Ultrasonography Assessment of the Aorta and Mesenteric Arteries

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KEYWORDS

• Ultrasonography • Aorta • Mesenteric arteries • AAA • Chronic mesenteric ischemia

KEY POINTS

- A basic knowledge of the anatomy of the abdominal aorta and its major branches is essential for proper interpretation of sonographic findings and for understanding the pathologic disease states that affect these vessels.
- An understanding of relevant anatomy and hemodynamics for normal vessels as well as for multiple disease states, including abdominal aortic aneurysm, vascular stenosis, dissection, and occlusion, is important for correct diagnosis.
- There are various Doppler techniques, protocols, and diagnostic criteria used in the evaluation of the aorta and mesenteric arteries.

INTRODUCTION

This article discusses the sonographic evaluation of the abdominal aorta and mesenteric arteries. Relevant anatomy and hemodynamics are reviewed for normal vessels as well as for multiple disease states, including abdominal aortic aneurysm (AAA), vascular stenosis, dissection, and occlusion. Doppler techniques, protocols, and diagnostic criteria are presented for evaluation of the aorta and mesenteric arteries. The learner is presented with essential information for correct diagnosis and recognition of potential pitfalls to avoid.

ANATOMY OF THE ABDOMINAL AORTA AND ITS MAJOR BRANCHES

A basic knowledge of the anatomy of the abdominal aorta and its major branches is essential for proper interpretation of sonographic findings and for understanding the pathologic disease states that affect these vessels.

Abdominal Aorta

The abdominal aorta is a continuation of the thoracic aorta. It begins at the aortic hiatus of the diaphragm, at the T12 level, and ends at approximately the L4 level by dividing into the right and left common iliac arteries. The common iliac arteries diverge and run inferolaterally along the psoas musculature. The abdominal aorta is approximately 13 cm in length, and its major branches may be described as both paired and unpaired, and parietal and visceral. Among its unpaired branches are the celiac trunk, superior mesenteric artery (SMA), and inferior mesenteric artery (IMA), and among paired branches are the renal and gonadal arteries. The lumbar arteries are parietal paired vessels that are located on both sides of the posterior aorta. There are normally 4 pairs of lumbar branches, with the inferior vessels on occasion arising from iliac artery branches. The abdominal aorta lies anterior to the spine, posterior to the pancreas and stomach, and to the left of the inferior vena cava.

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Anatomy of the Mesenteric Arteries and Collateral Pathways

Mesenteric arteries arise from the abdominal aorta. The celiac trunk is the first branch, measuring approximately 3 cm in length and arising from the anterior aspect of the aorta approximately at the level of the T12 and L1 vertebral bodies. It subsequently branches into the splenic, hepatic, and left gastric arteries. The SMA arises from the anterior aspect of the abdominal aorta and usually takes off 1 cm inferior to the celiac trunk, at the L1 level. The vessel courses caudally along the aorta surrounded by retroperitoneal fat, following the mesentery of the small bowel into the right lower quadrant. SMA gives off multiple branches including the inferior pancreaticoduodenal artery; 4 to 6 jejunal branches; 9 to 13 ileal branches; and the ileocolic, right colic, and middle colic arteries. In addition, the IMA originates from the anterolateral aspect of the aorta at the level of the L3 vertebral body, approximately 4 cm above the aortic bifurcation. It divides into the ascending left colic artery and 2 descending branches: the sigmoid and superior hemorrhoidal arteries (**Fig. 1**).

There is a rich collateral circulation between all three of the mesenteric arteries, ensuring blood supply to the essential organs and bowel if one or more of the vessels get compromised. Communication between the celiac and the superior mesenteric systems occurs by way of the gastroduodenal artery. The gastroduodenal artery is formed from the superior pancreaticoduodenal artery, a branch from the celiac system, and the inferior pancreaticoduodenal artery, a branch from the SMA. The SMA and IMA systems are joined by the arc of Riolan, connecting the middle colic branch of the SMA with the left colic branch of the IMA. It forms a short loop that runs close to the root of the mesentery. In addition, SMA and IMA are anastomosed by means of the marginal artery of Drummond, which is a continuous arterial circle or arcade along the inner margin of the colon, formed by anastomoses of the terminal branches of the ileocolic, right colic, and middle colic arteries (from the SMA) with the left colic and sigmoid branches of the IMA. In addition, there is communication of the IMA and internal iliac systems via anastomoses of the superior hemorrhoidal arteries (IMA branches) with the inferior hemorrhoidal arteries (internal iliac artery branches).

There is significant variation in the anatomy of the collateral circulation, with weak or absent connection between the mesenteric arteries in up to 30% of the population.[1]

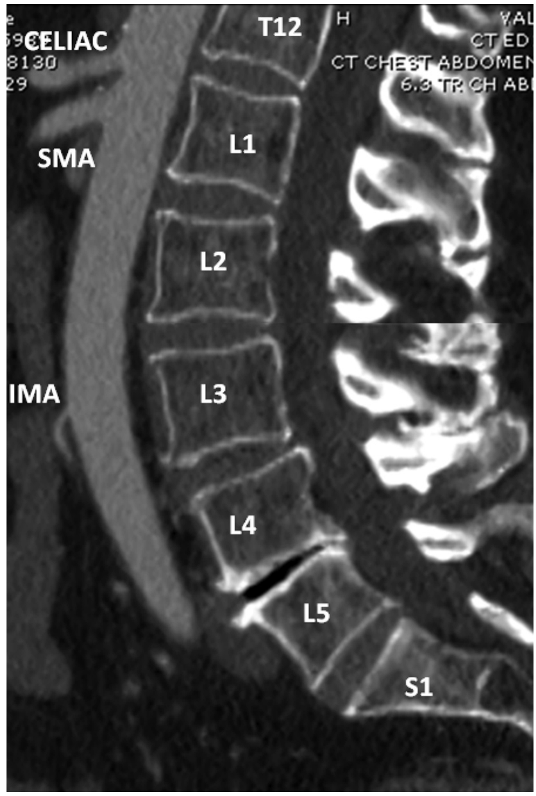

Fig. 1. Aortic branches. Contrast-enhanced sagittal computed tomography (CT) view of the aorta and its major branches. Relationship of the branches to the spine: celiac (T12–L1), SMA (L1), IMA (L3).

HEMODYNAMICS OF THE ABDOMINAL AORTA AND MESENTERIC ARTERIES

Hemodynamics of the Aorta

The abdominal aorta is an elastic structure that propagates moving blood peripherally during the cardiac cycle by means of distention in systole and elastic recoil of its walls in diastole. This physiology is reflected in pulsatile changes that are observed in the waveform during the cardiac cycle. Waveforms obtained in the proximal abdominal aorta differ from the ones obtained in the distal aorta. Although both segments show triphasic waveforms, the proximal abdominal aorta waveform patterns have more continuous blood flow during diastole (**Fig. 2**A).[2] This phenomenon is caused by the presence of several major branches of the abdominal aorta that supply the liver, spleen, and kidneys. These organs have low-resistance blood flow patterns and require continuous forward flow throughout systole and diastole for their function. Below the renal arteries, the abdominal aorta waveform pattern mimics that of a peripheral artery, showing a characteristic