

Significant Disease of the Celiac and Superior Mesenteric Arteries in Asymptomatic Patients: Predictive Value of Doppler Sonography

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OBJECTIVE. The purpose of this study was to assess the frequency of significant disease (i.e., occlusion or stenosis > 70%) of the celiac and superior mesenteric arteries in asymptomatic patients.

SUBJECTS AND METHODS. Using duplex sonographic criteria obtained from previous angiographic–duplex Doppler correlation studies, we assessed the frequency of significant disease in the celiac and superior mesenteric arteries in 184 patients who had no signs or symptoms of mesenteric ischemia.

RESULTS. For patients less than 65 years old, the frequency of significant disease was 3%, and it was isolated to the celiac artery. Significant disease was found in 18% of patients more than 65 years old (in 11%, isolated to one vessel; in 7%, disease of both vessels). Single-vessel disease was more common in the celiac artery (81%) than in the superior mesenteric artery (19%).

CONCLUSION. These results indicate that the finding of significant abnormality of the celiac and superior mesenteric arteries on Doppler sonograms does not necessarily indicate mesenteric ischemia.

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The diagnosis of mesenteric ischemia is often difficult to make on clinical grounds and is typically made late and preceded by multiple diagnostic procedures [1]. To date, arteriography has been required to make the diagnosis. However, recently, duplex Doppler sonography with color flow imaging has been suggested as a primary screening procedure for patients with suspected mesenteric ischemia [2]. Retrospective studies have shown a high correlation between peak systolic velocity assessed with duplex Doppler sonography and angiographically proved significant stenoses of the superior mesenteric and celiac arteries [3].

The frequency of significant stenoses in the asymptomatic population, however, is unknown. Therefore, it may be difficult to know what degree of confidence to ascribe to the finding of a significant stenosis detected at duplex Doppler sonography, particularly in patients with a clinical diagnosis that is less than definite. We therefore undertook a study to determine the frequency of significant disease in the celiac or superior mesenteric artery as seen at duplex Doppler sonography in a group of patients without signs or symptoms of mesenteric ischemia.

Subjects and Methods

Patients undergoing sonography of the pelvis or the upper part of the abdomen were considered for the study. Patients were excluded if they had symptoms suggesting mesenteric ischemia (abdominal pain, weight loss, or postprandial pain) or if they had not fasted overnight. A number of patients were also omitted if the available acoustic windows did not allow good visualization of both vessels with color Doppler imaging and an optimal angle for performing duplex Doppler sonography.

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Supine patients were examined sonographically by one of the authors with a 3.5-MHz sector scanner. The proximal part of the superior mesenteric artery and the celiac artery to its bifurcation were examined in longitudinal and transverse planes, as these are the sites of most significant arteriosclerotic lesions [4]. The study was initially performed with color Doppler sonography to identify any high-velocity jets and poststenotic turbulence (Fig. 1). Subsequently, angle-corrected duplex Doppler signals were obtained from both the superior mesenteric artery and the celiac artery, either near their origins or at any site of stenosis identified with color Doppler imaging. A vessel was said to be occluded if no signal could be obtained with either color or duplex Doppler sonography despite good visualization of the vessel. If significant disease was identified, patients were further questioned and excluded if they reported signs or symptoms that were suggestive of mesenteric ischemia.

The criteria described by Moneta et al. [3], which we have found to correlate well with angiographic findings in our symptomatic population, were used to define significant disease of a vessel (i.e., occlusion or a stenosis > 70%). In that study, sonography had a sensitivity of 75%, a specificity of 89%, and a positive predictive value of 85% in detecting significant stenosis when stenosis was

defined as a peak systolic velocity greater than 200 cm/sec in the celiac artery. Sonography had a sensitivity of 89%, specificity of 92%, and a positive predictive value of 80% in detecting significant stenosis when stenosis was defined as a peak systolic velocity greater than 275 cm/sec in the superior mesenteric artery.

Results

In 1 year, 184 patients from 4 to 92 years old were examined. The distribution of peak systolic velocities for the celiac artery and that for the superior mesenteric artery are shown in Figures 2 and 3, respectively. Ninety-seven patients were more than 65 years old. Of this group, 18% had significant arterial disease. One superior mesenteric artery was occluded (Fig. 1). Seven patients were found to have significant disease of both the celiac artery and superior mesenteric artery (7%). A further 11 patients (11%) had isolated stenosis of one vessel, usually the celiac artery (81% of all isolated stenoses). Representative normal and abnormal pulsed Doppler waveforms are shown in Figures 4–6.

Eighty-seven patients were less than 65 years old. In this group, only three stenoses were identified (3%), and these were isolated to the celiac artery. Two of these stenoses were found in patients less than 25 years old (Fig. 7).

Discussion

Splanchnic ischemia is an uncommon condition but has significant morbidity and mortality. Clinical diagnosis is difficult because the classic symptoms and signs occur late in the disease [1, 5]. Because angiography is invasive, expensive, and time-consuming, duplex Doppler sonography and color flow imaging have been suggested as possible screening tools in patients with suspected mesenteric ischemia [2]. However, angiographic studies have shown that patients with occlusion of multiple splanchnic vessels may be asymptomatic [6, 7]. The prevalence of asymptomatic stenoses in the general population has not been previously studied. Therefore, it is difficult to know how much importance to attach to the finding of significant disease in patients with suspected mesenteric ischemia.

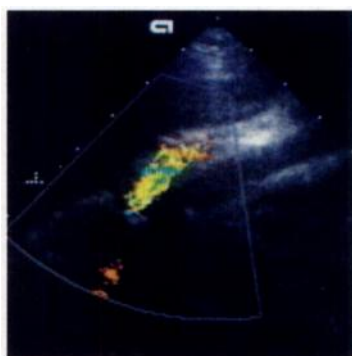


Fig. 1.—Longitudinal parasagittal sonogram of upper part of abdomen in an elderly asymptomatic patient. An orificial stenosis in celiac artery produces turbulent flow of increased velocity distal to stenosis. Inferior to this, origin of superior mesenteric artery can be seen. Gray-scale image shows internal echoes within its lumen, and color Doppler image shows no flow despite good visualization. Subsequent pulsed Doppler analysis also revealed no flow, and occlusion of superior mesenteric artery was therefore diagnosed.

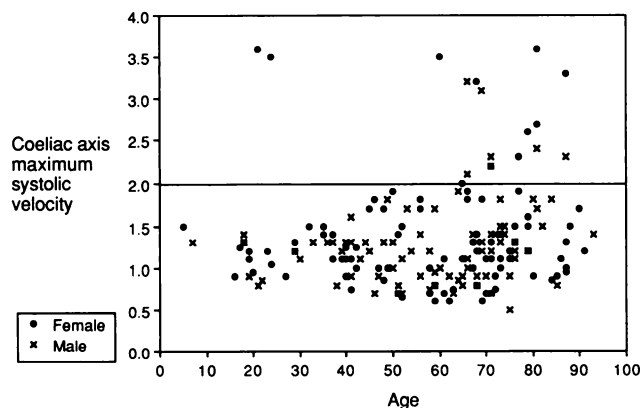


Fig. 2.—Graph shows variation of peak systolic velocity in celiac artery with age. Line at 2.0 m/sec indicates level defined as representing a significant stenosis on duplex Doppler sonograms.

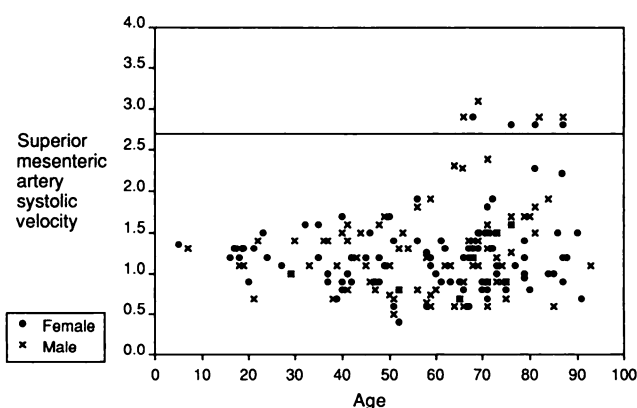


Fig. 3.—Graph shows variation of peak systolic velocity in superior mesenteric artery with age. Line at 2.7 m/sec indicates level defined as representing a significant stenosis on duplex Doppler sonograms.

Fig. 4.—A and B, Spectral waveforms show normal signals for both superior mesenteric artery (A) and celiac artery (B) in patient who has fasted. Peak systolic velocity is normal, and clear acoustic window below spectral waveform indicates laminar flow. Flow reversal early in diastole is a normal finding in superior mesenteric artery.

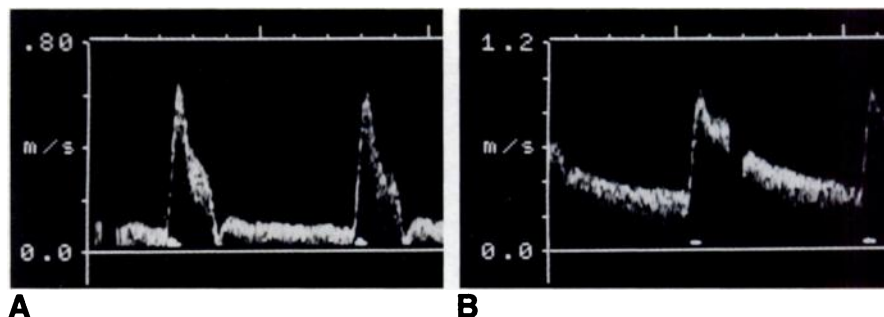


Fig. 5.—Spectral waveform of a moderate stenosis of superior mesenteric artery shows loss of normal flow reversal early in diastole, some widening of waveform that indicates more turbulent flow, and an elevated peak systolic velocity of 2.5 m/sec (upper limit of normal is 1.6 m/sec). This is, however, below cutoff for significant disease of 2.75 m/sec.

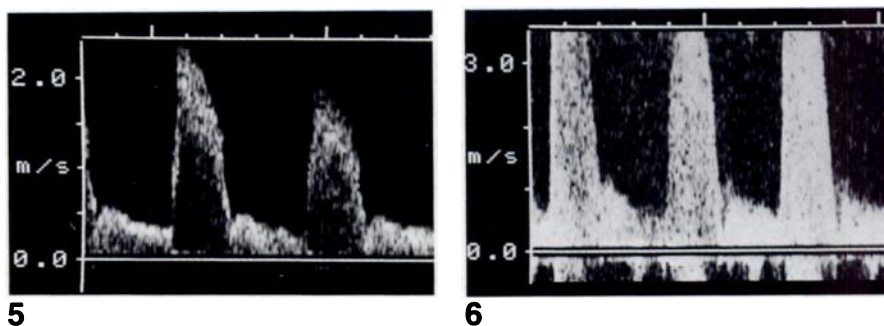


Fig. 6.—Spectral waveform from superior mesenteric artery shows signal that represents significant disease. Systolic velocity is increased with aliasing, spectral broadening, and complete loss of acoustic window in both systole and diastole. Peak systolic velocity was estimated at 3.5 m/sec by addition of aliased peak to truncated base.

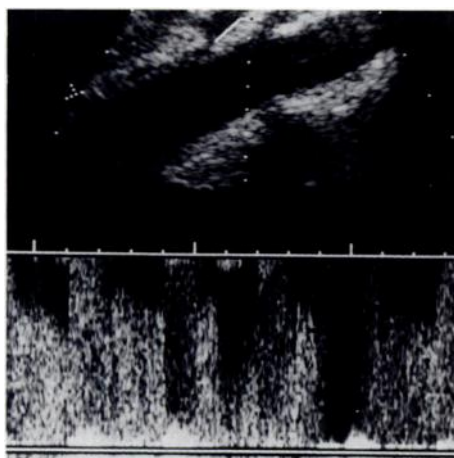


Fig. 7.—Duplex Doppler sonogram shows a significant stenosis of celiac artery in an asymptomatic 25-year-old woman. The gray-scale image shows a tight orificial stenosis of vessel with associated poststenotic dilatation. Gated Doppler signal from poststenotic segment is abnormal with markedly turbulent flow and elevated peak systolic velocity with aliasing. Peak systolic velocity was estimated at 3.6 m/sec by addition of aliased peak to truncated base.

In the patient who is thought to have chronic mesenteric ischemia, the finding of normal vessels on color and duplex Doppler sonograms when an optimal view has been obtained is probably sufficient to exclude significant disease of these vessels. However, the finding of significant disease must be viewed with caution. This study shows that the frequency of asymptomatic stenoses in the celiac artery and superior mesenteric artery in the elderly population is high (18%) but is less than the 27% reported in patients with

peripheral vascular disease [8]. However, genuine chronic mesenteric ischemia is thought to be rare [9]. Therefore, significant stenoses detected with duplex Doppler sonography may not indicate mesenteric ischemia.

It is possible that the prevalence of double-vessel disease is overestimated with duplex Doppler sonography. This is because a significant stenosis in one vessel will induce compensatory increased flow in the remaining vessel, therefore inducing a falsely elevated peak systolic velocity within the second vessel [10].

It is therefore suggested that significant stenoses shown by duplex Doppler sonography should be used only as an indication for further study in patients in whom mesenteric ischemia is strongly suspected. If not, a number of patients will undergo unnecessary examination and inappropriate treatment with its own associated morbidity and mortality [7, 11]. Bowel ischemia is said not to develop with single-vessel disease because of the potential for collateral formation [1]. Further examination therefore probably should be limited to patients who have evidence of disease within both vessels on duplex Doppler sonograms. Indeed, we found that the patients with symptomatic mesenteric ischemia who have obtained relief from reconstructive surgery have had occlusion of either the superior mesenteric artery or the celiac artery and a significant stenosis of the other artery shown by duplex Doppler sonography (none of the patients in this study had this combination).

Significant stenosis within the celiac artery (Fig. 7) in two asymptomatic females less than 25 years old may have been due to a congenital lesion or might have been a manifestation of celiac axis compression syndrome. The latter occurs when the median arcuate ligament of the diaphragm and the celiac ganglion are intimately related to the celiac artery and com-

press it [12]. However, in both patients, the celiac artery and the crus were not seen to be closely related on real-time imaging. These lesions may have represented atherosclerotic lesions occurring in particularly young patients. Neither patient, however, had any risk factors for atherosclerotic vascular disease, and the renal and carotid vessels appeared entirely normal. Both lesions occurred at the origin of the vessel and therefore are unlikely to be variants of fibromuscular hyperplasia.

The use of duplex and color Doppler sonography in the diagnosis of mesenteric ischemia has limitations in common with all duplex studies of intraabdominal vessels. These include failure to obtain an adequate Doppler signal due to obscuration by bowel gas or vessel wall calcification. Although we did not accurately estimate the number of patients in whom we could not obtain good visualization of both vessels, we estimate it was on the order of 25%. We were able to exclude such patients from our study, but this high failure rate would have serious implications for the use of duplex Doppler sonography for screening. Another possible source of problems is the inability to obtain an adequate angle of incidence for duplex Doppler sonography (an angle greater than 60° makes assessment of peak systolic velocity unreliable [10]). This is not usually a problem, however, as the majority of stenoses (all but one in this study) occur in the first few centimeters of both vessels. In this region, flow is almost toward the transducer and, therefore, ideal for Doppler evaluation. In the more distal stenoses, particularly in the superior mesenteric artery, it may be difficult to obtain an adequate angle.

In conclusion, significant disease in the celiac artery and the superior mesenteric artery as shown by duplex Doppler

sonography is common in asymptomatic elderly patients. This fact must be borne in mind when one is examining patients with possible mesenteric ischemia.

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