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Lower prevalence of non-tumoral perfusion defects in left hepatic lobe during CT arterial portography with splenic artery injection

Ramazan Kutlu [a,*], Ahmet Akbulut [b], Ahmet Sigirci [a], Alpay Alkan [a], Ibrahim Karaman [b], Tamer Baysal [a], Kaya Sarac [a]

[a] *Department of Radiology, Turgut Ozal Medical Center, Inonu University School of Medicine, 44069 Malatya, Turkey*
[b] *Radiology Clinic, State Hospital, Malatya, Turkey*

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Abstract

Objective: To determine whether there is a difference in the prevalence of non-tumoral perfusion defects (NTPD) in left hepatic lobe during CT arterial portography (CTAP) through splenic (SA) and superior mesenteric artery (SMA) injection. *Methods and patients:* For the preoperative evaluation, 59 patients (20 females, 39 males) who either have colorectal carcinoma metastasis (*n*: 42) or hepatocellular carcinoma (*n*: 17) underwent CTAP examination. Patients were divided into two groups (SA and SMA) according to the injection artery. The presence and type of NTPD in the left hepatic lobe were determined and compared. *Results:* There were significant differences in peripherally located wedge shaped, perihilar-periligamentous and pericholecystic NTPD, but no significant difference was found in lobar/segmental defects between the groups. *Conclusions:* Our study demonstrated lower prevalence of NTPD in the left hepatic lobe in CTAPs performed through SA injection and we think that this could be explained by the streamlining of portal blood flow.

Keywords: CTAP; Superior mesenteric artery; Splenic artery; Perfusion defects

1. Introduction

CTAP is the imaging of the liver with CT during intraarterial injection of the contrast material through a percutaneously inserted catheter into either SMA or SA. It is generally performed for patients who are possible candidates for surgical resection of their hepatic tumors. The frequency of the NTPD, which causes difficulties in the evaluation of the CTAP, is quite high. However, due to their characteristic appearances and localizations (e.g. around the gallbladder and falciform ligament and in segment IV etc.), they are usually recognized easily [1].

The theory of streamlining of portal vein flow refers to the preferential distribution of blood flowing from the superior mesenteric vein (SMV) and splenic vein (SV) into the right (RPV) and left portal vein (LPV), respectively [2]. This preferential distribution of portal flow could have unnoticed important consequences. This theory led us to retrospectively review our CTAP examinations to determine whether there is a difference in the prevalence of pseudolesions in left hepatic lobe during CTAP through SA and SMA injection.

2. Materials and methods

Between May 1999 and August 2002, 95 patients (29 females, 66 males) between the ages of 29 and 75 (mean age: 59 years) with the diagnosis of colorectal carcinoma metastasis ($n = 69$), primary hepatocellular carcinoma ($n = 20$) and gallbladder carcinoma ($n = 6$) and having liver lesions in their screening imaging studies and who were possible candidates for liver surgery were evaluated with CTAP examination. All angiographic procedures were performed after an overnight fasting either in Shimadzu IDR1000 C Vision digital fluoroscopy with DSA function or Philips Integris V5000 angiography machine. Seldinger approach from femoral artery was used in all cases. The artery to inject

* Corresponding author. Tel.: +90-422-341-0660x5703; fax: +90-422-341-0728.
E-mail address: rkutlu@inonu.edu.tr (R. Kutlu).

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was randomly selected during the angiography. In cases of hepatic artery anomaly, catheter tip was placed distal to the anomalous artery. All CT examinations were performed either in GE ProSpeed helical CT or Philips CT Secura. A total of 130 ml non-ionic contrast material was administered via power injector (Angiomat CT 9000 LF Liebel Fleischeim). A total of 120 kV, 200 mA, 10 mm collimation and 7 mm interval were used. All examinations were performed in caudal to cranial fashion after 25 s of contrast material injection through the catheter with a rate of 2–3 ml/s in one breath-hold. All patients returned to the radiology department 4–6 h later for delayed CT examination with the same parameters in cranial to caudal fashion.

NTPD in the left hepatic lobe were classified in to four groups for our evaluation purposes:

1) Peripheral wedge shaped: small, smooth, sharply marginated, without a tumor nodule on its apex and peripherally located hypodense areas (Fig. 1) [3].
2) Perihilar-periligamentous: posterior to the segments 4a and 4b, anterior to the portal vein, around the falciform ligament, linear or triangular shaped hypodense areas (Fig. 2A, B) [4].
3) Lobar/segmental: hypodense area in a whole lobe or segment (Fig. 3) [5].
4) Pericholecystic: hypodense areas in liver parenchyma around the gall-bladder fossa (Fig. 4) [3].

Each examination was reviewed blindly by three different radiologists to determine the presence and type of NTPD in the left hepatic lobe. Final evaluation result of the examination was given after consensus of the interpreters.

CTAP findings were correlated with that of surgical (n: 65), and delayed CT (n: 95) findings. Imaging findings were correlated with that of the surgery (palpation, visual inspection and intraoperative ultrasound) in 65 patients. Surgical correlation was not possible in the remaining 30 patients due to either the absence of surgical indication (insufficient liver volume after hepatic resection etc.) or patient's disapproval of surgery. Six patients with gallbladder carcinoma that could lead to false interpretations from the point of pericholecystic NTPD and 30 patients in whom surgery was not possible were excluded from the evaluation. The remaining 59 patients (20 females, 39 males, mean age: 55 years) constituted the study group and were classified according to the artery of contrast material injection into SMA ($n = 32$) and SA ($n = 27$) groups. Since it would be unethical to perform the CTAP examination twice in the same patient by SMA and than SA injections, we assumed that our patient cohorts have an equal distribution of underlying anatomic vascular variants (hepatic perfusion zones receiving blood from sources other than the hepatic artery and portal vein).

SPSS for Windows (version 10) program was used in the statistical evaluation. Student's t-test and χ^2-test were utilized and $P < 0.05$ was regarded as significant.

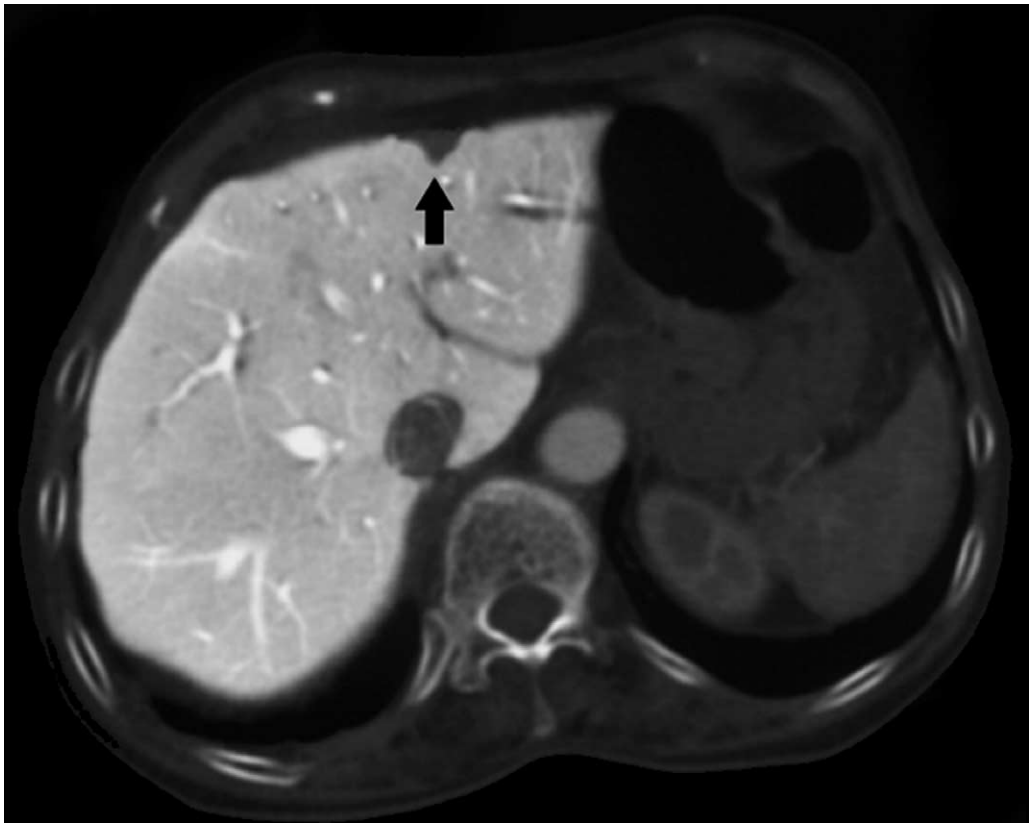
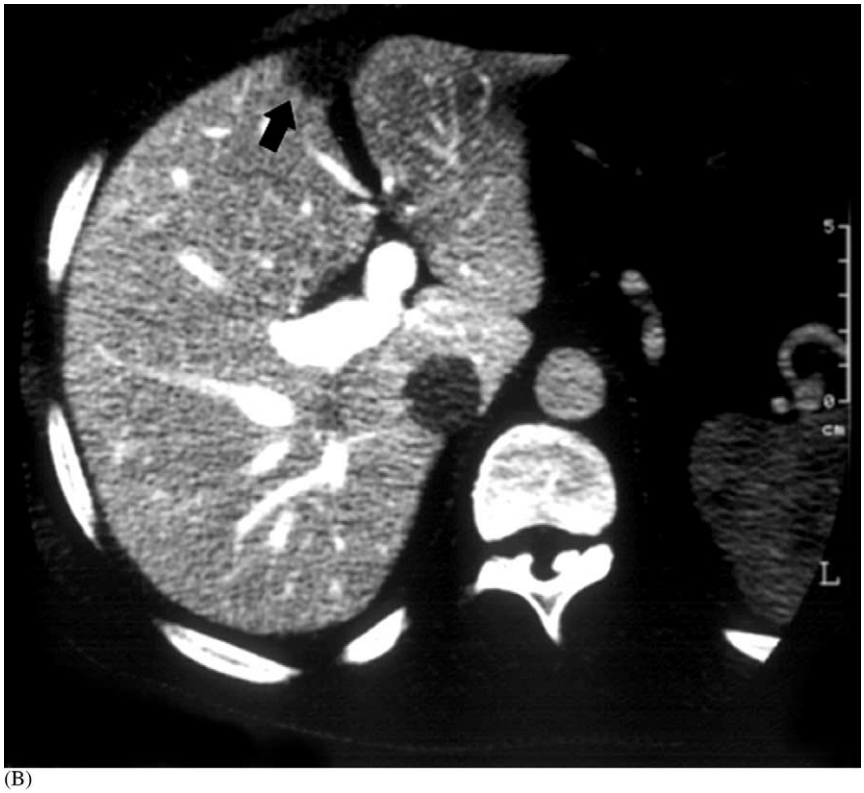


Fig. 1. Small, smooth, sharply marginated, wedge shaped perfusion defect (black arrow) in the segment IVa.

(A)



(B)

Fig. 2. Triangular shaped perfusion defect (black arrow) anterior to porta hepatis and posterior to segment IV (A). Round perfusion defect (black arrow) around the falciform ligament in segment IV (B).

Fig. 3. Segmental perfusion defect (black arrows) in segment II. Also, lobar perfusion defect involving the whole right lobe is noted.

Fig. 4. Perfusion defect (white arrows) adjacent to the gallbladder.

3. Results

Peripherally located wedge shaped ones were seen in 11 (34.3%) of the SMA and two (7.4%) of the SA group. The difference between the groups was statistically significant ($P = 0.04$). Perihilar and periligamentous defects were seen in nine cases (28.1%) of SMA and one case (3.7%) of SA groups and the difference between the groups was significant ($P = 0.03$). Lobar/segmental defects were seen in three cases (9.3%) of SMA and five cases (18.5%) of SA groups ($P = 0.3$). Pericholecystic perfusion defects were seen in 13 cases (40.6%) of SMA and two cases (7.4%) of SA groups and the difference between the groups was significant ($P = 0.02$).

4. Discussion

CTAP is one of the valuable imaging modality in the detection of intrahepatic tumors [1,3–8]. It has the superiority of detecting tumors of < 1 cm when compared to other imaging modalities [9]. However, this technique has some limitations. The false positivity rate is high due to presence of NTPD [1,3–9]. Artifacts due to differential enhancement of the liver lead to high occurrence rate of NTPD, which could mimic malignancy, hamper the interpretation of the CTAP examination [5,10].

In the literature, there are studies comparing the diagnostic quality of CTAP examinations through SMA and SA injections [5,11]. The reported results by these studies are conflicting. In the study by Little et al. [11], CTAP examinations performed through SA injection reported to give lower prevalence rates of NTPD. They have postulated that greater blood flow through the SV relative to SMV in fasting patients produces greater hepatic enhancement, with fewer non-tumor related perfusion defects. But McDermot et al. [5], reported that CTAP examinations which were performed through SA injection have no superiority over SMA injected ones from the point of NTPD.

NTPD are reported to be seen in areas that receive blood from sources other than the hepatic artery or portal vein [12]. This possible explanation for these types of pseudolesions has recently been termed as ‘third inflow’ in a review by Yoshimitsu et al. [10]. In these pseudolesion areas supplied by the blood coming from third inflow sources (aberrant veins or parts of normal veins that directly enter the liver independently of the portal venous system, e.g. cholecystic, parabiliary or epigastric-paraumblical venous system), there is a decreased portal perfusion due to communication of these veins with intrahepatic portal branches. According to the degree of this communication, pseudolesions may appear as ill- or well-defined areas of decreased portal perfusion. Contrast material administered during CTAP is carried by portal vein to the liver and contrast material in portal venules is diluted by the noncontrasted blood from these third inflow sources. The result is hypoattenuating perfusion defects.

Streamline theory was originally suggested in 1901 and it is first shown by injecting ink into the portal system of dogs and then during portography [2]. In a recent study by Gallix et al. [2], this theory was confirmed by MR angiography. Their study demonstrated that blood flow of SMV streamlines preferentially into the RPV and that of the SV into the LPV. Our study demonstrated significantly decreased prevalence of NTPD in SA group. Apart from the possible third inflow explanation, we think that streamlining of PV flow and preferential distribution could also explain our lower rate of NTPD in SA group. According to streamlining of portal blood flow, contrast material administered through SA goes preferentially to the LPV. Also the areas supplied by the third inflow veins receive more contrasted blood through intrahepatic portal branches and the expected decreased perfusion does not occur due to decreased dilution of contrasted blood. Streamlining could also explain the higher prevalence of NTPD in SMA group. When the SMA is used the areas where the NTPD are common (i.e. left hepatic lobe, as in our study), will receive less contrasted blood due to preferential distribution to the right lobe.

5. Conclusion

The frequency of NTPD leading to false positive results during CTAP is considerably high. The results of our study indicate that the prevalence of NTPD in the left hepatic lobe is lower in CTAPs performed through SA injection. The streamlining of portal blood flow could be an explanation of the lower prevalence of NTPD in left hepatic lobe.

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