

# The pancreaticoduodenal arteries in human foetal development

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*Knowledge of the course of the pancreaticoduodenal arteries is of great importance in pancreatic surgery. Lack of care in the preparation of these vessels may lead to ischaemia or necrosis of the duodenum, the first loop of the jejunum, the head of the pancreas and even the liver, bile ducts and transverse colon. In such events, the surgeon would need to diagnose the course of the vessels and their anastomoses intraoperatively. Anatomical dissection in this special area diminishes the risk of early complications in the form of bleeding and late complications in the form of narrowing of the anastomoses, fistulas, necrosis and intestinal ileus after surgical resection or drainage. The aim of the present study was to determine the variability of the pancreaticoduodenal arteries in human foetuses. The material examined consisted of 60 human foetuses of both sexes (33 male, 27 female) from spontaneous abortion or stillbirth and ranging in age from the 16<sup>th</sup> to 38<sup>th</sup> week of prenatal life. White latex solution to of volume between 15 ml and 30 ml was injected into the thoracic aorta. The results of this were that a typical pancreatic supply from the coeliac trunk and superior mesenteric artery was observed in all cases. The coeliac trunk, splenic artery and gastroduodenal artery also appeared invariably. However, variability was observed in further generations of branches. The gastroduodenal artery with its branches, the anterior and posterior pancreaticoduodenal arteries, was constantly present. Irrespective of the sex of the foetus, in 10% of cases a large vessel was observed which ran horizontally on the anterior surface of the pancreas from head to tail and which originated in the anterior superior pancreaticoduodenal artery. We termed this vessel the "anterior pancreatic artery". In all cases there were anterior and posterior pancreaticoduodenal arcades, but in two cases (3.3%) a double anterior pancreaticoduodenal arcade was observed.*

**Key words:** pancreas, human foetuses, anterior pancreatic artery, pancreaticoduodenal arcade, vascular loop

## INTRODUCTION

Knowledge of the course of the pancreaticoduodenal arteries is of great importance in pancreatic surgery [5, 9, 10, 13]. Lack of care in the prep-

aration of these vessels may lead to ischaemia or necrosis of the duodenum, the first loop of the jejunum, the head of the pancreas and even the liver, bile ducts and transverse colon. In such events,

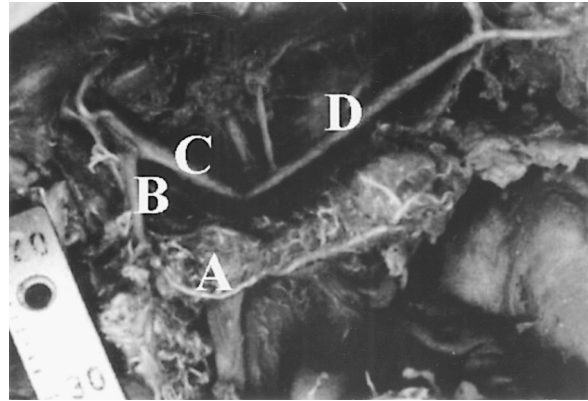
the surgeon would need to diagnose the course of the vessels and their anastomoses intraoperatively [9, 10, 21]. Anatomical dissection in this special area diminishes the risk of early complications in the form of bleeding and late complications in the form of narrowing of the anastomoses, fistulas, necrosis and intestinal ileus after surgical resection or drainage [10]. Michels' [12, 13] autopsy study confirmed the great variability of pancreaticoduodenal arcades and encouraged anatomists to undertake further research. The aim of the present study was to determine the variability of the pancreaticoduodenal arteries in human foetuses.

### MATERIAL AND METHODS

The material examined consisted of 60 human foetuses of both sexes (33 male, 27 female) from spontaneous abortion or stillbirth and ranging in age from the 16<sup>th</sup> to 38<sup>th</sup> week of prenatal life. The age of the foetuses was established on the basis of vertex-tuberal measurements in accordance with Iffy's tables [6, 7]. White latex LBS 3060 solution to a volume of between 15 ml and 30 ml was slowly injected into the thoracic aorta and the process continued until the solution had properly penetrated the terminal branches. The specimens were fixed in 10% neutral formalin solution. After dissection of the abdominal cavity, the gastrocolic ligament was severed in order to expose the pancreas and its arteries. The dissection and examinations were performed and photographs taken using a camera.

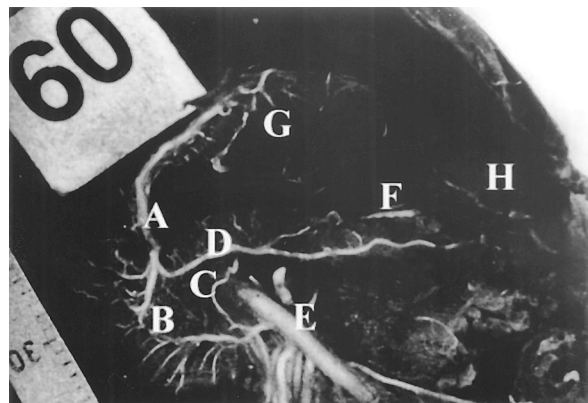
### RESULTS

In all the foetuses examined the 3 typical native arteries, namely the splenic, the gastroduodenal and the superior mesenteric, were observed. The gastroduodenal artery with its branches, the anterior and posterior superior pancreaticoduodenal arteries, was present in all cases. We did not observe any variability in the superior mesenteric artery trunk or its branches, including the inferior pancreaticoduodenal artery. However, variability was observed in the next generations of arterial branches. Irrespective of the sex of the foetus, in 10% of cases a large vessel was observed which ran horizontally on the anterior surface of the pancreas from head to tail and which originated in the anterior superior pancreaticoduodenal artery. This was termed the anterior pancreatic artery. This was termed the anterior pancreatic artery (Fig. 1). In all cases the anterior and posterior pancreaticoduodenal arcades were recognised, but in two cases (3.3%) a double anterior pancreaticoduodenal arcade was observed. These arches



**Figure 1.** Anterior pancreatic artery originates from anterior superior pancreaticoduodenal artery; A — anterior pancreatic artery, B — gastroduodenal artery, C — common hepatic artery, D — splenic artery

formed a characteristic vessel loop on the anterior surface of the head of pancreas. The former began with the superior pancreaticoduodenal artery, which was then duplicated. During their course these arteries made a semicircular loop on the anterior surface of the pancreas and joined the common inferior pancreaticoduodenal artery from superior mesenteric artery. The latter consisted of two arteries, the first arising from the gastroduodenal artery and the second being a branch from the anterior pancreatic artery. These formed a semicircle on the anterior surface of the head of pancreas, then merged into a single artery and joined the common inferior pancreaticoduodenal artery from the superior mesenteric artery (Fig. 2).



**Figure 2.** Double anterior pancreaticoduodenal arcade and anterior pancreatic artery; A — gastroduodenal artery, B — anterior pancreaticoduodenal arcade, C — anterior accessory pancreaticoduodenal arcade — "anterior loop of pancreas head", D — anterior pancreatic artery, E — superior mesenteric artery, F — splenic artery, G — stomach, H — spleen.

## DISCUSSION

The material examined consisted of fetuses above 16 week of prenatal life, when the process of formation of the pancreas from two dorsal and abdominal buds had been completed [15, 17–19]. The maternal pancreatic vessel, the splenic and gastroduodenal arteries and the superior mesenteric artery, were present in all cases and this fact corresponds to the results of the Japanese researchers Sakagami [16] and Kaneko [8]. The topography of the head of the pancreas shows that, after branching from the gastroduodenal artery, the anterior superior pancreaticoduodenal artery runs toward a point 1.5 cm below the papilla of Vater and then turns to the posterior aspect of the pancreas to join the anterior inferior pancreaticoduodenal artery [10]. The single arterial pancreaticoduodenal arcade is a permanent vascular configuration of the pancreas. Kimura [10] demonstrated its constant presence as we have done, whereas Sakagami [16] described the absence of this arch as casuistic. Knowledge of the vascular arcades of the pancreatic head may serve as a guide for a limited resection of the pancreas [5].

In 3.3% of cases we noted a double anterior pancreaticoduodenal arcade. Woodburne and Olsen [20] do not describe a similar configuration in their retrospective analysis of 150 cases [1]. Sakagami's results [16], together with our own, have demonstrated the constant presence of the posterior pancreaticoduodenal arcade, but Kimura [9] found this loop in only 88% of cases. A detailed study of pancreas vascularisation was conducted on 200 cadavers by Michels [12]. He described many variations and atypical connections between the pancreatic arteries. In his work 4 types of pancreaticoduodenal arcade, both anterior and posterior, are distinguished and classified by number: Type I consisted of a single arcade, Type II a double, Type III a triple and Type IV a quadruple arcade. Type I corresponds to a single loop described by other authors and frequently seen in our material. In Type II Michels analysed several variants of double arcade. In one case we found a duplicated pancreaticoduodenal artery, which could be included in this category but the second case of double arcade presented was different from that described by Michels. In his article [13] he claimed that the anterior and posterior pancreaticoduodenal arcades are never the same, varying in each body. In 44 out of 51 cadavers in the study made by Yamaguchi et al. [21] there was a communicating artery between the anterior and posterior pancreaticoduodenal arterial arcades. This passed

between the major and accessory pancreatic ducts and appeared to be vital for the papillary blood supply. This artery could be a good landmark during limited pancreatic resection such as duodenum-preserving subtotal resection of the pancreatic head or pancreatic segment resection. This artery is likely to be an indicator of the borders between the coeliac and superior mesenteric arterial territories, as well as those between the ventral and dorsal segments of the pancreas. No similar artery was observed in our material. In 10% of cases we noted a large vessel running horizontally on the anterior surface of pancreas from its head to its tail, which originated from the anterior superior pancreaticoduodenal artery. This vessel is called the anterior pancreatic artery.

We have not found any description of a similar artery in the literature. This artery may be a potential cause of bleeding after resection of the tail of the pancreas or spleen. We did not observe any pancreatic branches arising directly from the coeliac trunk or common hepatic artery, as described by Bertelli et al. [2] and Sakagami [16]. Nor did we find them arising from the common trunk of the inferior pancreaticoduodenal artery or the jejunal artery as in the study of Bertelli et al. [3] and Murakami et al. [14]. Furthermore, we did not confirm in our material the presence of a direct junction between the coeliac trunk and the superior mesenteric artery as observed by Feigel et al. [4]. There were also no junctions between the inferior pancreaticoduodenal artery and the left colic artery [11]. Knowledge of the vascular anatomy of the pancreas is especially important for limited resection, for example resection of the head of the pancreas in duodenum-preserving procedures and transplantation of this organ.

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