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ORIGINAL ARTICLE

Symptomatic Mesenteric Atherosclerotic Disease—Lessons Learned from the Diagnostic Workup

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Abstract
Objective This study aims to analyze the diagnostic workup in patients referred for endovascular mesenteric revascularization for symptomatic mesenteric atherosclerotic disease.
Material and Methods Fifty-five patients were identified between 2006 and 2011. Median follow-up time was 24 months.
Results Median age was 71 years, 67 % were women. Forty patients had acute on chronic mesenteric ischemia, eight had acute mesenteric ischemia, and seven had chronic mesenteric ischemia. Other manifestations of atherosclerotic disease were present in 71 %. Body mass index (BMI) <20 kg/m^2 was found in 37 %. Endoscopy diagnosed duodenitis (38 %; 13/34) and colitis in the right colon (57 %;12/21). All ulcers tested for *Helicobacter pylori* were negative (n=17). Patients received proton pump inhibitor, antibiotic, and cortisone therapy during diagnostic workup in 73, 42, and 29 % of the cases, respectively. Previous hospitalization for the same complaints had occurred in 78 %. CT angiography showed occlusion (n=30) and high-grade stenosis (n=25) of the superior mesenteric artery (SMA). Forty-eight patients were treated with stenting of the SMA. The BMI increased in both women (p=0.001) and men (p=0.03) after endovascular therapy. The in-hospital mortality rate was 18 %.
Conclusion Patients with abdominal pain, known atherosclerotic disease, right-sided colitis or *H. pylori*-negative duodenitis should undergo CT angiography immediately to be able to identify symptomatic mesenteric atherosclerotic disease.

Keywords Symptomatic mesenteric atherosclerotic disease · Endovascular treatment · Ischemic duodenopathy · Ischemic gastropathy · *Helicobacter pylori*

Introduction

Patients with symptomatic mesenteric atherosclerotic disease may have mild, recurrent, transient symptoms and go unrecognized for years prior to an acute and prolonged attack of mesenteric ischemia leading to intestinal infarction and death. The natural history and clinical presentation has therefore not been well characterized. The patients' symptoms with insidious onset of weight loss, food aversion, and diarrhea may lead to a variety of clinical management scenarios. The patient may primarily be taken care of different specialists such as a gastroenterologist, general surgeons, internal medicine specialist, specialists in infectious diseases, general practitioners, or psychiatrists, with frequent referrals between specialists. Unfortunately, autopsy rates have declined to such low levels[1] that it is impossible to calculate any reliable contemporary population-based incidence figures. The diagnosis often seems to be evident in retrospect when there has been an acute onset of chronic mesenteric ischemia (CMI) leading to acute peritonitis, and laparotomy and diagnosis of mesenteric ischemia. Hence, based on the diagnostic difficulties, prevalence and incidence data are virtually non-existing. While the current literature mainly focuses on outcomes after open or endovascular mesenteric revascularization, details of the diagnostic workup phase of these patients are lacking.

The main aim of the present study was to analyze the diagnostic workup phase in patients with symptomatic

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mesenteric atherosclerotic disease referred for endovascular mesenteric revascularization.

Methods

Setting

The Vascular Center, Malmö-Lund, Skåne University Hospital, Sweden is a tertiary referral center with a primary catchment population of approximately 756,000 inhabitants (Swedish Central Bureau of Statistics; http://www.scb.se). Sixty percent (33/55) of the patients were referred from a local hospital to Malmö, Skåne University Hospital for vascular treatment.

Study Population

The records of patients with a diagnosis of mesenteric artery occlusive disease during a 6-year period between January 1, 2006 and December 31, 2011 were retrieved through a combined search of a local endovascular database and the in-hospital registry of Malmö, Skåne University Hospital. Patients undergoing an attempt of endovascular mesenteric revascularization or angiography were registered prospectively in the endovascular database. Clinical records were reviewed retrospectively in the computerized journal system. The diagnosis of mesenteric artery occlusive disease was established after CT scan with intravenous contrast enhancement was performed.

Follow-up

All patients were monitored from the day of operation until death or January 31, 2012. Median follow-up time was 24 (interquartile range 3–41) months.

Definitions

Acute on chronic mesenteric ischemia was defined as an acute and often prolonged attack of mesenteric ischemia, in a patient with previous mild and self-limited attacks of unrecognized mesenteric ischemia, leading to a state of irreversible mesenteric ischemia without mesenteric revascularization and a potential threat to the individual. Hypertension was defined as a history of hypertension or treatment with antihypertensive medication. Ischemic heart disease was defined as previous myocardial infarction, angina pectoris, or coronary intervention. Stroke was defined as cerebral infarction or transitory ischemic attack. Any clinical atherosclerotic disease was present if the patient had ischemic heart disease, stroke, claudication, or had undergone peripheral vascular surgery. Diabetes mellitus was noted if the patient had antidiabetic treatment with diet, oral hypoglycemic agents, or insulin. Smoking included both current and former tobacco smokers. The Cockroft–Gault formula includes serum creatinine, age, weight, and gender to calculate glomerular filtration rate (GFR).[2] Renal insufficiency was defined as GFR <60 mL/min in patients 50–65 years of age, and GFR <50 mL/min in patients aged >65 years of age.[3] Anemia was defined as hemoglobin <134 g/L in men and <117 g/L in women. Spontaneous prothrombin time value ≥1.5 international normalized ratio (INR) (ref ≤1.2 INR) or an elevation of aspartate amino transferase (ref ≤0.65 μkat/L) or alanine amino transferase (ref ≤0.80 μkat/L) at more than twice the upper reference limit was considered as abnormal liver tests. Myocardial ischemia on ECG was defined as depressed ST segments >1 mm or associated T wave changes or a new left ventricular bundle branch block.[4, 5]

Statistical Methods

Data management and statistical analysis were performed using SPSS for Windows, version 17.0 (SPSS Inc., Chicago, IL). Differences in proportions were analyzed using chi-squared or Fisher's exact test and differences were evaluated using Wilcoxon signed-ranks test. Continuous variables were expressed in medians and interquartile ranges (IQR) or range. Associations between factors and mortality during follow-up were tested in a univariate Cox regression model. Significant associations were expressed in terms of hazard ratios (HR) with 95 % CI. A p value<0.05 was considered significant.

Results

Patient Characteristics, Comorbidity, and Medication

Patient characteristics are shown in Table 1, left column. Median age was 71 years (range 42–82). The female/-male ratio was 2.1:1. The median ages for the females and males were 74 years (57–82) and 67 years (42–82), respectively (p=0.010). CT angiography showed that the superior mesenteric artery (SMA) was occluded in 30 (55 %) patients and high-grade stenotic in 25 (45 %). The Celiac trunk was occluded in 15 (27 %) patients, high-grade stenotic in 31 (57 %), and open without high-grade stenosis in 9 (16 %). Clinically, there were 40 (73 %) patients with acute on chronic mesenteric ischemia, 8 (14 %) with acute mesenteric ischemia, and 7 (13 %) with chronic mesenteric ischemia at presentation. Clinical manifestations of any other atherosclerotic disease were present in 71 % (39/55) of the patients. The combination of medication with acetyl salicylic acid

Table 1 Patient-related prognostic factors at midterm in patients with symptomatic mesenteric atherosclerotic disease

Variable	*N* (%) of all eligible patients	Mortality at end of follow-up (%)	Mortality risk estimates at end of follow-up	
			Univariate analysis	
			p value	HR (95 % CI), if $p<0.1$
Age ≥80 years	6/55 (11)	4/6 (67)	0.095	2.6 (0.8–7.9)
Women	37/55 (67)	14/37 (38)	0.38	
Smoking	47/54 (87)	17/47 (36)	0.45	
Comorbidity				
Hypertension	40/55 (73)	13/40 (33)	0.58	
Diabetes mellitus	14/55 (26)	6/14 (43)	0.27	
Ischemic heart disease	14/55 (26)	6/14 (43)	0.63	
Atrial fibrillation	5/55 (9)	3/5 (60)	0.057	3.4 (1.0–12.3)
Claudication	22/55 (40)	7/22 (32)	0.69	
Stroke	17/55 (31)	6/17 (35)	0.78	
Previous vascular surgery	22/55 (40)	6/22 (27)	0.21	
Cardiovascular medication				
Acetylsalicylic acid	34/54 (63)	11/34 (32)	0.45	
Clopidogrel	6/54 (11)	3/6 (50)	0.96	
Vitamin K antagonist	3/54 (6)	1/3 (33)	0.71	
Statin	32/54 (59)	11/32 (34)	0.80	
Beta receptor blocker	28/53 (53)	11/28 (39)	0.24	
Angiotensin converting enzyme inhibitor	17/53 (32)	5/17 (29)	0.90	
Diuretic agent	22/52 (42)	11/22 (50)	0.005	5.3 (1.6–16.9)
Symptoms at final admission				
Symptoms coherent with CMI	46/55 (84)	14/46 (30)	0.062	0.4 (0.1–1.1)
Postprandial abdominal angina	44/55 (80)	14/44 (32)	0.77	
Weight loss	36/36 (100)	12/36 (33)	0.76	
Vomitus	28/51 (55)	14/28 (50)	0.039	3.0 (1.1–8.5)
Diarrhea	34/50 (68)	14/34 (41)	0.20	
Insidious/acute onset	48/7	4/7 (57)	0.087	2.7 (0.9–8.3)
Acute peritonitis	5/48 (10)	3/5 (60)	0.092	3.1 (0.8–11.4)
All patients	55	19/55 (35)		

CMI chronic mesenteric ischemia

(ASA) and clopidogrel was prevalent in five (9 %) patients. The three patients who were on vitamin K antagonist were not taking antiplatelet medication.

Symptoms and Signs

In retrospect, symptoms coherent with CMI prior to final admission were present in 84 % of the patients (Table 1, left column). Weight loss was found in all patients in whom weight changes could be evaluated. The median body mass index (BMI) was 20.2 kg/m^2 (range 14.1–29.6) in women (n=28) and 23.1 kg/m^2 (range 18.0–31.0) in men (n=15). The proportion of patients with BMI <20 kg/m^2 was 37 % (16/43). The median duration of CMI prior to final admission was 7 months (IQR 2–12).

Findings at Endoscopy

Forty patients (73 %) underwent endoscopy because of their symptoms. Findings at endoscopy performed before the diagnosis of mesenteric ischemia are shown in Table 2, left column, and specified in Table 3. Endoscopy was pathologic in 29 of 40 investigated patients (73 %). Six patients had ulcers or erosions in the descending part of duodenum. Five biopsies during upper endoscopy showed antral gastritis (n=2), duodenitis (n=1), and normal gastric histology (n=2). One patient had two remaining superficial ulcers, 2 cm in diameter, in corpus ventriculi, at repetitive gastroscopy despite ongoing proton pump inhibitor treatment. Diagnostic mucosal biopsy for testing the presence of *Helicobacter pylori* or gluten enteropathy was undertaken in 50 % (17/34) and 44 % (15/34),

Table 2 Management and diagnostic-related prognostic factors during the diagnostic phase at midterm in patients with symptomatic mesenteric atherosclerotic disease

Variable	*N* (%) of all eligible patients	Mortality at end of follow-up (%)	Mortality risk estimates at end of follow-up	
			Univariate analysis	
			p value	HR (95 % CI)
Endoscopy				
Endoscopy, any	40/55 (73)	13/40 (33)	0.56	
Endoscopy, pathologic	29/40 (73)	11/29 (38)	0.23	
Colonoscopy/investigation of colon	27/55 (49)	10/27 (37)	0.93	
Colitis in the right colon	12/21 (57)	6/12 (50)	0.24	
Colitis, any	13/23 (57)	6/13 (46)	0.28	
Gastroscopy	34/55 (62)	11/34 (32)	0.49	
Gastroscopy, pathologic	23/34 (68)	9/23 (39)	0.34	
Doudenitis	13/34 (38)	7/13 (54)	0.072	3.1 (0.9–10.7)
Gastrodoudenitis	22/34 (65)	9/22 (41)	0.28	
Medical therapy at any time point				
Proton pump inhibitor	40/55 (73)	15/40 (38)	0.45	
Cortisone	16/55 (29)	8/16 (50)	0.26	
Antibiotics	23/55 (42)	10/23 (43)	0.16	
Total parenteral nutrition	14/54 (26)	5/14 (36)	0.87	
Surgery prior to final admission				
Explorative laparotomy/laparoscopy	11/55 (20)	4/11 (36)	0.68	
Emergency bowel resection	3/55 (5)	0/3 (0)	0.42	
Hospital visits				
Previous evaluated by doctor at hospital for the same complaints	45/51 (88)	15/45 (33)	0.74	
Previous hospitalized for the same complaints	40/51 (78)	13/40 (33)	0.74	
Laboratory findings at final admission				
Low serum albumin (ref 36–45 g/L)	39/48 (81)		0.69	
Abnormal liver test	10/54 (19)	4/10 (40)	0.77	
Elevated pancreas amylase	9/38 (24)	5/9 (56)	0.37	
Elevated plasma lactate	12/25 (48)	5/12 (42)	0.58	
Renal insufficiency	18/55 (33)	8/18 (44)	0.24	
Anemia	30/55 (55)	8/30 (27)	0.165	
Ischemia on ECG	13/48 (27)	6/13 (46)	0.029	3.5 (1.1–11.0)
All patients	55	19 (35)		

respectively, of the patients undergoing esophagogastroduodenoscopy. All these 32 biopsies were negative. Colonoscopy was performed in 23 patients. Colitis was found in the right colon in 12 patients and the left colon in one. In two patients, colonoscopy was limited to the descending colon and sigmoideum, respectively. During colonoscopy, mucosal biopsy was performed in 18 out of 23 (78 %) patients, showing histopathological features of inflammation in nine (50 %).

Other Investigations

Three capsule endoscopies were performed and found positive and showed ischaemic lesions in the small bowel. One patient was examined with leukocyte scintigraphy, showing inflammatory focus in the right colon.

Other Medical Therapy

In the diagnostic phase, 80 % (44/55) of the patients were treated with proton pump inhibitors (73 %), cortisone (29 %) due to suspected inflammatory bowel disease, or antibiotics (42 %) (Table 2, left column). There was a trend towards an association between pathological esophagogastroduodenoscopy and medication with proton pump inhibitors ($p=0.052$). Total parenteral nutrition was necessitated due to bowel dysfunction in 26 % of the patients.

Table 3 Findings at endoscopy in patients with symptomatic mesenteric atherosclerotic disease

Anatomic location	Findings	No.
Upper endoscopy (n=23)		
Duodenum	Duodenitis	13
	Ulcers/erosions	6
Stomach	Antral gastritis	10
	Antral ulcers/erosions	13
	Scare after healed antral ulcers	2
	Corpus ulcers	6
	Corpus gastritis	1
	Pangastritis	1
Esophagus	Esophagitis	5
	Candida esophagitis	1
Colonoscopy (n=15)		
Colon	Colitis	13
	Colitis in the right colon	12
	Ulcers in the right colon	6
	Colitis in the left colon	4
	Ulcers in the left colon	1
Ileum	Ileitis	4
	Ulcer in the distal ileum	1

Right colon is located between the cecum to the mid-transverse colon and left colon between mid-transverse colon and sigmoid colon

Surgery Prior to Final Admission

Explorative laparotomy or laparoscopy was performed in 11 (20 %) patients in a hospitalization period prior to the final admission and resulted in bowel resection in three (Table 2, left column). Cholecystectomy due to gallbladder necrosis (n=1) and operation for an epigastric hernia (n=1) was also performed during a separate hospital stay.

Hospital Doctor's Delay

Forty-five patients (88 %) had been evaluated by a physician at a hospital for the same complaints prior to final admission and 40 (78 %) had been hospitalized previously (Table 2, left column). The median number of hospital visits at the emergency department and hospital stays were 4 (IQR 1–7) and 2 (IQR 1–4), respectively. One patient was evaluated 25 times and another patient was re-hospitalized 11 times prior to a final diagnosis. The median duration of hospital doctor's delay was 2.5 months (IQR 0.5–12).

Laboratory Findings at Final Admission

Forty-eight patients had serum albumin measured at final admission and 39 (81 %) had levels below the reference range (Table 2, left column). The median C-reactive protein (CRP) value was 94 mg/L (IQR 9–214) and the median white blood cell (WBC) count was 14.2×10^9/L (IQR 10.5–20.1). Twenty-five patients had plasma lactate measured at admission and in 12 (48 %) of them it was elevated. The median plasma lactate value was 2.2 mmol/L (range 0.6–21) (reference range 0.5–2.2 mmol/L). ECG at admission could be retrieved for 48 patients of which 13 (27 %) showed signs of myocardial ischemia according to the definition.

Endovascular Treatment

Fifty of the 55 patients were treated endovascularly for an occlusive lesion in the SMA (Table 4, left column): 48 were treated with stenting/stent grafting of the SMA, 1 with percutaneous transluminal angioplasty, and 1 with local thrombolysis. Two patients did not undergo a re-vascularization attempt because of advanced bowel ischemia at explorative laparotomy and two patients were treated with stenting of the celiac trunk only after failure of stenting the SMA. One revascularization attempt was interrupted due to another more emergent case. In most cases (81 %), femoral access was the primary choice for attempted recanalization. In 23 cases (46 %), the brachial artery was used for access and in nine cases it was the primary choice. In eight cases, the SMA was recanalized via retrograde puncture after laparotomy (hybrid procedure), and in all these cases, laparotomy was indicated due to suspicion of intestinal infarction. The use of multiple stents/stent grafts was frequent (40 %).

Surgery

There were 20 explorative laparotomies (Table 4, left column), 4 on-demand re-laparotomies, and 7 planned second look laparotomies performed. Cholecystectomy with or without bowel resection was performed in three and three patients, respectively.

Postoperative Medication

The frequency of patients with combination of medication with ASA and clopidogrel at discharge rose to 16 % (7/45). The proportion of patients with either ASA or clopidogrel medication was not significantly higher at discharge (78 %; 35/45) than at admission (65 %; 35/54) (p=0.16). The proportion of patients on statins was significantly higher at discharge than at admission (p=0.033).

Follow-up Endoscopic Examinations

Seven follow-up upper endoscopies showed antral erosions (n=2), healed antral (n=2) and corpus (n=1) ulcers, and

Table 4 Therapy-related prognostic factors at midterm in patients with symptomatic mesenteric atherosclerotic disease

Variable	*N* (%) of all eligible patients	Mortality at end of follow-up (%)	Mortality risk estimates at end of follow-up	
			Univariate analysis	
			p value	HR (95 % CI)
Endovascular treatment at index operation				
General/local anesthesia	29/26	11/29 (38)	0.37	
Access from the femoral artery	41/50 (82)	16/41 (39)	0.26	
Access from the brachial artery	23/50 (46)	5/23 (22)	0.19	
Retrograde recanalization from the SMA after laparotomy (hybrid procedure)	8/50 (16)	3/8 (38)	0.77	
Stent/stent graft in the SMA	48/55 (87)	17/48 (35)	0.88	
Emergency stent in the SMA	6/48 (12)	4/6 (67)	0.066	3.0 (0.9–9.4)
Balloon expandable stent in the SMA	40/48 (83)	15/40 (38)	0.56	
Self expandable stent in the SMA	21/48 (44)	6/21 (29)	0.62	
Stent graft in the SMA	3/48 (6)	1/3 (33)	0.993	
Multiple stents/stent grafts in the SMA (>1)	19/48 (40)	7/19 (37)	0.928	
Stent in truncus coeliacus	3/55 (5)	0/3 (0)	0.41	
Surgery				
Explorative laparotomy	20/55 (36)	12/20 (60)	0.003	4.2 (1.7–10.9)
Bowel resection	14/55 (25)	4/14 (29)	0.39	
Cholecystectomy	6/55 (11)	5/6 (83)	0.029	3.2 (1.1–8.9)
Postoperative medication				
Acetyl salicylic acid	34/45 (76)	6/34 (18)	0.22	
Clopidogrel	11/45 (24)	4/11	0.55	
Vitamin K antagonist	4/45 (9)	0/4 (0)	0.66	
Statin	36/45 (80)	6/36 (17)	0.22	
Re-intervention				
Re-intervention, any	12/53 (23)	2/12 (17)	0.058	0.2 (0.1–1.1)
Acute re-intervention	7/12 (58)	1/7 (14)	0.60	
Multiple re-interventions (>1)	3/53 (6)	1/3 (33)	0.34	
All patients	55	19 (35)		

normal findings (n=2). Follow-up colonoscopies in four showed normal findings.

Re-interventions

The re-intervention rate among those 53 patients that underwent an attempt of endovascular intestinal revascularization was 23 % (Table 4; left column). Seven out of 12 re-interventions were due to acute bowel symptoms and were performed after diagnostic CT angiographies. Five patients were asymptomatic, but significant in stent SMA stenosis was found after control CT angiography in four patients and control duplex in one patient. Five of the re-interventions were performed within the first follow-up year. Acute stent occlusions in the SMA occurred in four patients. All were managed with re-stenting. Bowel resection was needed in three out of four patients and explorative laparotomy and open thrombectomy in one. Two of these four patients died in-hospital after the acute stent occlusion. Covered stent grafts were deployed in the SMA in 5 (42 %) out of 12 re-interventions.

Weight Recovery

BMI at end of follow-up was possible to obtain in 34 patients: the median BMI for women (n=22) was 23.4 kg/m^2 (range 16.6–31.20), and for men (n=12) was 25.8 kg/m^2 (range 18.3–35.8). Paired data, BMI at the end of follow-up versus at admission, were available for 20 women and nine men, and analysis showed a significant increase in weight at the end of follow-up in both women (p=0.001) and men (p=0.03). Only one female patient underwent a substantial reduction in BMI from 22.0 to 16.8 kg/ m^2 after endovascular treatment and bowel resection. This patient were discharged with a short bowel syndrome and lived under social misery without proper health care support and finally died 14 months after the operation.

Predictors for Midterm Mortality

The in-hospital mortality rate was 18 % (10/55) and mortality at the end of follow-up was 35 % (19/55). The following factors were associated with increased midterm mortality: diuretic agent at admission (HR 5.3; 95 % CI 1.6–16.9), vomitus (HR 3.0; 95 % CI 1.1–8.5), ischemia on ECG (HR 3.5; 95 % CI 1.1–11.0), explorative laparotomy (HR 4.2; 95 % CI 1.7–10.9), and cholecystectomy (HR 3.2; 95 % CI 1.1–8.9).

Discussion

The results from the diagnostic workup in the current study strongly indicate that patients with mesenteric ischemia often are very misdiagnosed by their treating and referring physicians. Furthermore, the number of consultations in the primary care sector was not possible to estimate in this study. In the hospital setting, most patients were evaluated multiple times with several emergency admissions and hospital stays prior to diagnosis.

This study supports the view that most patients are elderly females with concurrent atherosclerotic disease as well as a history of smoking. Unfortunately, the diagnostic pitfalls during workup are many. While weight loss was found to be a consistent factor associated with CMI, most patients at presentation were not underweight, in contrast to previous reports.[6] This finding may reflect that diagnosis of mesenteric ischemia was made earlier in the present study compared to older reports, and that the prevalence of overweight in the general population has increased greatly lately. A few patients were in fact overweight at presentation, and it might be that some patients who had normal BMI at presentation were overweight before they fell ill with CMI.

Endoscopy, both gastroscopy and colonoscopy, was pathological in the majority of patients with symptomatic mesenteric atherosclerotic disease. This finding seems to be virtually unknown to physicians, perhaps also to gastroenterologists or endoscopists performing endoscopies. Unexplained right-sided colitis in an elderly patient with known vascular disease should raise the primary suspicion of mesenteric atherosclerotic disease until proven otherwise.

Some of the findings during upper endoscopy may be related to mucosal ischemia and it seems more likely that ulcers, erosions, and inflammation located in the descending part of the duodenum may be associated with mucosal ischemia in comparison with lesions located more proximally in the upper gastrointestinal tract. Absence of *H. pylori* among biopsies from the lesions at gastroscopy was found in all patients. This finding is very interesting since 30–60 % of patients with gastroduodenal ulcer disease have been found to have a *H. pylori* infection. Presence of *H. pylori*, in particular, has been found in a very high proportion of duodenal ulcers (70–100 %).[7, 8] Hence, *H. pylori*-negative ulcers and ulcers/erosions unresponsive to proton pump inhibitor should make the clinician suspicious of ischemic gastropathy[9] if symptoms are consistent with this disorder.

The histological results of the biopsies during endoscopies were of virtually no value during the diagnostic phase, and findings of colitis resulted in cortisone therapy against suspected inflammatory bowel disease rather than suspicion of mesenteric ischemia. On the other hand, capsule endoscopy revealed that all three patients undergoing this diagnostic modality had intestinal ischemia. Capsule endoscopy is a rather new diagnostic tool for investigating patients with intestinal ischemia,[10] but based on the positive experience in this study, capsule endoscopy might be worthwhile to consider more often in selected patients with CMI.

The high proportion of patients on proton pump inhibitors, cortisone, and antibiotic therapy among the study patients during the diagnostic phase reflects the physicians' inability to diagnose this patient category. Antibiotic therapy was often started in deteriorating patients with highly elevated CRP and WBC values without positive cultures or a clear indication. In line with a previous report, [11] none of the plasma markers were helpful for the diagnosis. A low serum albumin was present in most patients at admission, which probably reflects both a systemic inflammatory response and an insufficient nutritional status.

In the era of modern CT evaluation, it was surprising to find out that explorative laparotomy was performed in one out of five of the cases in the diagnostic phase during a previous hospitalization, and this finding may indicate that these CT examinations were executed without raising the question of occlusions or stenoses in the mesenteric vascular tree or mesenteric ischemia in the referral letter to the radiologist, leading to low quality images of the lumen of mesenteric arteries.[12]

Endovascular treatment with stent placement in the SMA or celiac trunk with access from the femoral or brachial artery, or after laparotomy and exposure of the SMA, was technically possible in virtually all cases. However, the re-intervention rate during follow-up was rather high as reported in another recent series.[13] Since acute re-intervention occurred more often than elective, and since acute stent occlusion was associated with a high mortality, a better follow-up or even intraoperative imaging protocol seems to be mandatory in these patients.

The prognostic factors associated with increased midterm mortality were either factors associated with acute mesenteric ischemia such as acute peritonitis and vomitus, or factors associated with cardiac failure such as atrial fibrillation, medication with diuretic agent, and ischemia on ECG, or factors indicating severe or extensive mesenteric ischemia or infarction such as explorative laparotomy, cholecystectomy, and duodenitis. Hence, a delayed diagnosis was usually associated with more invasive therapeutic options and a worse prognosis. A limitation of the study, from an epidemiological

point of view, is that it is impossible to enroll all patients with symptomatic mesenteric atherosclerotic disease into the study due to the diagnostic difficulties and the low postmortem examination rate in the population. Another limitation was the small sample size, reducing the possibility of an appropriate multivariate analysis.

Conclusion

Patients with abdominal pain and a history of peripheral vascular disease, findings of right-sided colitis at colonoscopy, and/or *H. pylori*-negative duodenitis at upper endoscopy should undergo CT angiography immediately to be able to identify patients with symptomatic mesenteric atherosclerotic disease.

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