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Incidence of the coeliac trunk and hepatic arteries variations during pancreatoduodenectomy: A computed tomography study

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Abstract

Aim: Coeliac trunk and hepatic artery variations are not uncommon and may complicate surgery in patients with periampullary cancer. We aimed to assess the prevalence and types of variations of the coeliac trunk and hepatic arteries and their relationship with surgical complications in patients undergoing pancreatoduodenectomy.

Materials and Methods: In this single-center study, we retrospectively reviewed the preoperative contrast-enhanced abdominal computed tomography scans of patients with periampullary cancer. Coeliac trunk branching with a particular focus on hepatic artery origin was assessed on arterial phase images.

Results: The study included a total of 66 patients [39 (59.1%) men] with a mean age of 63.92±12.98 years. The most frequent tumor origin was the pancreatic head, seen in 41 (62.1%) cases, followed by the ampulla in 15 (22.7%), distal common bile duct in seven (12.1%), and colon tumors invading the duodenum in two (3%). Arterial variations were observed in 15 (22.7%) cases. Total perioperative complications occurred in 14 cases (13 fistulas and one hematoma). There was a higher rate of complications in the group with variations (n=5, 33.3%) compared to the group without variations (n=9, 17.6%), but it was not statistically significant (p=0.496).

Conclusion: Coeliac trunk and hepatic arterial variations are very common but do not seem to significantly increase complications in patients undergoing pancreatoduodenectomy.

Introduction

Pancreatic cancer (PANC) is the 12th most common cancer in the world. PANC is one of the important causes of deaths associated with cancer due to its poor prognosis. The standard treatment for localized or locally advanced resectable tumors is surgery and adjuvant chemotherapy. The gold standard method in patients suitable for surgery is pancreaticoduodenectomy (PD) or the Whipple operation. Although the mortality of PD has decreased (below 5%), it is still considered an operation with a high morbidity [1].

Approximately half of the general population has anatomical variations in the arterial vascular structure of the liver [2]. The presence of anatomical differences in the coeliac trunk and hepatic arteries complicates PD. According to studies in the literature, the frequency of hepatic or coeliac trunk variations ranges from 10 to 24% [3-6]. The coincidence of both variations has been reported as 3.7% [5].

Many studies in the literature have reported that arterial variations do not negatively affect the surgical method [1-5, 7-9] Nakajima et al. determined that the aberrant hepatic artery (HA) variation had a negative effect on local recurrence [10]. In contrast, Crocetti et al. reported that the aberrant HA variation increased complications in patients that underwent PD, having negative impacts on blood loss during surgery, duration of operation, and length of stay in the hospital and critical care unit; however, it did not affect long-term of disease-free survival rates [11].

In this study, we aimed to assess the prevalence and types of variations of coeliac trunk and hepatic arteries in our clinic and their relationship with surgical complications

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in patients undergoing PD, thereby creating awareness, and providing an opportunity to prevent possible vascular complications. In addition, we believe that this study contributes to the uncertainty in the literature on the effect of vascular variations on the PD.

Materials and Methods

This retrospective study was approved by the ethics committee of our University Hospital (Istanbul Medeniyet University Göztepe Training and Research Hospital Clinical Research Ethics Committee, GEAH-KEK-2020/0700) and conducted according to the principles of the Helsinki Declaration of 1975, as revised in 2000. An informed consent was obtained from each patient before the computed tomography (CT) examination.

Study design

This study was designed as a descriptive study, and we retrospectively reviewed 66 adult patients diagnosed with histopathologically confirmed periampullary cancer and operated on in our hospital between 2018 and 2020. The data of 66 adult patients who were evaluated with preoperative contrast-enhanced abdominal computed tomography (CT) were included in the sample as the patient group. The scanning protocol included pre-contrast and dynamic contrast enhanced [1.5 mL/Kg of iopromide (Ultravist 370; Schering, Berlin, Germany)] imaging. Using bolus tracking, the late arterial phase at 35th second, and portal venous phase at 60th second were obtained. Arterial vascular variations evaluated on arterial phase images. Patients under 18 years of age and those with a history of abdominal tumor surgery were not included in the study. The primary endpoint of the study was to determine the prevalence and types of variations of coeliac trunk and hepatic arteries in our clinic, and the secondary endpoint to evaluate their relationship with surgical complications in patients undergoing pancreatoduodenectomy.

Radiological evaluation

We retrospectively reviewed the preoperative contrast-enhanced abdominal CT scans of patients with periampullary cancer to identify arterial abnormalities. Coeliac trunk and hepatic arteries were evaluated on arterial phase images. All CT scans were performed at our university hospital (GE Optima CT660; GE Healthcare, Milwaukee, Wisc., USA) using a tomographic slice thickness of up to 0.9 mm. We assessed coeliac trunk branching with a particular focus on the common, right, and left hepatic arteries' (HAs) origin at the arterial phase images. A radiologist with nine years of experience in abdominal radiology used the Uflacker classification when describing variations in hepatic arterial anatomy and determined the origin of the right and left hepatic arteries (Table 1) [12].

Statistical analysis

IBM SPSS Statistics for Windows version 25.0 (IBM Corp., Armonk, NY, USA) and Microsoft Excel computer programs were used to analyze the data obtained in the study. The Kolmogorov–Smirnov test was used to determine whether the data showed a normal distribution. Descriptive statistics were obtained to represent the data.

Table 1. The Uflacker's classification of celiac trunk anomalies.

Type	Variation
I	Classic pattern
II	Hepatosplenic trunk
III	Hepatogastric trunk
IV	Hepatosplenomesenteric trunk
V	Gastro-splenic trunk
VI	Celiaco-mesenteric trunk
VII	Celiaco-colic trunk
VIII	No celiac trunk

Categorical variables (also called qualitative variable) were presented as counts and percentages, and continuous variables (also called quantitative variable) as means and standard deviations. The chi-square test was used to compare complication rates between groups with and without variations. The Yates continuity correction was also added to make the chi-square approximation better. The results were evaluated at the 95% confidence interval and $p<0.05$ significance level.

Results

A total of 66 patients [39 (59.1%) men] with a mean age of 63.92 ± 12.98 years were included in the study. The most frequent tumor origin was the pancreatic head seen in 41 (62.1%) cases, followed by ampulla in 15 (22.7%), distal common bile duct in eight (12.1%), and colon tumors invading the duodenum in two (3%) (Table 2).

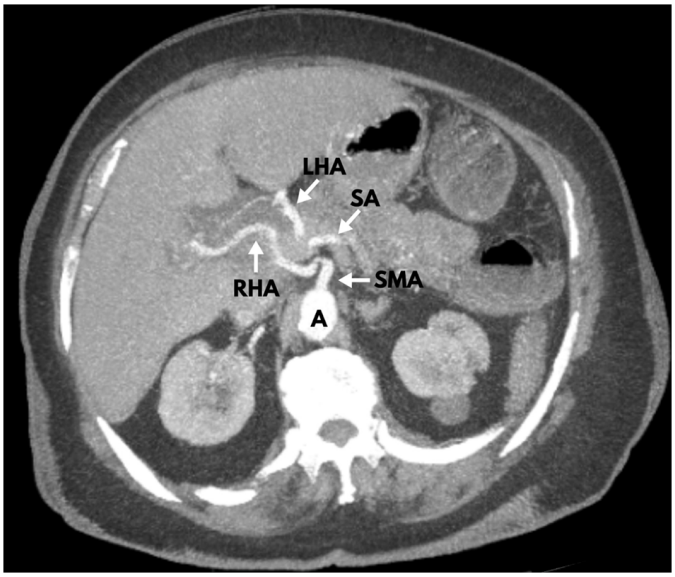
Table 2. Demographics data of the study.

	Mean±SD or n (%)
Age	63.92 ± 12.98
Tumor Location	
Pancreatic head	41 (62.1%)
Ampulla	15 (22.7%)
Distal common bile duct	8 (12.1%)
Colon tumors invading the duodenum	2 (3%)
Arterial variations	15 (22.7%)
Hepatic artery	11 (16.66%)
Celiac trunk	4 (6.06%)
Complications	14 (21.21%)
Fistula	13 (19.69%)
Hematoma	1 (1.51%)

Table 3. Comparison and statistical analysis of surgical complication rates according to the presence of vascular variation.

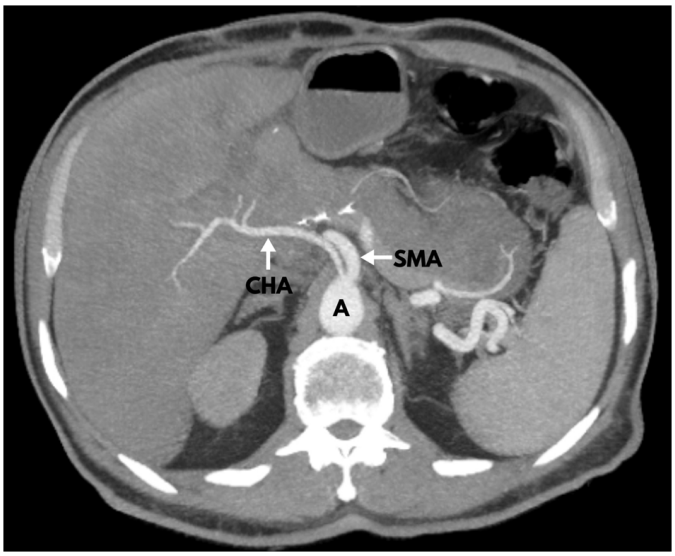
	Arterial variations (+)	Arterial variations (-)	p value
Surgical Complications	5 (33.3%)	9 (17.6%)	0.496*

*Chi-square test was used based on Yates Correction.



MIPs: Maximum intensity projection images, RHA: Right hepatic artery , SMA: Superior mesenteric artery , A: Aorta, SA: Splenic artery.

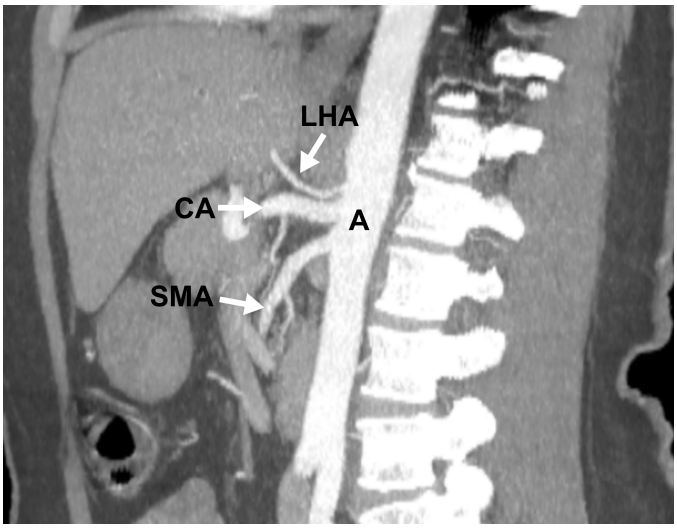
Figure 1. Computed tomography angiography MIPs. RHA originating from the SMA as a variation is seen in the abdominal CT angiography examination of an 80-year-old woman with a pancreatic head tumor.



CHA: Common hepatic artery, A: Aorta, SMA: Superior mesenteric artery.

Figure 2. The CHA originating from the aorta as a variation is seen in the abdominal CT angiography examination of a 65-year-old man with a pancreatic head tumor.

Arterial variations were observed in 15 (22.7%) cases, including 11 with variations of HAs (right HA originating from the superior mesenteric artery in eight (Figure 1), right HA originating from the aorta in one, left HA originating from the aorta in one, and both left and right hepatic arteries originating the from coeliac trunk in one) and four coeliac trunk variations (one case each from Uflacker types 1, 2, 3, and 5) (Figures 2, 3). These types are as



LHA: Left hepatic artery, SMA: Superior mesenteric artery, A:Aorta, CA: Celiac artery.

Figure 3. The LHA originating from the SMA as a variation was shown in the abdominal CT angiography examination of a 58-year-old woman with pancreatic head tumor.

follows: Classic coeliac trunk, hepatosplenic trunk, hepatogastric trunk, and gastrosplenic trunk.

In the sample studied, total perioperative complications occurred in 14 cases (13 fistulas and one hematoma). There was no statistically significant difference in the rate of complications in the group with variations compared to the group without variations (Yates correction=0.4618) (p=0.496) (Table 3).

Discussion

PANC continues to be an important health problem in Turkey. According to the 2020 Turkish Statistics data, PANC ranked ninth in new cases and third in cancer-related deaths. Approximately 60-70% of PANCs are seen in the pancreatic head, 15% in the pancreatic body, and 15% in the pancreatic tail [13]. In our study, PANC was most commonly localized in the head of the pancreas (62.1%), and the results were found to be consistent with the literature.

Anatomical variations in coeliac trunk and HAs were first reported by Michels in 55% of cadaver dissections [14]. Diagnostic methods, such as color Doppler ultrasonography, CT, and magnetic resonance angiography, were used to evaluate hepatic or coeliac trunk arterial anatomy. The advantages of CT include its minimally invasive nature, multi-slice imaging evaluation, and rapid results, but it also has the disadvantage of requiring the use of contrast material. Classical coeliac trunk trifurcation is present in 82-97% of cases [15-17]. The hepatosplenic trunk (2.8%) anomaly was reported as the most common anomaly. Common and right hepatic artery variations also affect the surgical procedure closely. The determination of vascular variations will be beneficial in order to facilitate surgical dissection, avoid possible bleeding, reduce blood loss during the operation, and facilitate the identification of tu-

moral tissue [18-20]. According to a few studies conducted in Turkey evaluating the anatomical variations of the abdominal aorta, the HA and/or coeliac trunk variation rate was 17.95%, 20%, and 24.1% in the coeliac trunk [21-23]. In our study, this rate was found to be 22.7%, which is in agreement with the literature.

CT is easily accessible in Turkey, which can be seen as an advantage in evaluating HAs and coeliac trunk variations. The results of studies conducted outside of Turkey are also similar to our findings. In a study by Zhang et al., HAs variations were reported to have an effect on surgical results, and their incidence was found to be 24.8% [5]. In another study, the incidence of HAs variations was determined to be 13% [4]. In 2021, Appanraj et al. evaluated both ceoliac trunk and common hepatic artery variations together and reported their rates as 10.9% and 3.7%, respectively, in their sample [3]. In a study by Mansour et al., anatomical vascular variation rate was found to be 20.3%, and a single anatomical variation was frequently reported.

PD remains a current curative option in the treatment of PANC. However, PD-related morbidity is still reported at a high rate. In a study by Colak et al. conducted in Turkey, the most common complications after PD were reported as wound infections (38.7%), delayed gastric emptying (22.5%), and fistulas (8%). In our study, the most common complication after PD was fistula development at a rate of 19.69%. This rate was 33.3% and 17.6% in the patients with and without HAs and/or coeliac trunk variations, respectively. Although our results were not statistically significant, we consider that arterial variation is closely related to surgical morbidity.

Limitations

Our study has certain limitations, the first of which concerns the retrospective design. Second, the small size of the patient population constituted a limitation. Prospective studies may have better outcomes for future research to better evaluate the relationship between HAs and/or coeliac trunk variations and the complications of PD.

Conclusion

In conclusion, although coeliac artery and HAs variations are very common and do not seem to significantly increase complications in patients undergoing PD, having knowledge of arterial variations in the preoperative period can decrease operative complexity and postoperative complications, resulting in better patient outcomes.

Disclosure of benefit

The authors have no conflict of interest, and the study was not supported or funded by any pharmaceutical companies.

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Ethical approval

This retrospective study was approved by the ethics committee of Istanbul Medeniyet University Göztepe Training and Research Hospital Clinical Research Ethics Committee, (GEAH-KEK-2020/0700).

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