SCIENTIFIC RESEARCH

VASCULAR ANATOMY CHARACTERISTICS OF THE PANCREATICODUODENAL REGION IN MULTIDETECTOR CT SCANNER IN BACH MAI HOSPITAL

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SUMMARY

Objective: To describe vascular anatomy characteristics of the pancreaticoduodenal region in multidetector CT (MDCT) scanner in Bach Mai Hospital).

Methods: Select good quality images among patients having abdominal MDCT in Bach Mai Hospital until 9/2023. Categorize these patients into different types of pancreaticoduodenal vascular anatomy. Calculate the number and percentage of those types.

Results: Out of 431 selected cases: the rate of visualization for great vessels, the inferior pancreaticoduodenal artery (IPDA), first jejunal vein (FJV) was 100%, 77,9%, and 86,1% relatively. Replaced left hepatic artery (LHA) arising from the left gastric artery is the most common variant (10.4%), the second variant is replaced right hepatic artery (RHA) arising from the superior mesentery artery (SMA) (4.6%). IPDA has its common trunk that arose from the first jejunal artery (J1A), SMA, and two branches arose from different origins, in 59.2, 26.8, and 14% of cases, respectively. Meanwhile, IPDA has its origin on the dorsal, right, and left aspects of the SMA in 56.6, 23.5, and 19.9% respectively. The trajectory of the first jejunal trunk (FJT) related to the SMA was anterior in 24% of cases, posterior in 60.5% of, and first and second jejunal vein (J1V and J2V) with an anterior and posterior trajectory in 15.5% of cases.

Conclusion: MDCT scanner enables visualization of small vessels in the pancreaticoduodenal region with high sensitivity.

Keywords: *pancreaticoduodenal region, vascular anatomy, hepatic artery, inferior pancreaticoduodenal artery, first jejunal vein, MDCT.*

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I. INTRODUCTION

Pancreaticoduodenal cancer is a common disease, of which adenocarcinoma of the pancreatic duct accounts for 82%, ampulla of Vater 9%, duodenum 6%, and common bile duct 3%. Currently, pancreaticoduodenectomy (PD), lymphadenectomy, and removal of the entire pancreatic mesentery are considered the best methods, providing the highest survival benefits for patients with tumors in this region. Traditional PD remains a challenge for surgeons due to high rates of postoperative complications and mortality. The main obstacle lies in the complex structure of the peripancreatic tissue, especially around the SMA. Safe surgery requires identifying and cutting the correct branches of the SMA and superior mesenteric vein (SMV). Including the IPDA - an important blood supply of the uncinate process and the J1A and FJV. Over the past few decades, the advent of the "artery-first approach" has allowed surgeons to evaluate the possibility of removing invasive tumors, avoiding venous congestion that reduces blood flow lost during surgery.

Determining anatomy and vascular anatomy variations before surgery plays a very important role. From there, the surgeon has a panoramic view of the actual vascular anatomy during surgery, plans the approach, ensures a safe surgical process, reduces surgical time, and minimizes wrong ligation and cutting as well as serious complications after surgery.

Along with the advancement of science and technology, imaging diagnostic tools are also constantly developing to help more accurately diagnose the vascular anatomy of the head of the pancreas. Among them, multi-sequence computed tomography is the most effective and popular means.

Up to now, there have been studies in the world evaluating the vascular anatomy of the pancreaticoduodenal region, but Vietnam has few systematical studies, so our purpose is: 'To characterize the characteristics of pancreaticoduodenal vascular on multirow detector computed tomography at Bach Mai Hospital'.

II. SUBJECTS AND METHODS

Subjects: Cross-sectional descriptive study at the Radiology Center, Bach Mai Hospital. Selection criteria: patients having abdominal MDCT, inpatients required to have medical records maintained. Exclusion criteria: MDCT films have incorrect phases, patients having surgery related to blood vessels in the pancreaticoduodenal region, acute and chronic diseases that limit assessment of vessels pancreaticoduodenal region, and patients having intravascular intervention in the pancreatic head region.

Research method: cross-sectional description.

Scanning technique: Patients were scanned with MDCT images on a 128-row SOMATOMA Definition AS and 256-row SOMATOMA Definition Flash CT machine from Siemens. Each patient received an intravenous injection of 350ml/ml contrast agent with a fixed dose of 80 ml in all patients, injection speed of 5ml/s. Shooting parameters: voltage 100KV, highest current 150mAs, using 4D care dose, rotation speed 0.33s/rev, spiral cutting layer thickness 0.6mm, regeneration 1mm, software window (WL = 50-70, WW=150-200).

Data analysis: SPSS 20.0 software (IBM, USA)

III. RESULTS

In a total of 431 patients, the anatomy of the hepatic artery was observed in 100% of cases, while the anatomy of IPDA and FJV in 77.9% (336) and 86.1% (371) of cases, respectively.

1. Anatomical of the right hepatic artery

Among 431 patients undergoing abdominal MDCT angiography, 340 patients had normal anatomy (78.9%). The group of variants is quite common and accounts for a total of 21.1%. Among them, the most common variant is type II (replaced LHA) accounting for 10.4%, followed by type III (replaced RHA) 4.6%, and type V (accessory LHA) accounting for 2.3%. Next, is type IV (replaced LHA and RHA) accounting for 0.9%, type VI (accessory RHA) and type IX (replaced CHA from SMA) both have a rate of 0.7%. Type VIII (combining accessory and replaced LHA/RHA), and type the anatomical type with the lowest percentage is VII (accessory LHA and RHA) equivalent to 0.2%.

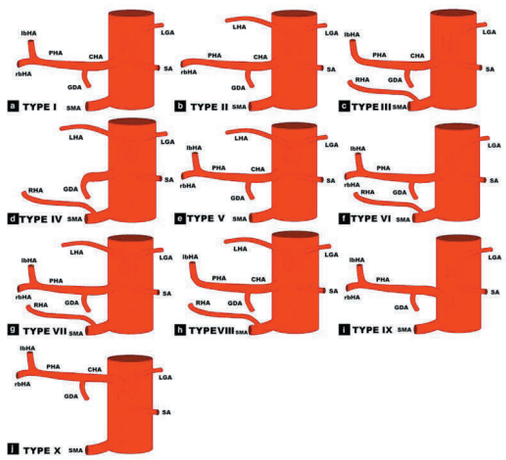


Fig 1. Modified Michels classification[1]: *(I) common type; (II) Replace left hepatic artery arose from a left gastric artery; (III) Replaced right hepatic artery arose from a superior mesenteric artery; (IV) Replaced left and right hepatic artery; (V) Accessory left hepatic artery arose from a left gastric artery; (VI) Accessory right hepatic artery arose from a superior mesenteric artery; (VII) Accessory left and right hepatic artery; (VIII) Combined accessory left hepatic artery and replaced right hepatic artery or accessory right hepatic artery and replaced left hepatic artery; (XI) Comon hepatic artery arose from superior mesenteric artery; (X) Comon hepatic artery arose from left gastric artery.*

Table 1. Anatomical hepatic artery variations: current modified classification and comparison with the main series in the literature

Michels classification	George Noussios[2] (n= 19013)	Koops[3]an aberrant or accessory left hepatic artery (LHA (n=604)	Chen[4] (n=381)	Rygaard[5] (n=216)	Michels[6] (n=200)	Current study (n=431)
I	81% (15342)	79.1%	80.3%	75.5%	55%	78,9% (340)
II	3% (556)	2.5%	7.8%	4.6%	10%	10.4% (45)
III	3.7% (710)	8.6%	5.2%	13.4%	11%	4.6% (20)
IV	0.8% (163)	1%	0.7%	0.9%	1%	0.9% (4)
V	3.2% (592)	0.5%	1.3%	0	8%	2.3% (10)
VI	1.6% (309)	3.3%	1.5%	0	7%	0.7% (3)
VII	0.2% (38)	0.2%	0.5%	0.5%	1%	0.2% (1)
VIII	0.35% (66)	0.2%	0	0,5%	2%	0.5% (2)
IX	1.2% (245)	2.8%	1.6%	1.4%	4.5%	0.7% (3)
X	0.04% (5)	0	0	0	0.5%	0.5% (2)
Others	4.1% (784)	1.8%	1.1%	0	0	0.2% (1)

In addition, we also found one case (0.2%) outside Michels classification as follows with an illustrative example (Figure 1.2): Replaced CHA from the abdominal aorta.

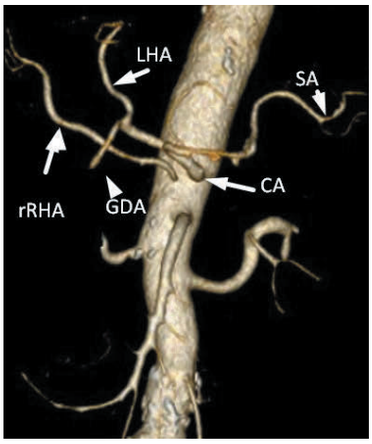


Figure 2. A female, 78-year-old, replaced RHA from the abdominal aorta. rRHA: replaced RHA, LHA: left hepatic artery, GDA: gastroduodenal artery, CA: celiac artery, SA: spleen artery.

2. Anatomy of the inferior pancreaticoduodenal artery

IPDA was observed in 77.9% (336) of 431 cases. Which, the IPDAs form a common trunk in 77% (259) of cases, before separating into 2 branches: the anterior inferior pancreaticoduodenal artery (AIPD) and the posterior inferior pancreaticoduodenal artery (PIPD). In contrast, cases where the AIPD and PIPD do not form a common trunk account for 23% (77) of cases.

(1) IPDA has three types of origin:

(2) From the first jejunal artery (J1A), accounts for 59.2% (199) cases

(3) From SMA directly 26.8% (90) cases

AIPD and PIPD have independent origins and account for 14% (47) cases.

Table 2. Anatomical IPDA: current modified classification and comparison with the main series in the literature

	Takamuro[7]several essential areas of confusion remain in interpretation of the vascular configuration. We note and discuss three key points in relation to this confusion: (1 (n=125)	Ionut Negoi[8]involving a total of 18,369 specimens, were included. The prevalence of the mesenteric-celiac trunk, replaced/ accessory right hepatic artery (RRHA (n=17854)	Horiguchi[9] (n=140)	Ishikawa[10] (n=150)	Current study (n=336)
IPDA from the first jejunal artery	58.9%	58.7%	71.4% (100)	66% (100)	59.2% (199)
IPDA from SMA	24.2%	35.8%	19.4% (27)	33% (49)	26.8% (90)
AIPD and PIPD have independent origins	16.9%	5.8%	9.2% (13)	1% (1)	14% (47)

(1) Of the 336 cases observed, 259 cases common trunk of IPDA, and the remaining 77 cases did not create a common trunk. Regarding the angle of the IPDA compared to the circumference of the SMA, in a total of 413 branches of the IPDAs, there are 3 following types:

IPDA from posterior side (12-5h) account for 56.6% (234)
(2) IPDA from the left side (5-7h) account for 19.9% (82)
IPDA from the right side (7-11h) account for 23.5% (97)

Table 3. Angle of IPDA: current modified classification and comparison with the main series in the literature

	Inoue[11] (n=183)	Current study (n=413)
Left side (12-5h)	13.7% (25)	19.9% (82)
Posterior side (5-7h)	65.6% (120)	56.6% (234)
Right side (7-12h)	20.5% (38)	23.5% (97)

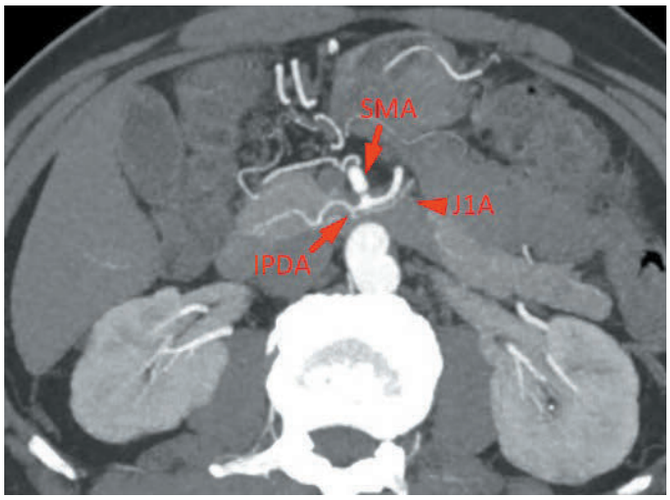
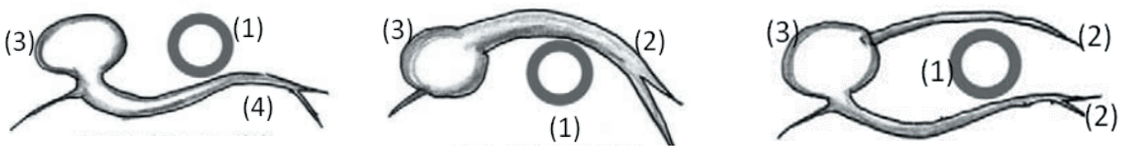


Figure 3. Male, 50-year-old, IPDA arose from the posterior side. SMA: superior mesenteric artery, IPDA: inferior pancreaticoduodenal artery, J1A: first jejunal artey.

3. Anatomy of the first jejunal vein

FJV was observed in 371 out of 431 cases. We found that the common anatomical pattern is that the FJV and J2V form the first jejunal trunk (FJT) before draining into the SMV - accounting for a total of 84.5% (224 patients), in which FJT mainly goes behind the SMA accounting for 60.5% (89 patients), the remaining 24% (89 patients) going anteriorly SMA. The remaining group accounts for 15.5%, equivalent to 58 patients, with FJV that do not drain to FJT, going anteriorly/posteriorly to SMA.



60.5% 24% 15.5%

Type 1. FJT drains posteriorly SMA *Type 2. FJT drains anteriorly SMA* *Type 3. FJV and J2V drain independently*

Fig 4. Variants anatomy of FJT

Table 4. Anatomy of FJV: current modified classification and comparison with the main series in the literature

Ishikawa classification	Ishikawa[10] (n=155)	Ionut Negoi[8]involving a total of 18,369 specimens, were included. The prevalence of the mesenteric-celiac trunk, replaced/accessory right hepatic artery (RRHA) (n=18369)	Current study (n=371)
Type 1	63% (98)	71.8%	60.5% (224)
Type 2	21% (32)	26%	24% (89)
Type 3	16% (25)	2.2%	15.5% (58)

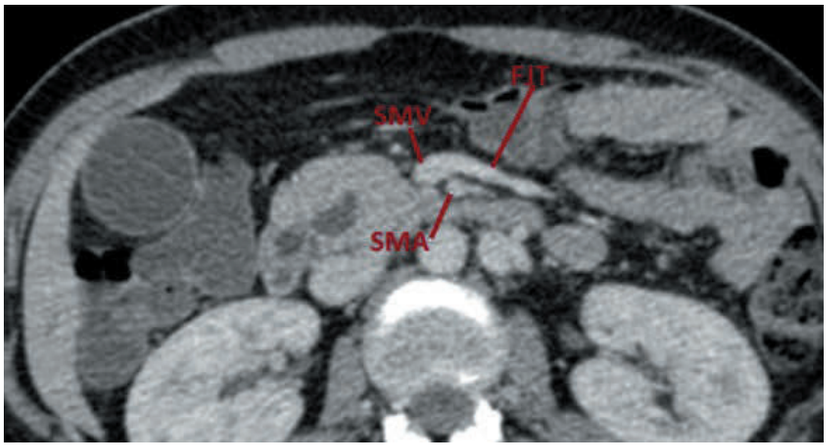


Figure 5. Female, 46-year-old, J1V drains to FJT which goes anteriorly SMA. SMA: superior mesenteric artery, SMV: superior mesenteric vein, FJT: first jejunal trunk.

IV. DISCUSSION

In PD, the method of "approaching the superior mesenteric artery first" is more advantageous than the traditional PD, meaning that during the surgery, the SMA is dissected first to determine the resectability before irreversible steps. This method helps determine the existence of arteries supplying to the liver arising from the SMA and helps surgeons avoid damaging these branches. Table 1.1 shows that anatomical type I is the most common group in our study (78.9%), this rate in other studies ranges from 55% to 81%. Among the common extra-anatomical variants, type II (replaced LHA) is the most common (10.4%) in the current study, and ranges from 2.5% to 10% in other studies. This type is less affected during PD. Type III (replaced RHA) is the second most common type after type II (4.6%), in other studies, it is from 3.7% to 13.4%. The artery usually passes posteriorly pancreatic head and enters the hepatoduodenal ligament, posterior to the common bile duct. However, some reports replaced RHA behind or through the head of the pancreas, making them very vulnerable during surgery. Injury to the replaced RHA will affect the right liver parenchyma and the common bile duct that supplies blood, leading to the risk of biliary enteric fistula after surgery. For type IX (CHA from SMA) - accounting for 0.7% and in other studies from 1.4% to 4.5%, resection of this branch will lead to liver parenchymal ischemia and the risk of post-operative biliary enteric fistula.

Introduced with the "arterial-first approach" approach, the concept of pancreatic mesentery represents a retropancreatic structure extending to and behind the SMA, containing blood vessels and nerve plexuses. Complete removal of the pancreatic mesentery and first jejunum is important, helping to achieve an R0 resection area, and increasing the possibility of complete resection of tumors in the pancreatic head area that have directly or indirectly invaded blood vessels and regional lymph

node metastasis. To completely remove the pancreatic mesentery, the first thing is to approach and dissect IPDA/J1A. In our study, IPDA often arose from J1A (59.2%), similar to other studies (ranging from 58.7% to 71.4%). The second most common form is IPDA arising directly from the SMA (26.8%), in other studies there is a large variation from 19.4% to 35.8%. The type that AIPD and PIPD arose independently is the least common, in our study it accounts for 14%, the smallest rate is 1% according to Ishikawa and 16.9% according to Takamuro. The side at which the IPDA separates from the SMA also has important implications regarding the approach: from the right, left, anterior, or posterior side. Most IPDA branches from the posterior side (5-7h), accounting for 56.6%. This rate is higher than in Inoue's study, up to 65.6%. The rate of IPDA separating from the right side (7-12h) and left side (12-5h) are almost similar, 23.5% and 19.9% respectively. While in Inoue's study, there is a larger difference: 20.5% and 13.7%.

In PD, J1A and FJV were dissected with the first jejuneum. Resecting FJT instead of FJV, leading to congestion of the elevated jejunum could conceivably be a risk factor for postoperative pancreatic fistula, which is the most common major complication after PD. FJT was found in 84.5% of cases, similar to Ishikawa (84%), and in Ionut Negoi's study, this rate increased to 97.8% of cases. In particular, FJT passes posteriorly to the SMA (60.5%) or anteriorly (24%).

V. CONCLUSION

MDCT helps evaluate the anatomy of the vessels in the pancreaticoduodenal area before surgery with the observed rate of large vessel branches being 100%, and small vessel branches ranging from 70-90%. In the anatomy of the hepatic artery, replaced RHA is the second most common variant after the replaced LHA type. Regarding the anatomy of IPDA, in most cases, the PIPDA and PIPDA arose from a common trunk and often arose from the first jejunal artery. In addition, the IPDA tends to arise from the back (5-7h compared to SMA). Regarding the FJV, most of them have a common trunk with J2V and FJT drain behind the SMA.

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Received: 11/10/2024. Assessed: 17/10/2024. Accepted: 02/11/2024