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Clinical anatomy of the caudal pancreatic arteries and their relevance in the surgery of the splenic trauma

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Abstract

Splenectomy is the treatment of splenic trauma but is not exempt from intra-operative and post-operative complications. Conservative approach is preferred for paediatric population and for minor trauma. The aim of the present study was to evaluate the vascularisation of the tail of the pancreas, with particular reference to the presence of anastomosis between the pancreatic and splenic vessels, through an anatomoradiologic study performed on 9 unembalmed cadavers (age range 44-77 years). To obtain vascular corrosion casts, the splenic, the gastroduodenal and the superior mesenteric arteries were injected with acrylic and radioopaque resins and computed tomography (CT) of the specimens were acquired. The caudal pancreatic arteries (mean number ± standard deviation: 3.2 ± 2.4) were observable in all the casts, originating from the splenic artery at its distal third (70%) and from its inferior branch (30%). At CT scans analysis the mean calibre of caudal pancreatic arteries was 2.1 ± 1.1 mm. Anastomosis were found with great pancreatic artery in 20%, and with hilar splenic artery in 80%. The pattern of anastomosis between the pancreas tail and the spleen could allow the surgeon to close the splenic artery at the origin and also the short gastric and the left gastroepiploic arteries, in cases of splenic trauma, favouring the hemostasis and allowing splenic preservation at a same time.

Key words

Spleen, anatomy, dissection, radiological anatomy, trauma.

Introduction

The spleen is the most frequently injured organ in blunt abdominal trauma, mainly because of its highly vascularized parenchyma and anatomic location. Splenectomy is the treatment of choice for splenic trauma but it is not exempt from intra-operative and post-operative complications, such as thrombocytosis, post-splenectomy infections and abdominal abscess (De Porto et al., 2010; Jones et al., 2010; Cameron et al., 2011). For these reasons, surgeons prefer to avoid splenectomy, especially for paediatric patients and for minor trauma (Upadhyaya, 2003), but have to accept the main risks of sudden delayed hemorrhage (Dent et al., 2004; Harbrecht et al., 2007; Bruce et al., 2011), of higher amount of blood transfusion (Cadeddu et al., 2006; Neal et al.,

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2012) and of not detecting other intra-abdominal lesions (Hom, 2010). The preservative approach includes conservative medical treatment and angioembolization without access to the peritoneal cavity. While the advantages of a conservative approach for minor splenic trauma have been extensively reported, its value for more severe spleen damage is still under debate (Sanders and Civil, 1999; Upadhyaya, 2003; Cirocchi et al., 2013).

From the anatomical point of view, the spleen is supplied exclusively from the splenic artery, that divides into two or three main branches before entering the hilum of the spleen. As these branches enter the hilum they divide further into four or five segmental arteries, supplying a segment of the splenic tissue (Standring et al., 2008). Other important branches of the splenic artery are the short gastric and the left gastroepiploic arteries, so that Vandamme and Bonte (1986) introduced the term truncus lienogastroepiploicus.

The aim of the present study was to evaluate the vascularisation of the tail of the pancreas, with particular reference to the branching pattern of the splenic artery, and the possible presence of anastomoses between the pancreatic tail and the splenic vasculature, by anatomoradiologic investigations.

Materials and methods

The study was performed on 9 unembalmed cadavers (age range 44-77 years; 3 males, 6 females) with no documented or anatomical evidence of pathology of the pancreas. The study was approved by the scientific coordinator of the donation program at the University of Padova, Italy. The specimens of duodenum, pancreas and spleen were excised together with the diaphragm muscle and the retroperitoneal structures, including the abdominal aorta (Macchi et al., 2001). To obtain vascular corrosion casts, the splenic, the gastroduodenal and the superior mesenteric arteries were injected with acrylic, radioopaque resin (Beracryl; Troller, Fulenbach, Switzerland; 200mL) with the specimen suspended in water, according to a protocol previously described (Macchi et al., 2003). Computed tomography (CT) axial scans of the specimens were acquired with a Philips Brillance iCT (Philips Medical Systems; Best, The Netherlands). Analysis and post-processing of the CT scans were carried out on an Aquarius Workstation (version 3.6.2.3; TeraRecon, San Mateo, California). Source images and 2D-3D reconstructions were reviewed at the workstation. After digestion of the parenchyma with sodium hydroxide, the following parameters were analysed on the corrosion casts and on the CT images:

- the presence and number of caudal pancreatic arteries, defined as branches destined to the tail of the pancreas;
- the pattern of branching of the splenic artery at the hilum;
- the presence of anastomoses between the caudal pancreatic arteries and the splenic vasculature;
- the calibre of caudal pancreatic artery.

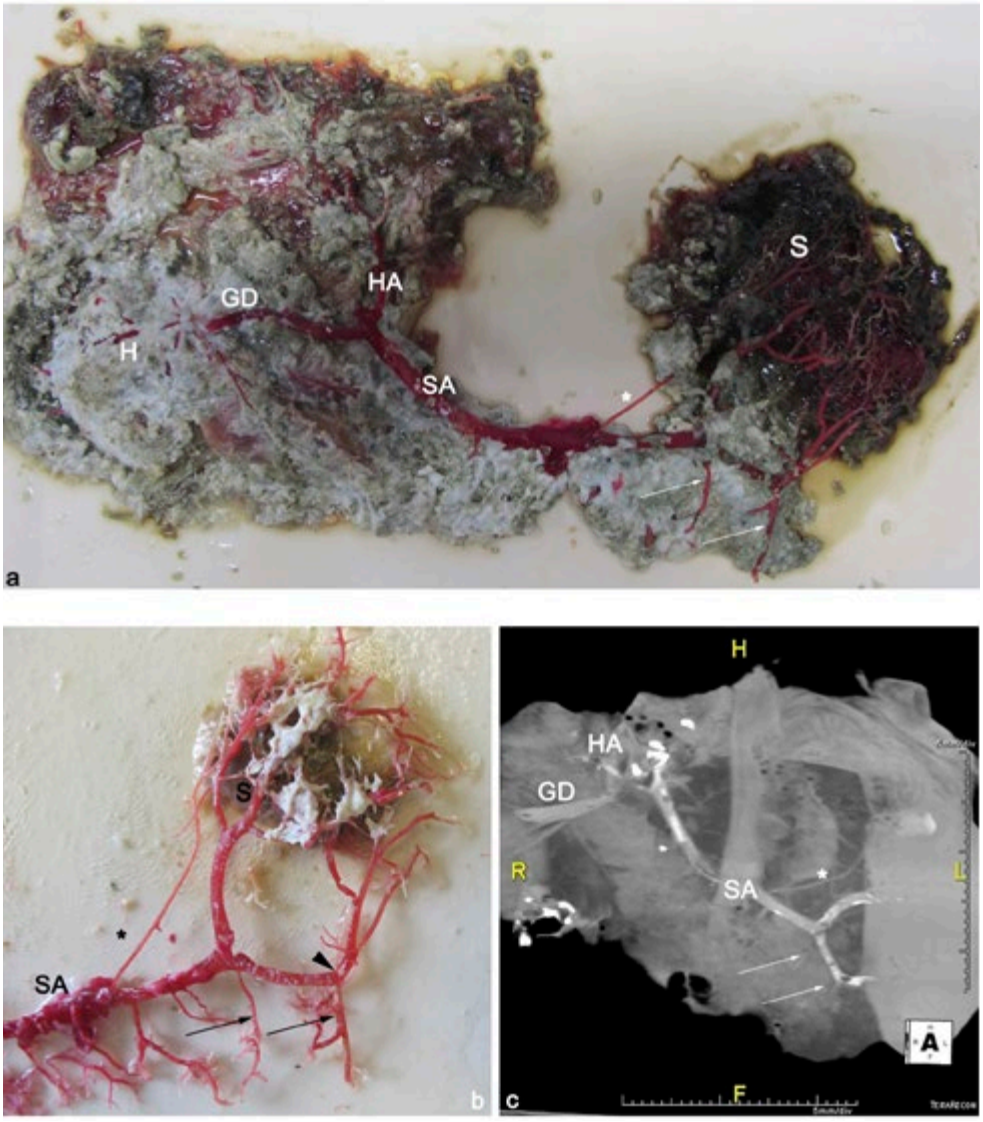

Figure 1 – A. Vascular cast of a specimen of duodenum, pancreas and spleen injected with acrylic resin (the celiac trunk was injected in red) during the corrosion phase, to highlight the relationship of the vessels with the parenchyma. The arrows indicate the caudal pancreatic arteries. B enlargement of the corrosion cast after complete removal of the parenchyma showing the vascularisation of the pancreas tail. An anastomosis between the inferior branch of the splenic artery and the caudal pancreatic arteries is present (arrow head). C, CT scan of the injected specimen. GD: gastroduodenal artery; H: head of the pancreas; HA: hepatic artery; SA: splenic artery; asterisk: polar artery.

Results

The caudal arteries were found in all the casts, with a mean number ± standard deviation (SD) of 3.2 ± 2.4 range (1-5). They originated from the distal third of the splenic artery in 70% cases and from the inferior branch of the splenic artery at the hilum in 30% cases. The caudal pancreatic arteries were thin branches with a straight course with very small collateral branches. At CT scans analysis, the mean (± SD) calibre of caudal pancreatic arteries was 2.1 ± 1.1 mm. The splenic artery divided far from the hilus into two or more branches in 40% cases, and near the hilus in 60% cases. In two cases a superior polar artery was present.

Vascular anastomoses were found with the great pancreatic artery in 20% of the casts. In 80% cases there was an anastomosis between the hilar splenic artery and the caudal pancreatic arteries: in 50% the anastomosis was found between the caudal pancreatic arteries and the inferior branch of the splenic artery and in 30% between the caudal pancreatic arteries and the main trunk of the splenic artery.

Discussion

The tail of the pancreas is supplied by one or more caudal arteries and/or by the extremities of the arteries of the pancreatic body. Caudal arteries have been reported to occur in 26% to 95% of cases (Ssoson-Jaroschewitsch, 1927), but they are considered constant by many investigators (Toni et al., 1985; Vandamme and Bonte, 1986; Bertelli et al., 1998). In our study the caudal pancreatic arteries were present in all the cases, probably due to the fact that in the corrosion casts also the smallest vessels are preserved and observable, whereas many studies on the vascularisation of the pancreas were conducted on angiographic images.

The vascularisation of the pancreatic tail is given by a single caudal artery in 32-36% cases, by two caudal pancreatic arteries in 46% cases, by three arteries in 8-20% cases, and by four arteries in 2% cases (Skandalakis et al., 1979; Vandamme and Bonte, 1986; Bertelli et al., 2004). In our study the caudal arteries showed a mean number of 3.2 ± 2.4, with range 1-5. The pancreas is a highly vascularised organ, that receives blood supply from multiple vessels, *i.e.* celiac trunk and superior mesenteric artery, that diffusely anastomose with each other mainly at the level of the head but also at the level of the body of the pancreas. The tail of the pancreas, even if small, shows numerous branches coming directly from the splenic artery or its branches. Thus it may be hypothesized that the rich vascularisation of the tail of the pancreas is correlated with its location at the carrefour between the gastric fundus, above, and the greater omentum, below.

The origin of the caudal arteries is variable, coming from a common trunk formed by the left gastroepiploic artery and the inferior splenic branch (50%) or from the splenic artery (21%), the left gastroepiploic artery (20%) and the inferior or superior splenic branches (9%) (Van Damme et al., 1967). In all the corrosion casts analyzed here the caudal pancreatic arteries originated from the splenic artery (70%) or from its inferior branch (30%). This result might be an artefact due to the preparation of the cast, because the stomach was not preserved and so the left gastroepiploic artery was not present.

The CT scans analysis allowed us to evaluate the calibre of the caudal pancreatic arteries (main calibre 2.1 ± 1.1 mm), that is difficult to evaluate directly on the casts. Our study has shown for the first time the size of the caudal pancreatic arteries, through the application of special methods of reconstruction of CT data with curved multiplanar reconstructions. Previous studies of our group have demonstrated the reliability of this method for other anatomical regions such as the pedicles of the gracilis muscle (Macchi et al., 2008) and the perforating arteries of the anterior abdominal wall (Macchi et al., 2014).

The caudal pancreatic arteries run downward or transversely to the right depending on the site of origin. In most cases, they enter the gland from the anterior aspect of the tail (Evrard, 1932). Anastomosis is usually with the transverse pancreatic artery, less frequently with the great pancreatic or dorsal pancreatic artery (Toni et al., 1985). In 33% cases, the caudal arteries are the sole source of blood for the tail of the pancreas with no apparent anastomosis with the arteries of the pancreatic body (Ebner et al., 1985). In our study, vascular anastomoses were found with the great pancreatic artery in 20% of the casts. In 80% cases we observed a vascular anastomosis between the hilar splenic artery and the caudal pancreatic artery. This anastomotic pattern between the pancreatic tail and the spleen could allow the surgeon to close the splenic artery at the level of its origin from the celiac trunk, and also close the short gastric and the left gastroepiploic arteries in cases of traumatic splenic hemorrhage. This technique results in a marked reduction of bleeding, allowing the surgeon to perform haemostasis on the splenic parenchyma. The spleen would not undergo ischemia due to the persistence of blood flow - although reduced - through the anastomosis with the caudal pancreatic arteries. This conservative approach is currently used by our surgical group in the treatment of minor splenic trauma, with the advantages of detecting other intra-abdominal lesions and avoiding the risks of thrombocytosis, post-splenectomy infections, abdominal abscess or pancreatic fistula.

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