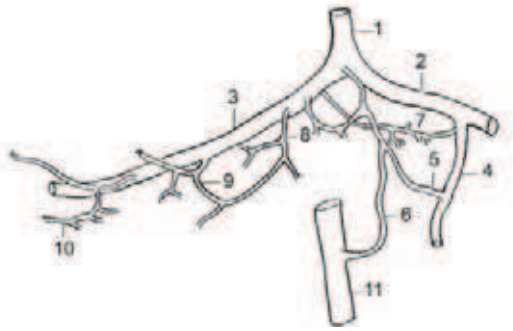
An anastomosis between the arteries of the pancreatic head and the tail was established via dorsal pancreatic artery in all cases. Namely, the right branch of dorsal pancreatic artery forms an anastomosis with pancreaticoduodenal superior anterior artery, which is the branch of gastroduodenal artery. Arteries in the pancreatic tail also anastomized, in particular greater pancreatic and dorsal pancreatic arteries. Artery to tail of pancreas participated in creating anastomoses with the arteries of the pancreatic tail (Figure 2). From case to case, when the diameter of larger blood vessels was smaller than usual, pancreatic branches had increased diameter and were more numerous. Splenic vein, superior mesenteric and portal vein were well visualized in our models. Intrapancreatic veins in the area of the body and the tail were also injected. Unlike the analyzed arteries, most of the veins were short, sparse and




1. celiac trunk
2. common hepatic artery
3. spleen artery
4. superior mesenteric artery
5. right gastroepiploic artery
6. left gastroepiploic artery

FIGURE 3. Corrosion preparation of a newborn. Ventral view




1. celiac trunk
2. common hepatic artery
3. splenic artery
4. gastroduodenal artery
5. pancreaticoduodenal superior posterior artery
6. pancreaticoduodenal inferior posterior artery
7. supraduodenal artery
8. dorsal pancreatic artery
9. greater pancreatic artery
10. inferior pancreatic artery
11. superior mesenteric artery

FIGURE 4. Corrosion specimen of a newborn. Dorsal view

maintained vertical position. All the veins that collect blood from the area of the pancreatic body and tail converge into the splenic vein. At the level of the pancreatic head and duodenum richer venous vessels were observed. These veins follow the course of arteries and are positioned vertically against the duodenal axis. Veins of the pancreatic head and duodenum converge into portal vein or upper mesenteric vein after they have formed front and rear pancreatic-duodenal veins (Figure 2). Rich vascular network in the pancreas was demonstrated by injection-corrosive method in the newborn model (Figure 3). In all models, trunks celiac and upper mesenteric artery branched off abdominal aorta. Due to the small diameter of the blood vessels in newborns, we used magnification to better observe and describe the arteries which diverge for pancreas.

In one model we found arterial trunk which diverged at exact place where celiac trunk divided into its terminal branches. This arterial branch was divided into two branches; the one that diverged towards the right side and participated in forming posterior pancreatic-duodenal arcade and the one that diverged towards the left side and participated in anastomoses with pancreatic branches of splenic artery. It should be mentioned that the named branch diverged from celiac trunk at its posterior side (Figure 4).

The other arterial branches which diverge towards pancreas in this case had its usual course. In infant models, arteries at the periphery of organs formed rich anastomoses so that capillary network was visualized well in the pancreatic body and tail. If we compare models of the age group 45 to 65 years to the newborn group we may conclude there are no differences in number, manner of branching and course of the arteries in these two groups. In newborns, we noted the abundance of blood vessels that is not observed in models of the age group 45 to 65. In adults there is a relative reduction in arterial network caused by the growth of the organ. Possible variation in the blood vessels most likely occurs in the first month of intrauterine development during formation of the arteries which vascularize branches of supra-mesocolic "floor".

## Discussion

Examination of the corpororcaudal segment of the pancreas blood system by injection-corrosive method provides many precise and detailed data since it enables visualization of main arterial branches and their final branches to the level of arterioles. Blood vessels in the area of body and tail of pancreas anastomize well and the ensuing network consists of loops of different forms and sizes. The established distribution of blood vessels in body and tail of pancreas corresponds to the one described by most authors (1, 2, 7). All the arteries that diverge towards the area of body and tail of the gland richly anastomize so that we observed well developed arterial-arterial intracorporal anastomosis and anastomosis between body and tail of the gland. However, arteries of the pancreatic body anastomized with arteries of the pancreatic head. Understanding the exact anatomy of the arteries

that vascularized corporal-caudal segment of the pancreas has its practical value. In accordance with the data from literature and those obtained in this study, it can be stated that the body and tail of pancreatic have rich vascularization. The described numerous anastomoses in this area indicate the possibility of establishing collateral circulation in the case of reduced blood flow through one or more arteries. Many authors (3, 4, and 6) stated that splenic artery was exclusively responsible for vascularization of the pancreatic body and tail. There are also studies that describe vascularization of the corporo-caudal segment of pancreas, which is provided from other sources (5, 6). In newborns, an abundance of blood vessels, which do not appear in models of 45 to 65 years age group, is observed. There is a relative reduction of arterial network in adults that is most likely caused by the growth of the organ. Following the review of the available reference data we found no information regarding vascular network of the newborns. The results of our investigation indicate that the pancreatic body and tail are in whole vascularized by splenic artery and its collateral branches, whose number ranges from one to five. By concluding this investigation and in accordance with the findings of most authors we may observe that spleen artery and vein form one vascular axis sufficient enough to maintain corporo-caudal segment of pancreas during its transplantation.

## Conclusion

Pancreas is vascularized by splenic, gastroduodenal and mesenteric superior arteries. The above mentioned blood vessels send numerous branches into the different parts of pancreas and adjacent organs. Therefore, the arterial network of pancreas is in close relation with the arterial circle of the surrounding organs. Anastomoses exist at all levels of pancreas, i.e. between the body and the head of pancreas, the body and the tail and intracorporal anastomoses. The above mentioned anastomoses provide good blood supply to the organ as a whole in a case of compromised blood supply of one or more main arteries and these anastomoses may be considered sufficient anastomoses. Comparison of the findings revealed no differences in the number, ramification pattern and arterial courses between the two experimental groups of organs. All possible blood vessel variations were most probably the result of early processes of intrauterine development. Existence of the individual differences, the development of artery-arterial anastomoses indicates obligatory preoperative supraselective angiography that enables insight into the blood vessels distribution "in vivo".

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