Asymptomatic celiac and superior mesenteric artery stenoses are more prevalent among patients with unsuspected renal artery stenoses

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The prevalence of unsuspected renal artery stenosis among patients with peripheral vascular disease has been reported to be as high as 40%, but the prevalence of asymptomatic celiac and superior mesenteric artery stenoses in these patients is not known. The biplane aortograms of 205 male patients who were military veterans and had aneurysms or occlusive disease were independently reviewed, and medical records were studied to determine associated coronary disease, risk factors, and patient outcome. Fifty-six patients (27%) had a 50% or greater stenosis in the celiac or superior mesenteric artery, and seven patients (3.4%) had significant stenoses in both mesenteric arteries. Patients with celiac or superior mesenteric artery stenoses were older ($p = 0.002$) and had a higher prevalence of hypertension ($p = 0.029$) than those without significant mesenteric stenoses. Fifty of the 205 patients had significant renal artery stenoses, and 20 had advanced (>75% diameter loss) renal stenoses. Ten of the 20 patients (50%) with advanced renal stenoses had a concomitant celiac artery stenosis, compared to 40 of the 185 patients (22%) who did not have advanced renal stenoses ($p = 0.011$). In the present study asymptomatic celiac or superior mesenteric artery stenoses were common among male veterans evaluated for peripheral vascular disease, but the prevalence of significant stenoses in both the celiac and superior mesenteric arteries was low. The prevalence of significant celiac stenosis was higher in patients with advanced (>75%) renal artery stenoses who might be considered for prophylactic renal revascularization. Lateral aortography with evaluation of the celiac artery is always appropriate in these patients. (J Vasc Surg 1991;14:195-9.)

Celiac artery branches have been shown to be reliable and durable sources of inflow for renal revascularization.[1-3] Despite the widespread policy of performing celiac angiography before hepatorenal and splenorenal arterial bypasses, the prevalence of flow-limiting celiac artery stenoses among patients with peripheral vascular disease has not been reported. The prevalence of unsuspected renal artery stenoses in patients with atherosclerosis of the aorta or lower extremity has been demonstrated to be as high as 44%,[4,5] and it is reasonable to assume that there is an equally high prevalence of unsuspected flow-limiting stenoses in the other major branches of the abdominal aorta. The purpose of this study was to determine the prevalence of celiac and superior mesenteric artery stenoses in patients with atherosclerosis of the aorta and lower extremity and to determine the likelihood of concomitant renal and celiac artery stenoses occurring among these patients.

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PATIENTS AND METHODS

Lateral and anteroposterior views of the upper abdominal aorta are part of routine aortography procedures at the Dallas Veterans Administration Medical Center, allowing complete radiographic assessment of arterial flow in the celiac and superior mesenteric arteries. Assessment of renal artery flow is nearly always possible from anteroposterior views of the aorta obtained during rapid injection sequences. Routine direct injection of the inferior mesenteric artery is not performed, and overlying branches obscure evaluation of inferior mesenteric flow in many cases. For this reason assessment of inferior mesenteric flow was not considered in this study.

Consecutive abdominal aortograms obtained for evaluation of aortic aneurysms or lower extremity occlusive disease during a recent 24-month period were reviewed. All patients who were evaluated for aortic aneurysm repair during this period underwent angiography. Aortograms were also obtained in patients with the following manifestations of lower extremity occlusive disease: rest pain, nonhealing ischemic ulcers, gangrene, or disabling claudication. Patients who underwent angiography for evaluation of renovascular hypertension or chronic mesenteric ischemia were excluded from the present study. Three patients who did not have technically adequate lateral aortograms were also excluded.

The degree of arterial stenosis was assessed in the celiac, superior mesenteric, and renal arteries of all patients. Percent stenosis was calculated by the formula: 1 – N/D, where N is the most narrow diameter of the stenosis, and D is the diameter of a nonstenotic segment in the main artery. Branch stenoses were not considered in the present analysis. All arteriograms were reviewed independently by two vascular surgeons. Measurement discrepancies were settled by a panel of three vascular surgeons. The degree of arterial stenosis was classified according to the method of Olin et al.[5]: (1) normal; (2) mild, 1% to 49% stenosis; (3) moderate, 50% to 75% stenosis; (4) severe, 75% to 99% stenosis; and (5) occluded. For purposes of definition in this study, stenoses measuring 50% or greater diameter loss were considered *significant,* and stenoses measuring 75% or greater diameter loss were considered *advanced.*

The medical records of all study patients were reviewed to determine age, sex, indication for arteriography, presence of risk factors (smoking, hypertension, and diabetes), and presence of clinically apparent coronary artery disease (CAD). Patients were considered to have CAD if one or more of the following was present: previously documented myocardial infarction, previous abnormal cardiac catheterization, previous coronary artery bypass, ischemic changes seen on electrocardiogram, and symptoms of angina pectoris.

Continuous data are expressed as mean ± one standard deviation. Statistical comparisons between categorical parameters were performed by use of chi-square analysis. Comparisons between large groups of unpaired data were made with the unpaired Student's t test. Differences were considered significant at the $p < 0.05$ level.

RESULTS

Two hundred eight patients who met the inclusion criteria underwent aortography during the study period. Three of these had inadequate lateral studies and were therefore excluded from the analysis. The mean age for the 205 study patients was 63 ± 9 years (range, 32 to 84 years; median, 64 years), and all were men. Fifty-five patients (27%) underwent arteriography for evaluation of abdominal aortic aneurysms (AAAs), and 150 (73%) underwent evaluation of lower extremity ischemia. Sixty-eight patients (33%) had occlusive lesions predominantly in the aortoiliac segment, and 82 (40%) had lesions predominantly in segments distal to the inguinal ligament (lower extremity [LE]). Although the 82 patients with LE lesions were not considered for simultaneous aortic and renal artery reconstruction, this group was included to establish the prevalence of unsuspected celiac and superior mesenteric artery stenoses in patients with peripheral vascular disease elsewhere. The prevalence of risk factors among the three patient groups is shown in Table I.

Mesenteric arteries

Fifty-six of the 205 patients (27%) had at least one mesenteric artery stenosis that ranged from 50% to 99%. The average age for patients with mesenteric artery stenosis was 66 ± 7 years and was 62 ± 9 years for patients without mesenteric artery stenosis ($p = 0.002$, t test). Fifty patients (25%) had a significant stenosis or occlusion of the celiac artery, and 13 (6%) had a significant stenosis or occlusion of the superior mesenteric artery. Mesenteric artery stenosis was observed in 40% of patients with AAA, in 25% of patients with lesions in the aortoiliac segment, and in 29% of patients with LE lesions (Table II).

Seven patients (3.4%) had significant (>50% diameter or occlusion) mesenteric artery stenoses in both the celiac and superior mesenteric arteries. Four of the seven were admitted with AAAs, two with aortoiliac lesions, and one with LE lesions. The distribution of stenoses is shown in Table III. None of the seven patients was admitted with symptoms of mesenteric ischemia, including two patients with occlusion of the celiac and superior mesenteric arteries.

Renal arteries

Fifty of the 205 patients (24%) had a significant stenosis (>50% diameter loss) in one renal artery, and 20 patients (40% of these) had an advanced

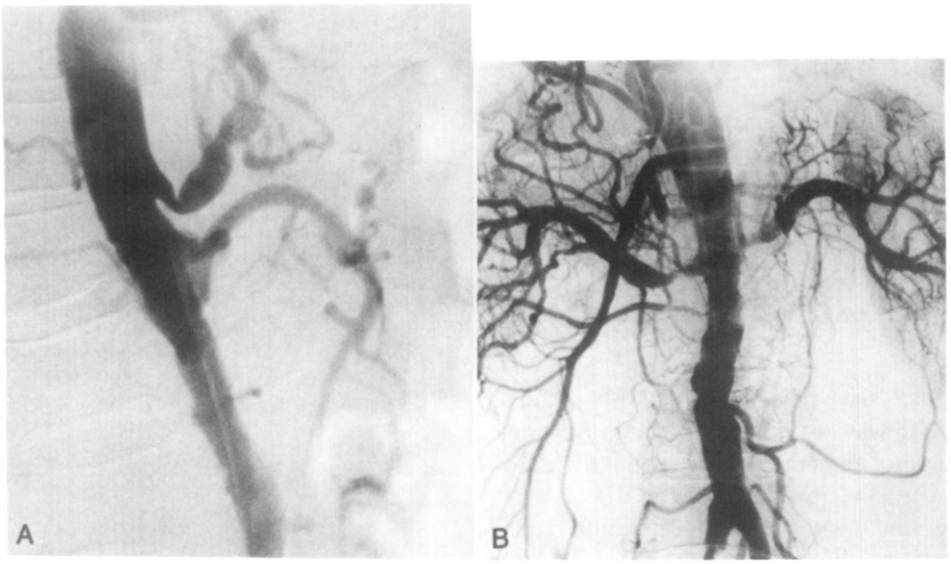

Fig. 1. Lateral and anteroposterior angiograms of 1 of the 17 subjects with concomitant renal artery and celiac artery stenoses.

techniques.[1-6] Our data lend strong support for this notion. Some surgeons would consider performing an extraanatomic bypass in a patient who requires renal revascularization but who also has significant occlusive or aneurysmal disease of the aorta. Our data demonstrate that such patients are more likely to have an asymptomatic celiac artery stenosis than are their counterparts with peripheral vascular disease who do not have advanced RAS. Assessment of celiac artery flow is absolutely essential before performing extraanatomic renal artery bypasses in these patients. Lateral aortography with views of the entire celiac artery represents a "gold standard" for assessing the adequacy of celiac artery flow. Duplex ultrasonography may hold promise as a substitute for angiography in the evaluation of celiac flow, but its sensitivity has not been examined in patients under consideration for extraanatomic renal artery bypasses. These conclusions have the limitation of data derived from an all male population of military veterans.

Whether it is possible to perform a successful renal artery bypass with branches from a celiac artery harboring a significant stenosis is not examined in the present study. It is well known that the mesenteric circulation has abundant collateral vessels that support gastrointestinal blood flow in the presence of two, and in some cases three, occluded mesenteric arteries.[7] It is possible that the hepatic or splenic circulation would still support a renal artery bypass in the presence of a significant celiac artery stenosis. However, this premise would be difficult to establish because of the various influences that govern flow in the mesenteric circulation. To maximize the chance of success after an extraanatomic renal artery bypass, it is best to avoid the possibility of inadequate renal artery revascularization by use of a branch of a celiac artery harboring a flow-limiting stenosis.

The presence of an advanced RAS may be an indicator of stenosis involving either the celiac or superior mesenteric artery. However, the clinical impact of a single asymptomatic mesenteric artery stenosis appears to be benign.[7] The prevalence of single, unsuspected celiac or superior mesenteric artery stenoses among patients with aortic and LE occlusive disease is similar to the prevalence of unsuspected RAS. Some authors have advocated performing prophylactic mesenteric bypasses during aortic surgery in patients who have significant celiac and superior mesenteric artery stenoses.[8] Our data suggest that this should very rarely require consideration in asymptomatic patients. The prevalence of significant stenoses in both the celiac and superior mesenteric arteries was 3.4% in our series, and only 2.9% of patients had severe mesenteric stenoses or occlusions. The merit of performing prophylactic mesenteric bypasses to prevent acute mesenteric ischemia has not been evaluated.

The factors underlying the development of a mesenteric artery stenosis are not demonstrated in the present study. Patients who had significant mesenteric artery stenoses were older than their counterparts who did not. There was also a higher

Table I. Prevalence of risk factors

	Abdominal aortic aneurysm	*Aortoiliac occlusive disease*	*Infrainguinal occlusive disease*
No. patients	55 (27%)	68 (33%)	82 (40%)
Average age	67 yr	58 yr	63 yr
Smokers	45 (82%)	60 (88%)	68 (83%)
Diabetes	6 (11%)	17 (25%)	35 (43%)
Hypertension	33 (60%)	38 (56%)	38 (46%)
Coronary artery disease	32 (58%)	29 (43%)	24 (29%)
Perioperative death	1 (2%)	5 (7%)	6 (7%)

(>75% diameter loss) renal artery stenosis (RAS). None of the RAS was suspected before angiography. The average age of patients with a significant RAS was 68 ± 6 years, compared to 62 ± 9 years for patients who did not have a significant RAS ($p < 0.001$, t test). A significant RAS was seen in 22% of patients with AAA, in 24% of patients with aortoiliac lesions, and in 24% of patients with LE lesions.

Seventeen of the 50 patients (34%) with significant RAS had concomitant celiac artery stenoses (Fig. 1). Ten of the 20 patients (50%) with advanced RAS also had significant celiac artery stenoses, compared to 40 of the 185 patients (22%) who did not have advanced RAS ($p = 0.011$, chi-square analysis). Five of the seven patients (71%) with significant stenoses in both mesenteric arteries had RAS.

Evaluation of risk factors and coronary artery disease

The 56 patients with MAS were compared with the 149 patients without mesenteric artery stenosis. The two groups were compared for presence of hypertension, smoking, diabetes mellitus, and CAD, as well as for the incidence of perioperative deaths. Thirty-six patients (64%) with mesenteric artery stenosis had hypertension, compared to 73 (49%) without mesenteric artery stenosis ($p = 0.029$, chi-square analysis). Fifty patients (89%) with mesenteric artery stenosis were smokers, compared to 124 (83%) without mesenteric artery stenosis (NS). Thirteen patients (23%) with mesenteric artery stenosis and 45 patients (30%) without mesenteric artery stenosis had diabetes (NS). Twenty-eight patients (50%) with mesenteric artery stenosis had CAD, compared to 58 (39%) without mesenteric artery stenosis (NS). Four patients (7%) with mesenteric artery stenosis and eight patients (5%) without mesenteric artery stenosis died during the study period or ensuing 2-year follow-up (NS). None of the patients with mesenteric artery stenosis died in the perioperative period. Three patients (2%) without mesenteric artery stenosis died after iliac angioplasty, aortobifemoral bypass grafting, and femorodistal bypass grafting, respectively. Four patients (7%) with mesenteric artery stenosis died during the follow-up period (two of myocardial infarction, one of pulmonary causes, and one of an unknown cause), as did five patients (3%) without mesenteric artery stenosis (one of myocardial infarction, one of lung cancer, and three of unknown causes). To our knowledge no patient died of mesenteric infarction or complications of renal artery disease.

Table II. Distribution of mesenteric artery stenoses

	Abdominal aortic aneurysm	*Aortoiliac occlusive disease*	*Infrainguinal occlusive disease*
Celiac artery			
None	25 (45%)	40 (59%)	38 (46%)
Mild	12 (22%)	16 (24%)	24 (29%)
Moderate	11 (20%)	6 (9%)	9 (11%)
Severe	5 (9%)	5 (7%)	10 (12%)
Occluded	2 (4%)	1 (1%)	1 (1%)
Superior mesenteric artery			
None	47 (85%)	54 (79%)	68 (83%)
Mild	4 (7%)	9 (13%)	10 (12%)
Moderate	2 (4%)	4 (6%)	1 (1%)
Severe	0	1 (1%)	2 (2%)
Occluded	2 (4%)	0	1 (1%)

Table III. Status of the superior mesenteric artery in patients with a 50% or greater celiac artery stenosis

	Abdominal aortic aneurysm	*Aortoiliac occlusive disease*	*Infrainguinal occlusive disease*
Superior mesenteric artery			
Normal	13	8	17
Mild	1	2	2
Moderate	2	1	1
Severe	0	1	0
Occluded	2	0	0

DISCUSSION

Hepatorenal and splenorenal bypasses are widely accepted alternatives for renal revascularization and are favored over aortorenal bypasses by some surgeons.[6] Previous reports have suggested the need to document adequate inflow in the celiac circulation of patients under consideration for these extraanatomic

prevalence of hypertension among patients with mesenteric artery stenoses. However, both groups were similar in the type of associated peripheral vascular disease and had a similar incidence of smoking and diabetes. Our patients with mesenteric stenoses did not have an increased prevalence of disseminated atherosclerosis. Mesenteric artery stenoses were not associated with an increased risk of CAD as defined in the present study, nor of perioperative death.

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