JBR–BTR, 2012, 95: 345-349.

PICTORIAL ESSAY

MULTIDETECTOR CT OF HEPATIC ARTERY PATHOLOGIES

D. Karaosmanoglu[1], B. Erol[2], M. Karcaaltincaba[3]

The hepatic artery can be involved by a variety of pathology and diseases. Today MDCT enables high quality imaging of the hepatic artery using axial, MIP and volume rendered images. We illustrate MDCT findings of anatomical variations, aneurysm, dilatation, dissection, arteriovenous fistula, thrombosis and stenosis. Aneurysms can be saccular, fusiform and multiple and may develop due to atherosclerosis, vasculitis, trauma and biopsy. Dilatation of hepatic artery can be seen in portal hypertension, Osler-Weber-Rendu disease and hemangiomatosis. Hepatic artery can be occluded after trauma and transplantation. Dissection develops due to atherosclerosis, Marfan and Ehler Danlos syndromes and during pregnancy. Arteriovenous fistula can be congenital and acquired. We conclude that various hepatic artery pathologies can be confidently diagnosed by MDCT.

Key-words: Aneurysm, hepatic - Hepatic artery, CT – dissection.

Imaging of the visceral vascular structures non-invasively with the development of MDCT is one of the most important forward leaps in radiology in the last decade. With the improvement of the MDCT technology any arterial and venous vascular structure of the abdomen can be easily detected and treatment planning can be done in a straightforward manner. Compared to conventional catheter angiography, MDCT imaging of the vascular tree is sometimes more contributory to the patient's treatment plan. Pathologies of the hepatic artery are not rare and in some specific situations may be utmost important for the patient's morbidity and even mortality. In this manuscript, we have tried to provide an overview to pathologies of the hepatic artery in terms of MDCT findings.

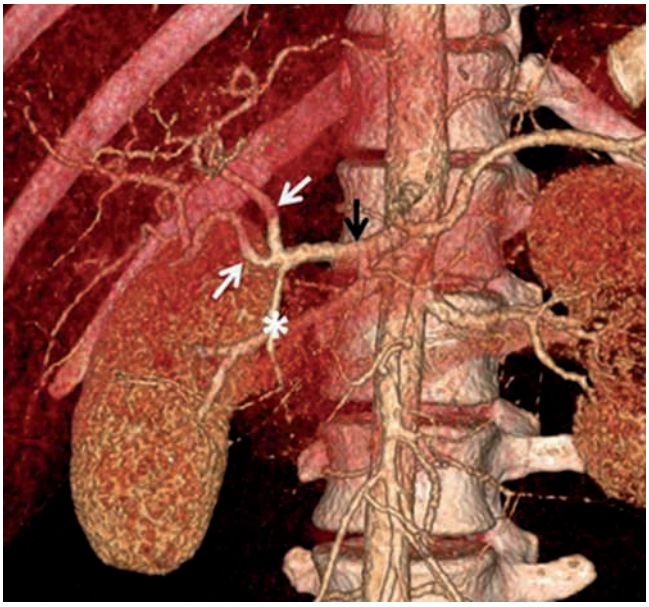

Fig. 1. — Normal hepatic artery anatomy with volume rendered (VR) images. The common hepatic artery then bifurcates (black arrow) into the gastroduodenal artery (asterisk) and proper hepatic artery. The proper hepatic artery bifurcates into the right and left hepatic arteries (white arrows).

Anatomical variations

Exact delineation of the hepatic artery and its branches is a significant factor for the success of liver transplantation, especially for the grafts from living donors. Sufficient arterial flow via the hepatic artery is one of the most important factors for the survival of the graft. MDCT is increasingly being used for the evaluation of the hepatic artery in the pre-transplant phase (1). With the use of the MDCT, other vascular structures related to the liver can also be quickly examined in a single imaging study within a remarkably short period of time. Michel's classification is the conventional method for the evaluation the vascular variations, and in this system only 55% of the hepatic arteries show the classic branching (1) (Fig. 1). Left hepatic artery arising from the left gastric artery and the replaced right hepatic artery from the superior mesenteric artery are the most common arterial variations (i.e. Michel's type II and III, respectively) and may be seen in 10% and 11% of the subjects. Hepatic artery originating directly from the abdominal aorta is an uncommon presentation (0.2-3%) but an important finding for the surgeon (2-4) (Fig. 2). Apart from these anatomical variations, a replaced right hepatic artery can give rise to splenic artery (Fig. 3). For pre-transplant imaging, the calibration of the hepatic arteries may also be easily evaluated.

From: 1. Department of Radiology, Massachusetts General Hospital Harvard Medical School, Boston MA, USA, 2. Department of Radiology, Antalya Education and Research Hospital, Antalya, Turkey, 3. Department of Radiology, Hacettepe University, Faculty of Medicine, Ankara, Turkey.
Address for correspondence: Dr. M. Karcaaltincaba, M.D., Liver imaging team, Liver Imaging Team, Department of Radiology, Hacettepe University School of Medicine, Sihhiye, Ankara, 06100, Turkey. E-mail: musturayk@yahoo.com

Fig. 2. — A. Common anatomical variants of the hepatic artery. Coronal MIP images of the right hepatic artery (arrow) originating from superior mesenteric artery. B. Coronal MIP images show the left hepatic artery (arrow) originating from the left gastric artery (arrowhead). C. Axial CT images showing the hepatic artery (arrow) originating directly from abdominal aorta (arrowhead).

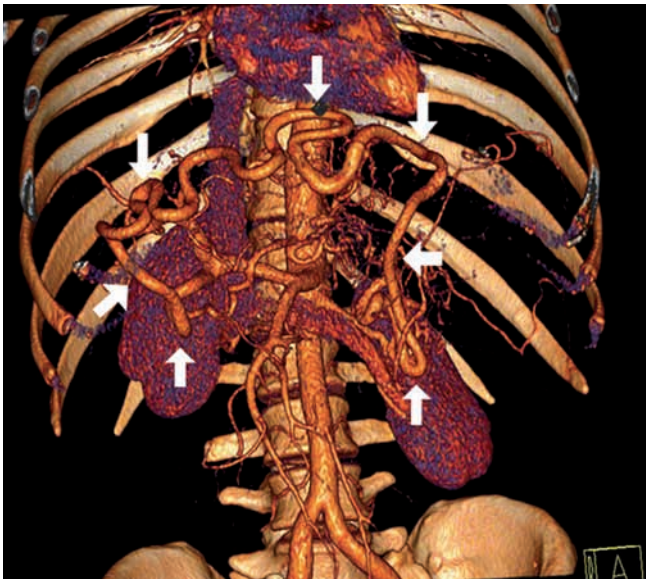

Fig. 3. — VR image shows a replaced right hepatic artery (arrows) from superior mesenteric artery supplying splenic artery.

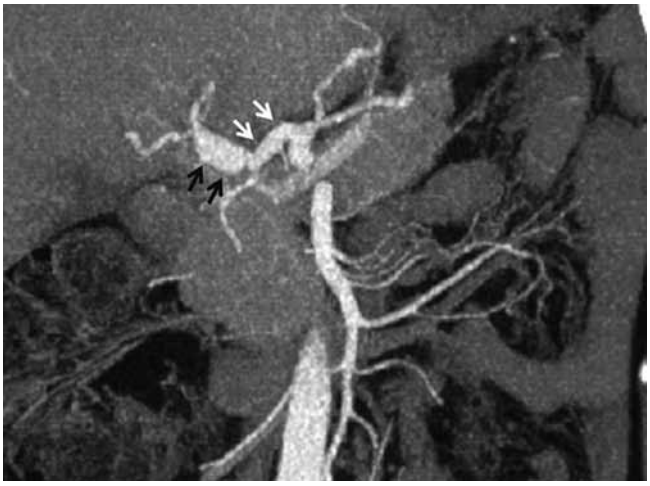

Fig. 4. — Diffuse aneurysmal dilatations of the common (white arrows) and proper (black arrows) hepatic arteries.

Aneurysm of the hepatic artery

Hepatic artery is the fourth most frequent site of peripheral arterial aneurysms after aorta, iliac artery and splenic artery (5). Among the underlying predisposing factors atherosclerosis, trauma, inflammation and iatrogenic factors may be counted (6). With the increased use of cross-sectional imaging and diagnostic and therapeutic interventions of the liver increased the incidence of the detection of this abnormality (7). Almost 75-80% of the hepatic artery aneurysms are extrahepatically located at different locations on the course of the artery and they are generally solitary (8) (Fig. 4). Atherosclerotic aneurysms are typically extrahepatic, while intrahepatic aneurysms and pseudoaneurysms are generally related to trauma and biopsy. The aneurysms of the hepatic artery may vary in size and may have a diameter of 14 cm, with a median diameter of 3.6 cm (9) (Fig. 5). The reported indications for treatment of common hepatic artery aneurysms are: symptomatic aneurysms, aneurysms larger than 2 cm, non-atherosclerotic aneurysms and multiple aneurysms (9). Surgery and endovascular intervention are the main treatment modalities. Intrahepatic hepatic artery aneurysms are generally secondary to surgical or percutaneous interventions and the appropriate treatment of this aneurysm must be tailored on individual basis (Fig. 6).

Vasculitis is among the causes of the aneurysms of the hepatic artery. The aneurysms may be seen as diffuse multiple or solitary. Several infectious and inflammatory vasculites including polyarteritis nodosa and systemic lupus erythematosus may cause visceral arterial aneurysms including the hepatic artery (10) (Fig. 7).

Dilatation of the hepatic artery

Dilatation of the hepatic artery may be secondary to several different disorders; however portal hypertension and cirrhosis are the most common causes. Dilatation and spiraling of the hepatic artery (corkscrew appearance) is the classic finding of portal hypertension (Fig. 8).

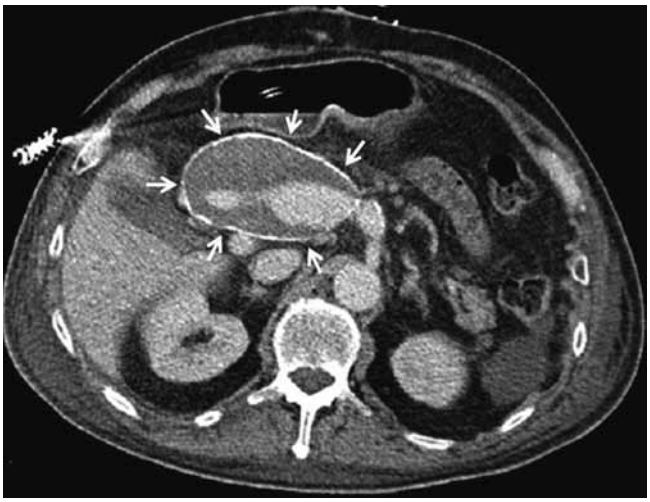

Fig. 5. — Giant aneurysm of the hepatic artery (arrows) in a 69 year-old patient with a history of hypertension. Patient had no history of trauma or surgery. The calcified plaques at the wall identifies the origin of the pathology as atherosclerotic.

Fig. 6. — Aneurysmal dilatation (arrow) of the segment 8 branch of the hepatic artery. The patient underwent non-focal liver biopsy six weeks before the procedure, most likely iatrogenic. The patient was completely asymptomatic, CT was done for an unrelated reason.

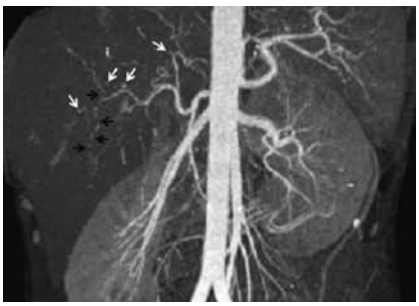

Fig. 7. — 23-year-old patient with a history of treatment resistant systemic lupus erythematosus. Multiple stenoses (black arrows) and aneurysmal dilatations (white arrows) of the intraparenchymal branches of the hepatic artery are shown.

Fig. 8. — Prominent increase in caliber of the hepatic arteries (arrowheads) with spiraling (corkscrew appearance, arrows) in a patient with severe portal hypertension due to chronic portal vein thrombosis. Also note early bifurcation of hepatic artery as an anatomic variation.

Fig. 9. — Diffuse dilatation of the common hepatic artery (arrows) in a 26-year-old female patient with a history of Osler-Weber-Rendu syndrome. Note the absence of corkscrew appearance of the artery in contrast to patients with portal hypertension.

Osler-Weber-Rendu disease is another rare cause of dilatation of the hepatic artery (Fig. 9). The dilatation of the artery may be extra or intrahepatic and sometimes both (11). Multiple telengiectasias in the liver parenchyma is another interesting finding in this uncommon abnormality.

Diffuse hepatic hemangiomatosis is rare and usually detected in newborns with associated abdominal

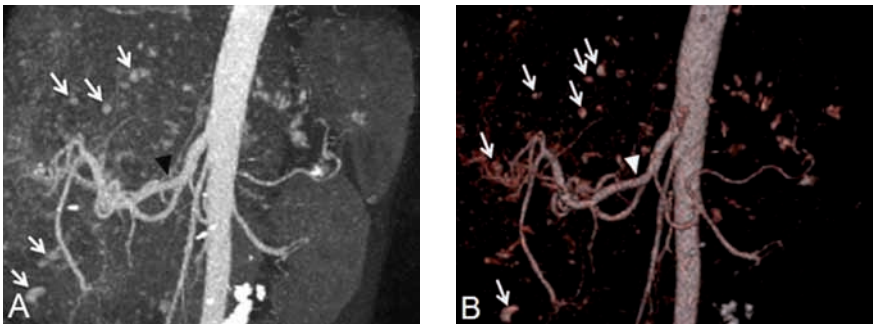

Fig. 10. — Coronal MIP (A) and VR images (B) show dilated hepatic artery (arrowhead) and multiple hemangiomas (arrows) in a patient with hemangiomatosis.

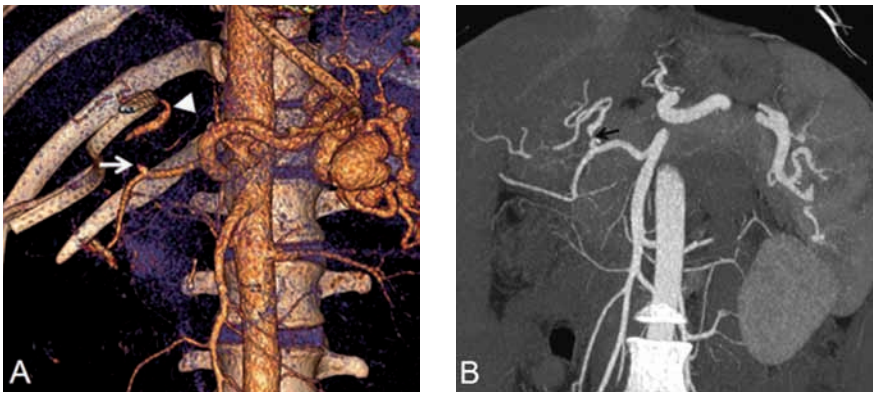

Fig. 12. — Complete absence of contrast enhancement in the hepatic artery at the hepatic hilum (arrow) consistent with short segment thrombosis in a patient with hepatic transplant (performed 2 days before imaging). VR image shows collateral filling of left hepatic artery (arrowhead) (A). Prior color Doppler US was unable to demonstrate the arterial signal at the hilum in another patient. Coronal MIP image shows the exact location of the stenosis (black arrow) (B). Catheter angiography confirmed the diagnosis.

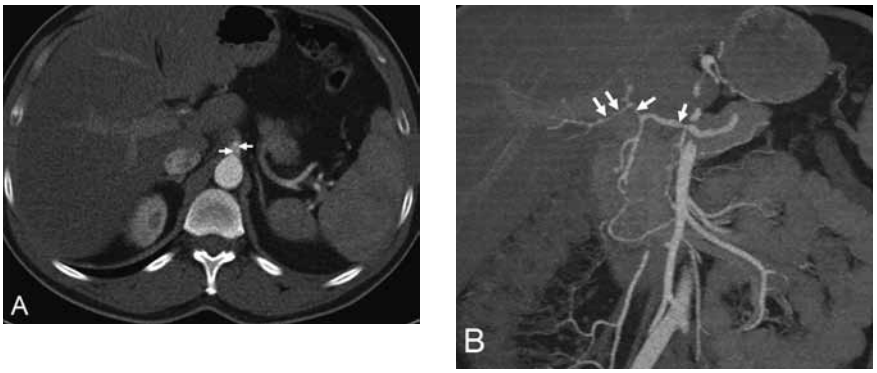

Fig. 13. — Axial CT (A) and coronal MIP images (B) show aortic dissection extending from celiac artery (arrows) to hepatic artery and of their branches (arrows).

distension and sometimes with congestive heart failure. It is generally associated with skin involvement and isolated forms are rare (1). Hepatic artery can be dilated in a patient with associated hepatic hemangiomatosis (Fig. 10). The underlying etiology for hepatic artery dilatation is most likely the increased arterial circulation of the liver.

Arterioportal fistula

Arterioportal fistula (APF) is a rare cause of portal hypertension. The clinical findings are highly variable ranging from asymptomatic cases to severe findings of portal hypertension, eventually resulting in death. APF may be congenital, post-traumatic and iatrogenic (12). When the rare congenital cases are set aside, most of the patients are traumatic or iatrogenic. Clinical diagnosis is mainly done with imaging. Color Doppler US, CT and MRI may all be used in the diagnosis. Catheter angiography may also be used for detection and treatment. On arterial phase images, enhancement and dilatation of the portal vein and multiple ectatic vascular structures are the main findings (Fig. 11). Increased blood flow to the portal system is most likely the cause of the hyperkinetic portal hypertension (12). Endovascular treatment is the main treatment modality for these patients with highly successful results.

Fig. 11. — Arterial phase coronal MIP image shows enhancing and dilated portal vein (black arrows), dilatation of the hepatic artery (white arrows) and with multiple ectatic vascular structures (asterisk) in between these two vessels consistent with arterioportal shunt.

Hepatic artery thrombosis or stenosis

The rate of hepatic artery complications after liver transplant ranges between 5-20% are among the most problematic problems in the early phase of the post-transplant period (13, 14). The hepatic artery thrombosis or stenosis are the predominant disorders affecting the hepatic artery in the posttransplant period. Hepatic artery thrombosis is a potentially complicating pathology that may end up with liver failure (75-88%) and death may ensue in 57% of these patients (15).

The hepatic artery is very significant for the liver parenchyma and bile duct system, particularly in the early post-operative period. Early detection of this abnormality is of

paramount importance for prompt intervention and potential salvage of the graft. Generally color Doppler US is the first imaging modality in the early phase with its great versatility that allows bedside evaluation. In the past, catheter angiography was the main evaluation method for hepatic artery; currently CT and MR angiography are preferred for diagnosis. CT angiography is highly useful compared to MRI with its quick application and highly accurate results. MRI also demands strong patient cooperation for accurate imaging which may be hard to obtain in a patient in early postoperative period.

Classical imaging finding in CT angiography is the absence of contrast filling in the presumed trajectory of the hepatic artery right anterior to portal vein in the hepatic hilum (Fig. 12). With isotropic multiple reformatted images the exact location of the stenosis or thrombosis may be detected and useful guidance for endovascular or surgical intervention may be supplied. Additionally other vascular or visceral organ abnormalities that may mimic arterial complications may also be easily detected.

Hepatic artery dissection

Dissection of the abdominal visceral arteries are rare clinical occurrence and may be iatrogenic or due to continuation of the abdominal aortic aneurysm (16) (Fig. 13). Arterial dissection is essentially the separation of two layers of the arterial wall secondary to intramural hematoma (17). Patients may be asymptomatic or may present with signs of ischemia of the affected vascular territory. Dissection of the hepatic artery is rare and may present with jaundice (16). Apart from the iatrogenic dissections several underlying diseases may cause the dissection of visceral artery aneurysms like, atherosclerosis, collagen vascular disorders, Marfan syndrome, Ehler Danlos syndrome, pregnancy and syphilis (18). MDCT angiography appears to be the most useful modality for this diagnosis.

Conclusion

MDCT angiography is a very robust and versatile imaging modality which allows highly accurate and prompt information about the pathologies of the hepatic artery. With the ability of imaging the trajectory of hepatic artery in almost every plane with isotropic data, it is relatively straightforward for the radiologists to recognize these abnormalities and inform the referring clinician in a very time efficient manner. Obtaining both arterial and venous phase images may increase the diagnostic accuracy of MDCT, allowing both the evaluation of the hepatic vasculature and the other abdominal mimickers. In this article, we summarized the role of MDCT in a variety of clinical disorders of the hepatic artery and increased the acquaintance of the practicing radiologists.

References

1. Duran C., Uraz S., Kantarci M., et al.: Hepatic arterial mapping by multidetector computed tomographic angiography in living donor liver transplantation. *J Comput Assist Tomogr*, 2009, 33: 618-625.
2. Lippert H., Pabst R.: Arterial variations in man: Classification and Frequency. Munich, *Springer-Verlag*, 1985.
3. Nakamura H., Uchida H., Kuroda C., et al.: Accessory left gastric artery arising from left hepatic artery angiographic study. *Am J Roentgenol*, 1980, 134: 529-532.
4. Van Damme J.P., Bonte J.: Vascular anatomy in abdominal surgery. Stuttgart, Georg *Thieme Verlag*, 1990.
5. Stanley J.C., Wakefield T.W., Graham L.M., Whitehouse W.M. Jr., Zelenock G.B., Lindenauer S.M.: Clinical importance and management of splanchnic artery aneurysms. *J Vasc Surg*, 1986; 3: 836-840.
6. O'Driscoll D., Olliff S.P., Olliff J.F.: Hepatic artery aneurysm. *Br J Radiol*, 1999, 3: 836-840.
7. Jeans P.L.: Hepatic artery aneurysms and biliary surgery: two cases and a literature review. *Aust N Z J Surg*, 1988, 58: 889-894.
8. Bachar G.N., Belenky A., Lubovsky L., Neuman-Levine M.: Sonographic diagnosis of a giant aneurysm of the common hepatic artery. *J Clin Ultrasound*, 2002, 30: 300-302.
9. Abbas M.A., Fowl R.J., Stone W.M., et al.: Hepatic artery aneurysm: factors that predict complications. *J Vasc Surg*, 2003, 38: 41-45.
10. Choy C.W., Smith P.A., Frazer C., Jeffrey G.P.: Ruptured hepatic artery aneurysm in polyarteritis nodosa:a case report and literature review. *Aust NZ J Surg*, 1997, 67: 904-906.
11. Buscarini E., Buscarini L., Civardi G., Arruzzoli S., Bossalini G., Piantanida M.: Hepatic vascular malformations in hereditary hemorrhagic telengiectasia:imaging findings. *Am J Roentgenol*, 1994, 163: 1105-1110.
12. Lu Z.Y., Ao J.Y., Jiang T.A., Peng Z.Y., Wang Z.K.: A large congenital and solitary intrahepatic arterioportal fistula in an old woman. *World J gastroenterol*, 2009, 15: 1656-1659.
13. Cavallari A., Vivarelli M., Bellusci R., Jovine E., Mazziotti A., Rossi C.: Treatment of vascular complications following liver transplantation: multidisciplinary approach. *Hepatogastroenterology*, 2001, 48: 179-183.
14. Wang X.H., Yan L.N., Zhang F., et al.: Early experiences on living donor transplantation in China:multicenter report. *Chin Med J*, 2006, 119: 1003-1009.
15. Stange B.J., Glanemann M., Nuessler N.C., Settmacher U., Steinmüller T., Neuhaus P.: Hepatic artery thrombosis after adult liver transplantation. *Liver Transpl*, 2003, 9: 612-620.
16. Woolard J.D., Ammar A.D.: Spontaneous dissection of the celiac artery: a case report. *J Vasc Surg*, 2007, 45: 1256-1258.
17. Foord A.G., Lewis R.D.: Primary dissecting aneurysms of peripheral and pulmonary arteries: dissecting hemorrhage of media. *Arch Pathol*, 1959, 68: 553-577.
18. Matsuo R., Ohta Y., Ohya Y., et al.: Isolated dissection of the celiac artery – a case report. *Angiology*, 2000, 51: 603-607.