

American Journal of Transplantation Images in Transplantation – Continuing Medical Education (CME)

Each month, the *American Journal of Transplantation* will feature Images in Transplantation, a journal-based CME activity, chosen to educate participants on current developments in the science and imaging of transplantation. Participants can earn 1 *AMA PRA Category 1 Credit*[™] per article at their own pace.

This month's feature article is titled: "Liver transplant recipient with right lobe ischemia and transaminitis 1-month posttransplant."

Accreditation and Designation Statement

This activity has been planned and implemented in accordance with the accreditation requirements and policies of the Accreditation Council for Continuing Medical Education (ACCME) through the joint providership of Elsevier Office of CME, the American Society of Transplant Surgeons, and the American Society of Transplantation. Elsevier Office of CME is accredited by the ACCME to provide continuing medical education for physicians, and fulfills the requirements for the American Board of Surgery (ABS) for Maintenance of Certification (MOC).

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Statement of Need

Adequate arterial blood flow is essential to hepatic allograft survival and, particularly, critical for biliary tree health. Arterial blood flow can be affected by hepatic artery thrombosis, hepatic artery stenosis, nonocclusive hypoperfusion syndrome (HAHS), portal hyperperfusion with resultant hepatic arterial buffer response, and splenic artery steal syndrome. Hepatic arterial HAHS is a rare cause of graft dysfunction with potentially devastating consequences. Despite the severity, it can be difficult to diagnose, thereby posing a challenge for transplant providers.

Purpose of the Activity

The purpose of this activity is to improve participant understanding of rare causes of hepatic allograft arterial dysfunction. The activity offers a framework for approaching patients with suspected arterial hypoperfusion including diagnostic considerations and treatment strategies.

Identification of Practice Gap

While arterial hypoperfusion is a known complication following liver transplantation with severe consequences, it is often underdiagnosed or recognized late due to the inconsistent timeline within which it presents and its variable clinical picture. Furthermore, diagnosis is often delayed as clinical presentations associated with arterial hypoperfusion are frequently attributed to other more common complications such as technical issues with the arterial inflow, hepatic artery stenosis or thrombosis, and rejection. This is further challenged by the fact that there are no standardized criteria for risk stratification and early diagnosis of HAHS. Taken together, these considerations point to a practice gap requiring individual clinicians to develop their own framework for evaluating and treating patients with suspected HAHS.

Learning Objectives

Upon completion of this educational activity, participants will be able to:

- Identify the diverse clinical presentations of arterial hypoperfusion to facilitate timely diagnosis and intervention.
- Describe the diagnostic workup for arterial hypoperfusion including relevant laboratory investigations and imaging modalities.
- Compare different treatment strategies for arterial hypoperfusion.

Target Audience

This activity targets the educational needs of medical and surgical practitioners who manage liver transplant patients including hepatologists, radiologists, liver transplant surgeons, advanced practice providers, and trainees.

Disclosures

No commercial support has been accepted related to the development or publication of this activity. Elsevier Office of CME has reviewed all disclosures and resolved or managed all identified conflicts of interest, as applicable.

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Instructions on Receiving CME Credit

This activity is designed to be completed within an hour. Physicians should claim only those credits that reflect the time actually spent in the activity. This activity will be available for CME credit for 12 months following its publication date. At that time, it will be reviewed and potentially updated and extended for an additional 12 months.

Physicians must correctly answer 75% or more of the posttest items to claim MOC credit.

Follow these steps to participate, answer the questions and claim your CME credit:

- Log on to <https://www.amjtransplant.org/cme/home>
- Read the learning objectives, target audience, and activity disclosures.
- Read the article in print or online format.
- Reflect on the article.
- Access the CME Exam, and choose the best answer to each question.
- Complete the required evaluation and print your CME certificate.



Images in Transplantation (CME)

Liver transplant recipient with right lobe ischemia and transaminitis 1-month posttransplant

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ARTICLE INFO

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Case description

The patient is a 42-year-old man with alcohol-related decompensated cirrhosis who underwent a deceased donor liver transplantation approximately 1 month before the index presentation. Posttransplant course was uncomplicated, and he was discharged home on postoperative day 11. He was readmitted with acute kidney injury, worsening volume overload and hyponatremia on postoperative day 17. These were found during routine laboratory workup at his clinic visit. At this time, the patient was relatively asymptomatic with some mild lower extremity edema. His acute clinical picture was attributed to supratherapeutic tacrolimus levels (24 ng/mL), and with pharmacologic adjustments, his acute kidney injury and hyponatremia were improving. However, on postoperative day 23, he had an episode of hypotension, and he was transferred to the intensive care unit. As part of his workup, he

underwent a computed tomography scan of the abdomen and pelvis with intravenous contrast, which demonstrated hypoperfusion of the right posterior sector of the liver and inability to visualize distal branches of the hepatic arteries in the parenchyma (Fig. 1). Repeat liver enzymes at this time demonstrated a sudden and significant increase in aspartate transaminase/alanine transaminase into the 5000–6000 range from normal earlier that day. A duplex ultrasound of the liver demonstrated good arterial waveforms in the porta hepatis and left lobe, but no detectable arterial waveform in the right lobe. Subsequently, interventional radiology performed a visceral angiogram, which did not demonstrate any hepatic artery stenosis but did reveal marked preferential flow into the splenic artery with diminutive caliber of the hepatic arterial vasculature (Fig. 2A, B). The proximal splenic artery was embolization with significant improvement of hepatic perfusion (Fig. 3A, B) and subsequent liver enzyme tests.

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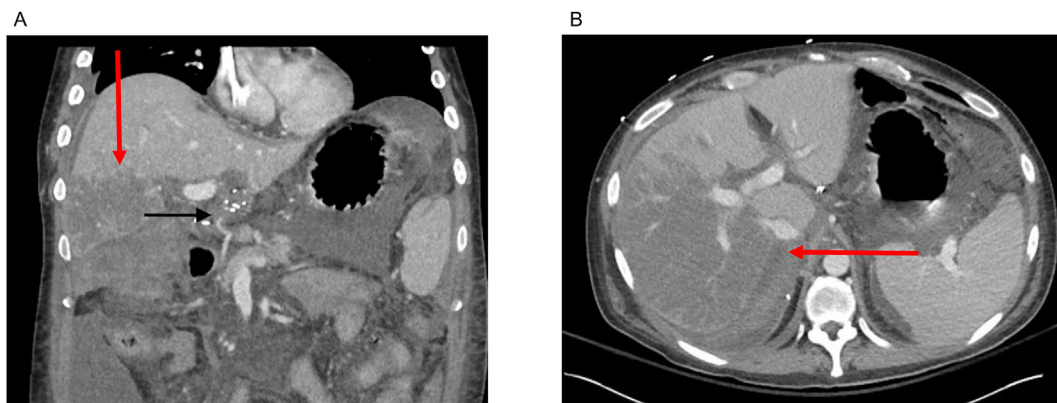


Figure 1. (A) Coronal reformat image of a computed tomography (CT) angiography of the abdomen demonstrating hypoperfusion of the right posterior lobe of the liver (red arrow) and nonvisualization of distal branches of the hepatic arteries in the parenchyma (black arrow). (B) Axial image of a CT angiography of the abdomen demonstrating hypoperfusion of the right posterior lobe of the liver (red arrow) and nonvisualization of distal branches of the hepatic arteries in the parenchyma (black arrow). (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article).

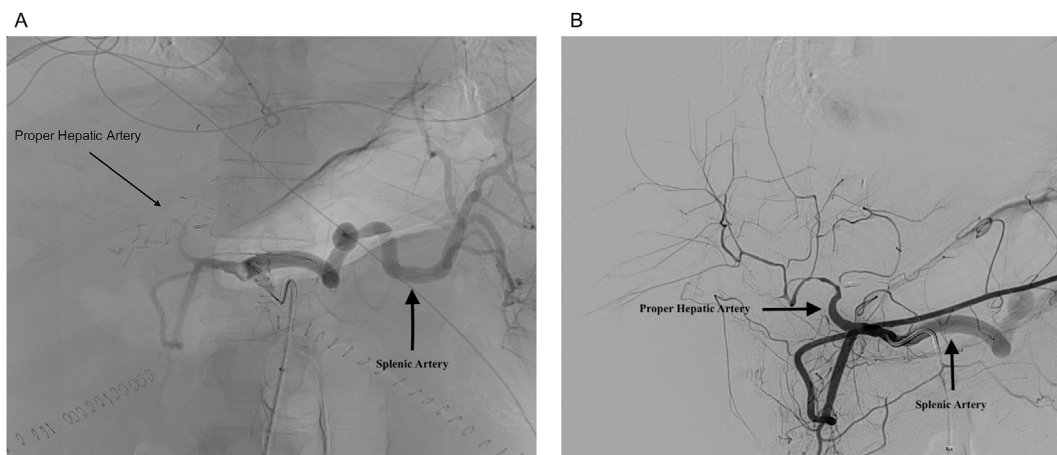


Figure 2. (A) Celiac artery angiogram showing marked preferential flow into the splenic artery with diminutive caliber of the hepatic arterial vasculature. (B) Celiac artery angiogram after proximal splenic artery embolization showing preserved flow to the spleen and pancreas via collaterals.

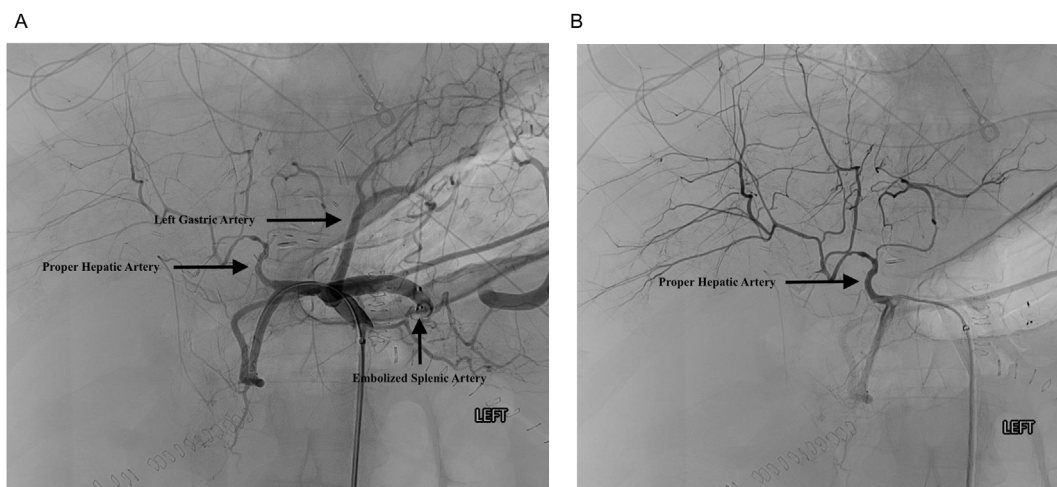


Figure 3. (A) Common hepatic artery angiogram showing no proximal hepatic artery stenosis. However, hepatic artery branches are diffusely small in caliber. The splenic artery is larger in caliber with brisk flow. (B) Common hepatic artery angiogram after proximal splenic artery embolization showing overall improved hepatic perfusion and distal hepatic arterial arborization.

Questions

1. What is the definition of hepatic artery hypoperfusion syndrome (HAHS)?
 - a. Thrombus formation in the distal donor hepatic artery causing preferential splenic arterial flow
 - b. Narrowing of the arterial anastomosis causing preferential splenic arterial flow and resultant hypoperfusion of the liver
 - c. Hypoperfusion of the liver due to arterial flow diverted by the gastroduodenal artery
 - d. Hypoperfusion of the liver due to reduced arterial in flow that improves with splenic artery embolization or ligation
 - e. Hypoperfusion of the liver due to low flow state caused by hypotension
2. The ultrasound findings most associated with hepatic artery HAHS are:
 - a. Low resistive indices and high diastolic flow
 - b. High resistive indices and high diastolic flow
 - c. Low resistive indices and reversal of diastolic flow
 - d. High resistive indices and reversal of diastolic flow
3. What is the most common presentation of hepatic artery hypoperfusion in liver transplant recipients in the early postoperative period?
 - a. Elevated liver enzymes
 - b. Coagulopathy
 - c. Jaundice
 - d. New-onset ascites
 - e. Asymptomatic
4. What is the most commonly used treatment for hepatic arterial HAHS as a result of splenic artery steal when diagnosed after the index transplant operation?
 - a. Splenic artery ligation
 - b. Splenic artery embolization
 - c. Splenectomy
 - d. Splenic devascularization
 - e. Gastroduodenal artery ligation

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