

Clinical significance of mesenteric arterial collateral circulation in patients with celiac artery compression syndrome

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ABSTRACT

Objective: Although extensive collateral arterial circulation will prevent ischemia in most patients with stenosis of a single mesenteric artery, mesenteric ischemia may occur in these patients, for example, in patients with celiac artery compression syndrome (CACS). Variation in the extent of collateral circulation may explain the difference in clinical symptoms and variability in response to therapy; however, evidence is lacking. The objective of the study was to classify the presence of mesenteric arterial collateral circulation in patients with CACS and to evaluate the relation with clinical improvement after treatment.

Methods: Collateral mesenteric circulation was classified on the basis of angiographic findings. Collaterals were categorized in three groups: no visible collaterals (grade 0), collaterals seen on selective angiography only (grade 1), and collaterals visible on nonselective angiography (grade 2). Surgical release of the celiac artery in patients with suspected CACS was performed by arcuate ligament release. Clinical success after surgical revascularization was defined as an improvement in abdominal pain.

Results: Between 2002 and 2013, there were 135 consecutive patients with suspected CACS who were operated on. In 129 patients, preoperative angiograms allowed classification of collateral circulation. Primary assisted anatomic success was 93% (120/129). In patients with grade 0 collaterals, clinical success was 81% (39 of 48 patients); with grade 1 collaterals, 89% (25 of 28 patients); and with grade 2 collaterals, 52% (23 of 44 patients; $P < .001$).

Conclusions: Patients with CACS and with extensive collateral mesenteric arterial circulation are less likely to benefit from arcuate ligament release than are patients without this type of collateral circulation. The classification of the extent of mesenteric collateral circulation may predict and guide shared decision-making in patients with CACS. (J Vasc Surg 2017;■:1-9.)

Patients with stenosis or occlusion of a single mesenteric artery seldom develop symptoms of chronic mesenteric ischemia. It is commonly accepted that this is due to the extensive mesenteric arterial collateral circulation. However, patients with mesenteric one-vessel disease

may develop symptoms of ischemia. Therefore, it can be challenging to determine if abdominal complaints are related to impaired mesenteric flow due to an arterial stenosis or whether these symptoms have another origin.

A specific group of patients with one-vessel disease is patients with celiac artery compression syndrome (CACS). This nonatherosclerotic, respiration-dependent compression of the celiac artery (CA) may induce ischemia.¹ Several studies have demonstrated successful treatment of CACS with CA release through release of the arcuate ligament.²⁻⁶ However, CA compression is a common finding. Up to 50% of asymptomatic individuals have compressive features of the CA, especially during expiration.^{7,8} In only a small number of patients with abdominal complaints is CACS the cause of the symptoms.^{1,9} It is assumed that the abundant collateral circulation prevents ischemia in most patients and that these collaterals develop from small embryonic remnants.¹⁰ A lack of collateral mesenteric circulation could then contribute to the development of symptoms in patients with CACS.

We recently studied collateral circulation in mesenteric disease and demonstrated the pathophysiologic effect of single mesenteric vessel stenosis on collateral circulation.¹¹ Angiography in patients with stenosis in a single

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*A list of members of the Dutch Mesenteric Ischemia Study Group is listed in the [Appendix](#).

Author conflict of interest: none.

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The editors and reviewers of this article have no relevant financial relationships to disclose per the JVS policy that requires reviewers to decline review of any manuscript for which they may have a conflict of interest.

0741-5214

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mesenteric artery showed collateral circulation in 50% of patients. In half of these patients, the collateral was prominently visible during nonselective visceral angiography. We proposed a grading of collaterals based on angiography findings.

In this study, we investigated the association between the extent of collateral mesenteric circulation and clinical success after arcuate ligament release in patients with CACS.

METHODS

Study design. All patients who underwent treatment for CACS in the period 2002 to 2013 were prospectively included in an ongoing database and were retrospectively analyzed in the study. Mesenteric collaterals were identified and categorized on preoperative angiography, and the effect on the treatment of single-vessel stenosis was evaluated. Angiography has been the “gold standard” and offers a dynamic picture of the grade of stenosis during respiration. Especially in this category of patients with respiration-dependent stenosis, angiography has been our preference. Additional information of flow direction through collaterals is also an advantage of angiography. According to national regulations, Institutional Review Board approval was not required for this retrospective study. Therefore, no informed consent was obtained from the patients. Patients’ data were analyzed anonymously.

Participants. We used a standard workup for evaluation of chronic mesenteric ischemia including structured medical history, assessment of vessel anatomy, and tonometry function test.¹ All patients had preoperative duplex ultrasound and visceral angiography before treatment. Celiac compression was diagnosed when an eccentric stenosis of the CA by respiration-dependent compression by the arcuate ligament was present. CACS was suspected when this compression was accompanied by chronic abdominal symptoms not caused by other diseases, an abnormal tonometry function test (gastric exercise tonometry)¹ result, and a significant eccentric compression of the CA. Patients with celiac stenosis <70% needed a positive tonometry test result or typical clinical presentation. The diagnosis was made and treatment advice given in a multidisciplinary working group on mesenteric ischemia, as previously described.¹² Of the 129 patients, 46 patients were also included in a previous study.¹¹

Abdominal angiography. Multiplane digital subtraction angiography of the abdominal aorta and its branches enabled multiple oblique projections of the abdominal aorta and of the origin and outflow of the mesenteric arteries. Angiography was performed during maximum expiration and inspiration phases of respiration, as described previously.¹³ For nonselective angiography, a pigtail catheter was placed in the aorta 3 to 4 cm

ARTICLE HIGHLIGHTS

- **Type of Research:** Single-center retrospective cohort study
- **Take Home Message:** In 135 patients with celiac artery compression syndrome, only 52% of the patients with extensive collateral circulation had clinical benefit from ligament release. Benefit was >80% in those with no or small collateral circulation.
- **Recommendation:** The authors suggest that patients with symptomatic celiac artery compression syndrome with extensive collateral flow may not benefit from release of the median arcuate ligament.

above the CA ostium, and a standard bolus of 25 mL of contrast material was given with a pump flow of 15 mL/s. Before 2009, all patients underwent both nonselective and selective angiography. After 2009, selective cannulation was performed in selected cases only if stenosis was doubted on nonselective angiography. Nonselective anteroposterior view angiography was performed during expiration unless duplex ultrasound suggested a stenosis during inspiration. A lateral view was obtained during both expiration and inspiration. Selective angiography was performed during the phase of respiration with maximal grade of stenosis. Each angiogram was reviewed in blinded fashion by three observers, one interventional radiologist (D.G.) and two vascular surgeons (R.H.G., A.P.). When discrepancies occurred between the observers, results were compared and a consensus was reached. The degree of stenosis was assessed as percentage of the normal diameter.^{14,15}

Classification of mesenteric collateral circulation. A differentiation was made between normal arterial connections of the three mesenteric vessels and pathologic hypertrophic collaterals. This was based on size and visibility by the three independent observers. We classified only interconnecting vessels as collaterals when they were both clearly visible and hypertrophic. Collateral vascularization was assessed and categorized according to appearance on preoperative angiography as previously described.¹¹ This categorization is based on visibility of the collateral on nonselective or selective angiography, which differentiates between grade 1 and grade 2 (Figs 1 and 2). Three groups were identified: grade 0, grade 1, and grade 2 collaterals (Table I). Collaterals were further categorized according to their anatomy: gastroduodenal or pancreaticoduodenal artery, arc of Buhler, Rioloan artery, and Drummond artery.

Intervention. Release of the median arcuate ligament was performed in a retroperitoneal open (before 2005) or endoscopic procedure (since 2005) as reported.⁵ The open CA release was performed by a transperitoneal upper

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