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FEATURES OF THE FORMATION OF THE PORTAL VEIN AND ITS BRANCHES IN THE INDEGENOUS AND NON-INDIGENOUS POPULATION OF THE REPUBLIC SAKHA (YAKUTIA) ACCORDING TO MULTISPIRAL COMPUTED TOMOGRAPHY

DOI 10.25789/YMJ.2021.76.10

УДК 611.019

We have studied the variant anatomy of portal vein confluence formation and its branching in the cut and non-indigenous population of RS(Y) using vascular reconstruction of multispiral computed tomography data in patients undergoing MSCT with intravenous contrast enhancement without pathology of the hepatobiliary zone. The obtained results of the study indicate the presence of a role for the ethnic component in the formation of confluence and branching (division) of IWs in the studied groups. However, the small sample size of patients on the obtained results of the study should be taken into account.

Keywords: portal vein, portal vein tributaries, variant anatomy, division of the portal vein.

Introduction. It is known that the portal vein (PV) is a large vascular structure that supplies up to 75-80% of blood to the liver. It is formed by the fusion of the splenic, superior and inferior mesenteric veins. The IV pool collects blood from the organs of the gastrointestinal tract (except for the thoracic esophagus and the lower rectum), spleen, pancreas, gallbladder and peritoneum. Its distal part of the IV, flowing into the liver, forms a part of the portal fissure and is divided into lobar branches of the IV [1, 14].

Few early studies confirm possible ethnic differences in the variant anatomy of angioarchitectonics; the works describe the presence of certain types of variant anatomy of blood vessels in various ethnic groups, which are rarely found in the general population [10, 12]. The populations of the regions of Eastern Siberia are distinguished by a special anthropological status, which was formed as a result of a long (over several millennia) settlement in difficult climatic and geographical territories by indigenous peoples [7].

Modern non-invasive diagnostic imaging methods (magnetic resonance imaging — MRI, multispiral computed tomography — MSCT, and ultrasound duplex examination of blood vessels) allow surgeons to plan possible anatomical variants of vessels, including the hepatobiliary zone, at the preoperative stage, which significantly reduces the risk of intraoperative complications [6] Knowledge of the PV variant anatomy in the perioperative period is of crucial importance and allows surgeons and interventional oncologists to plan the course of complex surgical procedures, such as: liver transplantation, liver resection, two-stage liver resection by ALPPS, pancreatic resection, portal vein embolization, formation of transjugular intrahepatic shunts (TIPS), as well as percutaneous liver interventions [9].

Purpose of the Study: analyzing the portal vein in the indigenous and non-indigenous population of the Republic of Sakha (Yakutia), according to multispiral computed tomography.

Materials and Methods. The study included the results of 50 sequential MSCT (multispisral computed tomography) organs of the abdominal cavity and retroperitoneal space with intravenous contrast enhancement according to the standard protocol and with standard packing for the period of 2020 with patients who underwent routine diagnostic examination in the Department of Radiology Diagnostics of the Yakutsk Republican Oncological Dispensary. The main conditions for inclusion were age over 18 years, absence of pathology (portal hypertension, portal vein thrombosis, tumor lesion) in the gastropancreatobiliary zone, absence of surgical intervention (Whipple procedure, splenectomy, extensive operations on the liver and/or colon) or other conditions that would change the blood flow in the PV. Additional condition was high quality MSCT images. The image quality was assessed according to the following parameters: the contrast of the vessel versus tissue contrast, the contrast of the vessel versus the noise level, the presence of motion artifacts, and the presence of metallic artifacts. Failure to comply with this requirement was an exclusionary factor.

All patients included in the study were divided into 2 groups depending on ethnicity living on the territory of the Republic of Sakha (Yakutia): group 1 included patients of indigenous nationality, group 2 — non-indigenous nationality. In group 1, there were 13 (52%) men and 12 (48%) women among 25 patients. The average age of men included in the study was 65±10.9 years, women — 56±15.5 years. Group 2 (25 patients) included 9 (36%) men and 16 (64%) women. The average age of men included in the study was 57±8.1 years, women — 57±10.3 years.

Postprocessing of DICOM (Digital Imaging and Communications in Medicine) files was carried out using the OSiriX software suite; it consisted in performing multiplanar (2D) and 3D reconstructions of MSCT angiograms of the abdominal organs in the venous phase. To study the

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confluence of PVs, we applied the classification of P. Krumm et al. (2011) [13, 17], which identifies 10 types of PV formation and is shown in Figure 1:

Type A — Inferior mesenteric vein (IMV) flows into the splenic vein (SV).

Type B — IMV is located at the corner of the confluence of the superior mesenteric vein (SMV) and SV; this fusion forms the portal vein.

Type C — IMV flows into SMV.

Type D — accessory mesenteric vein enters the confluence angle, as in type B.

Type E — similar to type A with two equal trunks of the IMV and the accessory mesenteric vein, IMV flows into the SV.

Type F — similar to type E, the IMV flows into the accessory mesenteric vein, which, in turn, is equal in diameter to the IMV and flows into the angle of confluence of the IMV and SV.

Type G — similar to type A, but the auxiliary mesenteric vein and IMV flow into the SV at the same point.

Type H — no IMV.

Type I — similar to Type A, IMV flows into the SV, but there is an accessory mesenteric vein between IMV and SMV.

Type J — IMV is equal in diameter to the SMV and flows into the corner of the confluence of the IMV and SV.

To study the division of the portal vein, we used the classification of T. Nakamura et al. (2002) [9], which identifies 5 types of PV division, which is shown in Figure 2:

A — the classic version of PV division into right and left trunks.

B — true trifurcation, without the main trunk of the right PV.

C — extrahepatic discharge of the anterior branch of the right PV.

D — intrahepatic discharge of the anterior branch of the right PV.

E — the absence of an integral branch of the anterior right PV. Departure of individual segmental branches from the PV.

Statistical data processing was performed on a personal computer using Microsoft Excel spreadsheets and the SPSS 20 statistical software package.

Results and Discussion

The portal vein supplies 75-80% of blood to the liver, its main tributaries are the splenic and superior mesenteric veins. In most cases they merge in the posterior surface in the neck of the pancreas, forming a single trunk up to 5-8 centimeters, and then bifurcate at the gate of the liver.

All obtained MSCT images had high image quality, which made it possible to identify 100% of the PV along its entire length.

As we note, the inferior mesenteric vein and accessory mesenteric veins play the main role in the anatomical variation in the formation of PV confluence [5, 13, 15]. The data of PV confluence studies published by a few Russian and foreign authors vary from group to group. We also investigated the confluence of PVs based on the classification of P. Krumm et al. and we have found the following anatomical variations in the formation of the PV: in the indigenous group, Type C was the most frequent at 48% (12 patients) with Type A at 44% (11 patients); Types B & F were less frequent at 4% (1 patient) each. We did not find other variants of confluence formation in this group. When analyzing the patients by gender in the study group, we found that Type A was more common in women — 8 (32%) than in men — 12% (3). At the same time, Type C was more common in men — 9 (36%) than in women — 3 (12%). Types B 3 (12%) and F 1 (4%), which were identified only in the male population of the indigenous population, are much less common. In the group of non-indigenous, studies of the formation of confluence of the PV showed that Type A with 12 patients (48%) and C with 6 patients (24%) were also more common, and Types B (4 patients, 16%) and H (1 patient, 4%) were less common. In addition, one female patient had a case of PV confluence that was not described in our classification, when the main trunk corresponds to Type C, but the inflow of IMV flows into the accessory mesenteric vein. No other options have been identified. When analyzed by gender in the non-indigenous group, Type A was more common in women 7 (28%) than in men 5 (20%), while Type C was more common in women 4 (16%) than in men 3 (12%); Type B was much less common with

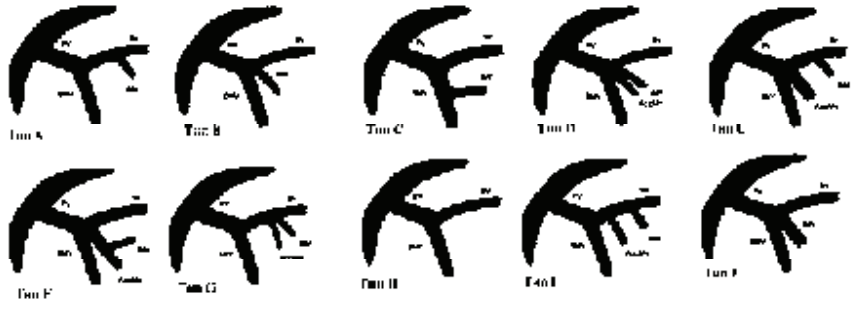

Fig. 1. Classification of types of portal vein confluence formation according to Krumm et al. [13]: Type A – the inferior mesenteric vein (IMV) flows into the splenic vein (SV); type B - IMV is located at the angle of confluence of the superior mesenteric vein (SMV) and the SV, this confluence forms the portal vein; type C - NBV flows into the VBV; type D - the accessory mesenteric vein enters the confluence angle, as in type B; type E - similar to type A with two equal trunks of the IMV and the accessory mesenteric vein, the IMV flows into the NE; type F - similar type E, the IMV flows into the accessory mesenteric vein, which, in turn, is equal in diameter to the SMV and flows into the confluence angle of the SMV and NE; type G - similar to type A, but the accessory mesenteric vein and the IMV flow into the NE at one point; type H - no NBV; type I - similar to type A - the IMV flows into the NE, but there is an accessory mesenteric vein between the IMV and the SMV; type J - NBV is equal in diameter to VBV and flows into the angle of confluence of NBV and SV

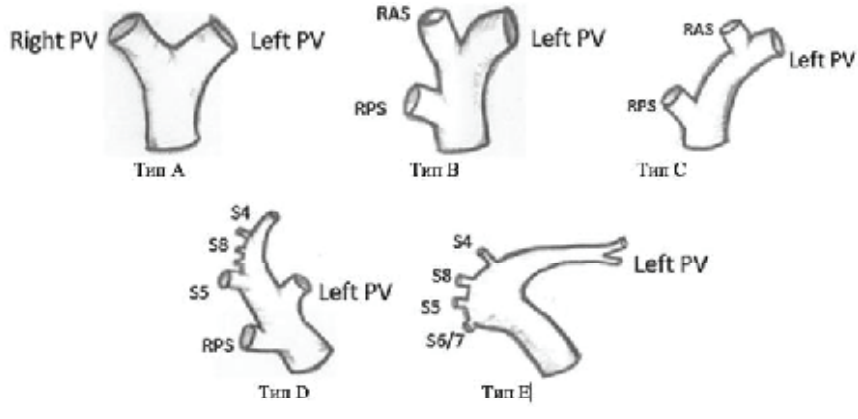

Fig. 2. Classification of division of the portal vein according to T. Nakamura et al. [16]: A - the classic version of the division of explosives into the right and left trunks; B - true trifurcation, without the main trunk of the right explosive; C - extrahepatic origin of the anterior branch of the right BB; D - intrahepatic origin of the anterior branch of the right BB; E - the absence of an integral branch of the anterior right BB. Departure of individual segmental branches from the BB

2 (8%) cases in men and women (1 in each gender), and type H was detected in 1 (4%) woman.

Thus, in our study, we revealed significant differences in the variants of the formation of PV confluence in the studied groups, since Type C prevails (48%) in the first group, while in the second group it is Type A (48%). In the group of the indigenous population, we found 4 variants of the formation of confluence of PV, and in the group of the non-indigenous population we found 6 variants. Also, in the group of the indigenous population the variations were mainly represented by the male sex (72%), while in the group of the non-indigenous population they were evenly distributed. Type A prevailed (32%) in women in the first group, Type C prevailed (36%) in men. In the second group, Type A prevailed in both sexes (52%). The data obtained show that there is a difference in the variants of the formation of the PV confluence, mainly in the inflow of the IMV into the SMV and SV depending on the groups. In the indigenous group, the IMV flows more into the SMV, and in the non-indigenous group, the IMV flows more into the SV, which is reflected in Graph 1. Knowledge of rare variants of PV confluence formation is important for surgeons when planning intervention in the mesenteric root area, as well as during operations on the pancreas or intestines.

Portal vein branching has been studied in more detail than its confluence. Over the past decades, most of the studies have focused on the X-ray testing, but we also see morphological studies. In the Russian Federation, fundamental research on the portal vein variant anatomy can be found in the works of Shapkin V.S., Gaivoronsky I.V., and Kolsanov A.V. [2.6]. The applied value of the PV variant anatomy is extremely important in the surgical disciplines. Special attention should be paid to the distal anatomy of the portal vein in patients undergoing liver resection and transplantation to ensure adequate graft selection and appropriate anastomoses and to avoid unintentional impairment of blood perfusion. Moreover, the morphological deviation of the glisson stem is often associated with variations in the branching of the PV, and their assessment is necessary to reduce the risk of iatrogenic complications. Thus, the preoperative study of PV branching is a guarantee of safety and efficiency in resection and endovascular surgery of the liver [4, 8].

To assess the IV branching in our study, we used the classification of portal vein branching according to T. Nakamura et al. The study revealed: in the indigenous group, Type A was identified as predominant with 20 (80%) cases, Type C with 3 (12%) cases and Type B with 2 (8%) cases. When analyzed by gender, the branching of the portal vein was distributed as follows: Type A — 11 cases in men (42.3%) and 9 cases in women (36%), Type B — 1 case in men and 1 case in women (4%), while Type C was more common in women 2 (8%) than in men 1 (4%). In the non-indigenous group, Type A was found in 24 (96%) cases, Type B in 1 (4%) case, and Type C was not detected at all. When analyzing the patients by gender, we found Type A to be more common in women (64%) than in men 8 (32%), while Type C was found in 1 (4%) case in men of this group. The percentage of standard PV branching, i.e. the branching of the portal vein into two trunks in our study in subgroup analysis was at 80% in the indigenous group, and at 96% in the non-indigenous group, while the deviation from the standard anatomy of the PV branching was 20% and 4%, respectively. The data obtained correspond to the results of large studies of the PV branching [3, 11], which are reflected in Graph 4.

Conclusion. The results of our study indicate the presence of significant differences in the formation and branching of PVs between the studied groups. In the first group of the indigenous population, we found only 4 types of PV confluence formation, with Type C prevailing at 48%. In the second group, we found 6 types of PV confluence formation; in this group Type A prevailed at 48%, and 1 case of confluence formation was not described in the classification of P. Krumm et al. When analyzing the gender characteristics of the indigenous population group, we found gender differences in the formation of PV; for example, Type A prevailed in women, and Type B in men. In the non-indigenous group, Type A prevailed in the non-indigenous group in both sexes. When analysing PV branching variants according to T. Nakamura et al. in both groups, we see Type A prevailing, and the variability of branching types in the indigenous group was 20%; Type C was found in 12% of cases, and Type B was detected in 8% of cases. In the non-indigenous group, Type C was identified in 4% of cases.

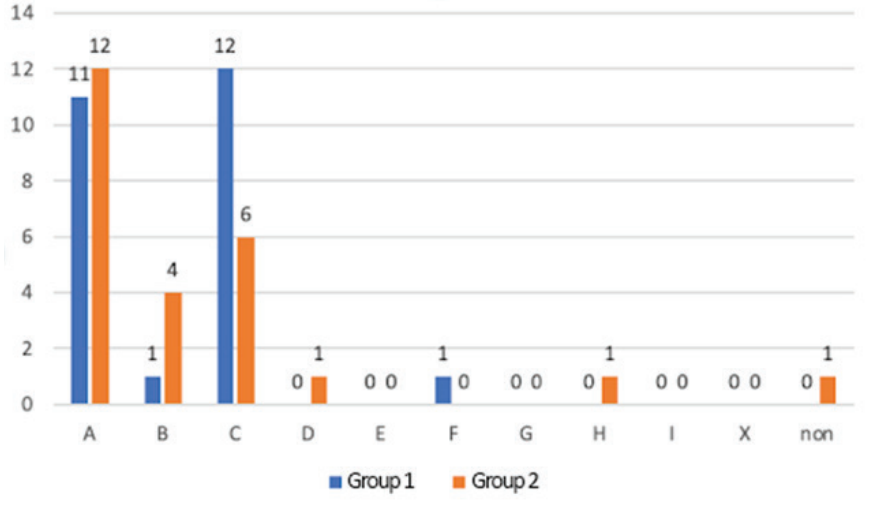

Fig. 3. Variants of PV Confluence According to the Classification by P. Krumm et al. In the Study Groups (non — Missing Applicable Classification)

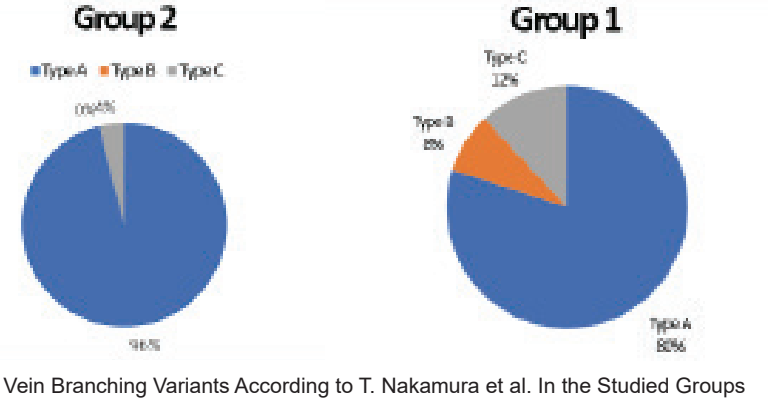

Fig. 4. Portal Vein Branching Variants According to T. Nakamura et al. In the Studied Groups

Thus, a detailed study of the ethnic features of the portal vein variant anatomy is relevant in view of the development of modern surgery in terms of the safety and effectiveness of surgical interventions in the gastropancreatobiliary zone.

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