

**Case
Report**

Non-obstructive Mesenteric Ischemia: A Potentially Lethal Complication after Cardiovascular Surgery: Report of Two Cases

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We report two cases of non-obstructive mesenteric ischemia (NOMI), a rare but potentially lethal complication after cardiovascular surgery, which was successfully managed. In both cases (a 74-year-old chronic hemodialysis patient who underwent emergency aortic valve replacement and coronary artery bypass graft (CABG), and a 74-year-old patient who underwent emergency abdominal aortic aneurysm operation), NOMI occurred early postoperatively (on day 8 and 22, respectively). They suffered from severe abdominal pain, confusion, and metabolic acidosis. Contrast-enhanced multi-detector CT (MDCT) scan and subsequent selective mesenteric angiography revealed characteristic signs of NOMI, for which selective papaverine infusion through the angiography catheter was performed. It was effective in both cases to halt progressive bowel ischemia and bided our time to perform a hemicolectomy of the necrotic segment. Contrast-enhanced MDCT scan and subsequent selective angiography are vital for diagnosis. If the condition does not improve after selective papaverine infusion, exploratory laparotomy and resection of necrotic intestinal segment should be performed immediately.

Keywords: nonocclusive mesenteric ischemia, cardiovascular surgery, papaverine infusion

Introduction

Although non-occlusive mesenteric ischemia (NOMI) is a rare complication after cardiovascular surgery (with the frequency between 0.1 and 0.87%).^{1,2} It is a devastating condition with poor prognosis, with reported mortality rates ranging from 30% to 93%.^{3–5}

Here, we report two consecutive cases of NOMI, for whom contrast-enhanced multi-detector CT (MDCT)

scan and subsequent selective angiography could offer precise and relatively early diagnosis. Selective infusion of papaverine following angiography effectively contained necrosis process and enabled us to have time for laparotomy and necessary surgical procedures.

Case Report

Case1

A 74-year-old woman with chronic obstructive pulmonary disease (COPD) was referred to our hospital with the diagnosis of impending rupture of abdominal aortic aneurysm (AAA) with intestinal obstruction. She underwent an emergency aneurysmectomy and prosthetic grafting for AAA. After subsidence of the abdominal pain probably originated from surgical wound, the pain recurred and progressively increased with restlessness at 13:00 on 22nd postoperative day. Blood analysis at 20:00 showed metabolic acidosis (arterial pH, 7.34; the base

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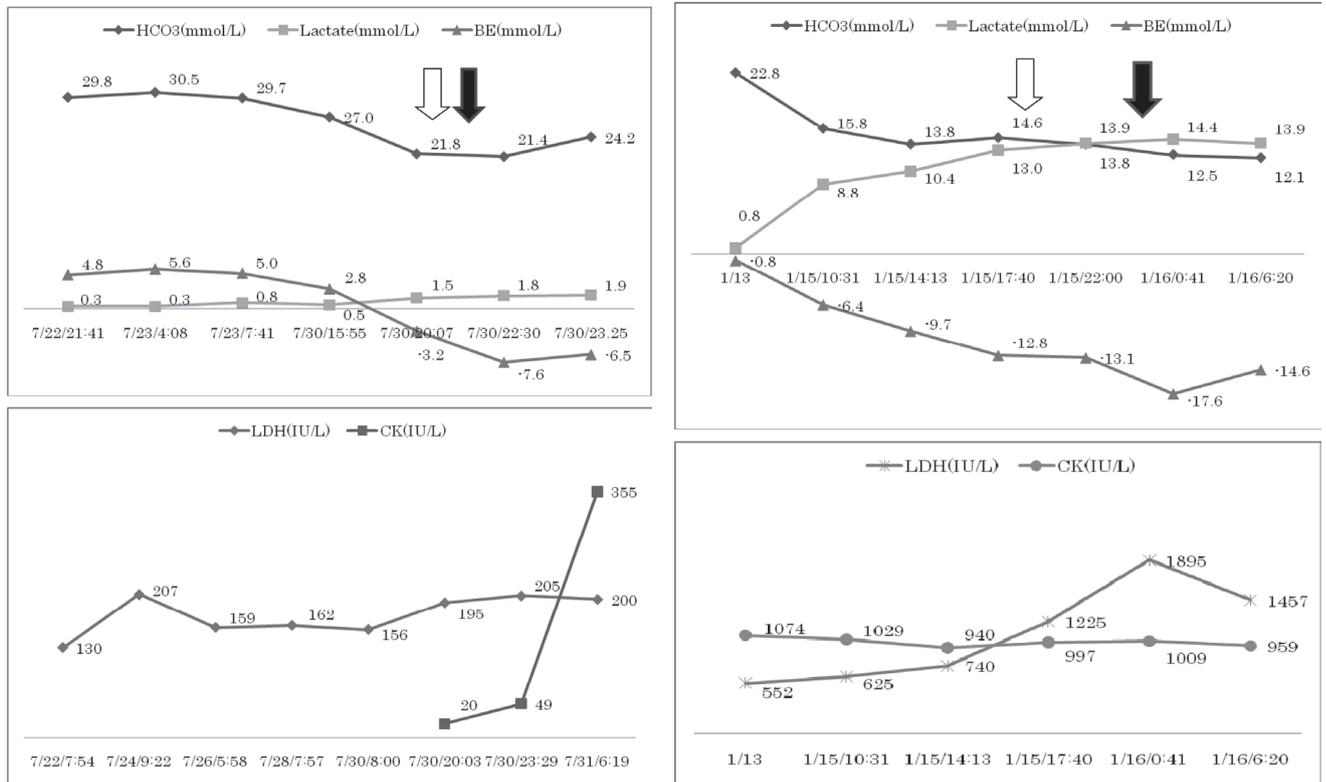


Fig. 1 A: Sequential changes of laboratory data in Case 1. The black arrow shows the timing of operation. The white arrow shows the timing of angiography. B: Sequential changes of laboratory data in Case 2. The white arrow shows the timing of angiography.

excess 3.2) (**Fig. 1**), but LDH and CK were within the normal range (195 IU/L and 20 IU/L, respectively). A contrast-enhanced MDCT scan at 18:45 showed enlarged segments of ascending to transverse colon with the wall flaccid and thinned (**Fig. 2**). Wall in these segments were poorly dyed with the contrast medium. No mesenteric torsion leading to mechanical obstruction was found. Also, proximal mesenteric trunk was patent with no signs of thrombotic and/or embolic arterial obstruction. These findings, the bowel ischemia without major arterial obstruction, strongly suggested the occurrence of NOMI, which lead us to perform subsequent selective mesenteric angiography for the definitive diagnosis. It was performed at 20:30. It revealed that proximal superior mesenteric artery (SMA) with diffusely spastic distal branches. Inflow velocity of the contrast medium was significantly decreased (**Fig. 3A**). After selective drip infusion of papaverine (40 mg/min), which was started from 20:40, through the angiography catheter into SMA, distal perfusion was improved (**Fig. 3B**), and the filling velocity of contrast medium was significantly increased. Although

her pain decreased to a considerable extent, remaining colon ischemia was suspected as the residual abdominal symptom did not disappear completely. Considering possible grave consequence of NOMI when treated belatedly, subsequent exploratory laparotomy was performed, in which colon segments supposedly involved in NOMI showed good appearance with recovered perfusion so that any colonic resection did not seem necessary. The papaverine infusion had been continued for 36 hours from the beginning. She completely recovered from severe abdominal pain at the end of the infusion, we decided to stop it. Although she needed a long time to recover because of the presence of COPD and muscle weakness, finally, she was able to leave the hospital on postoperative day 79.

Case2

A78-year-old man with chronic renal failure and hemodialysis-dependent (HD) was referred to our department for surgical treatment. His condition was diagnosed as unstable angina with triple vessel disease, and aortic

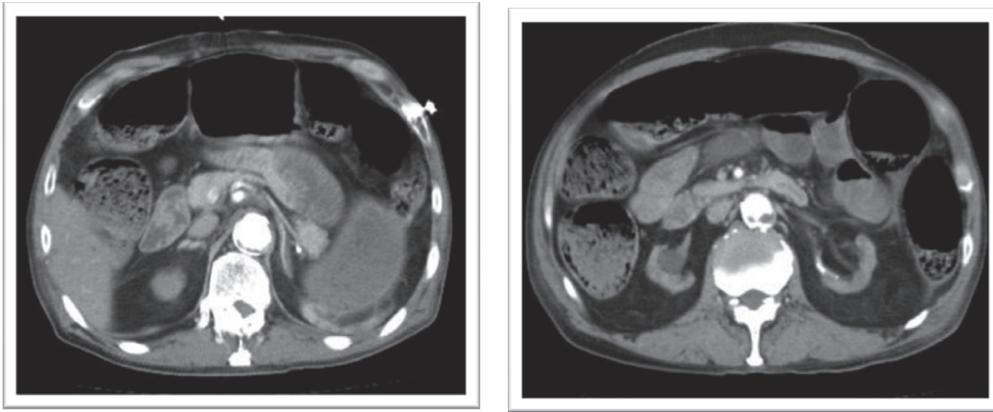


Fig. 2 Abdominal CT of Case 1.
There was no mesenteric torsion. The intestinal wall of the segment of luminal dilatation (from ascending to transverse colon) was flaccid and thin and was poorly dyed with contrast medium.

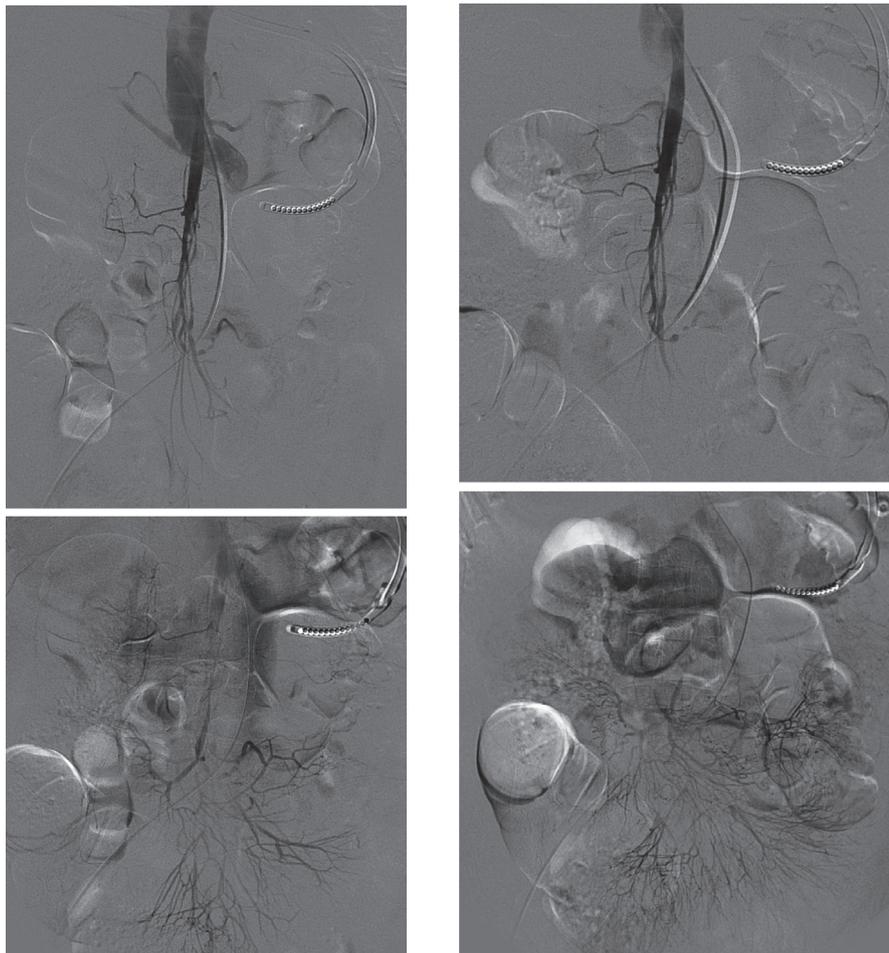


Fig. 3 A | B
A: Selective superior mesenteric angiography before papaverine infusion in Case1. Prominent vasoconstriction with poor distal opacification of peripheral vessels was found. Inflow velocity of contrast medium was decreased.
B: Selective superior mesenteric angiography after papaverine infusion in Case1. Distal perfusion of superior mesenteric artery became better. Inflow velocity of contrast medium was normalized.

valve stenosis. Echocardiography showed a transvalvular peak pressure gradient of approximately 60 mmHg. Although cardiac contractility was preserved, with the left ventricular ejection fraction measured on echocardiography of approximately 70%, his cardiac pumping function failed to achieve a sufficient output and blood pressure. Expeditious intra-aortic balloon pump support was established, and emergency combined surgery of coronary artery bypass grafting with five distal anastomoses and aortic valve replacement using a mechanical valve prosthesis was subsequently performed. Although immediate postoperative recovery was smooth, his consciousness level deteriorated to stupor during HD on postoperative day 8. He also had abdominal pain and bloody stool at 14:00 after the HD. Laboratory data showed metabolic acidosis (arterial pH of 7.398 and the base excess 9.7) with increased lactate concentration (10.4 mmol/L) and LDH 1225 IU/L. (**Fig. 1B**). An abdominal roentgenogram showed gas in the small bowel and dilated colon, both abnormal findings which prompted us to perform contrast-enhanced MDCT scan. On CT which was performed at 15:35, no mesenteric torsion leading to bowel obstruction was found. In transverse to descending colon, the wall was found thin, with the lumen significantly dilated, and poorly dyed with the contrast medium such as case 1. Subsequent selective mesenteric angiography was performed at 18:40 and it revealed the same findings in Case 1. With the diagnosis of NOMI, selective continuous infusion of papaverine (40 mg/min), which was started at 18:45, was performed as in the first case. Distal perfusion of SMA was improved, and inflow velocity of the contrast medium was increased, as well. Considering the persisting acidosis and lactate accumulation, and with betting the improvement of the whole bowel perfusion by papaverine infusion, which was still going on (**Fig. 1B**), subsequent expeditious laparotomy was performed. On laparotomy, necrosis was contained to lower half of the colon, which was resected. Colostomy was made with the ascending colon stump. The papaverine infusion was continued for 48 hours from the beginning. He recovered from abdominal pain at the end of the infusion. The pathological findings of the resected colon showed neutrophil infiltration of all layers of the wall and necrosis of intestinal mucosa. Although he was complicated with superficial wound infection, postoperative recovery was good with angiographically proved wide patency of all coronary grafts and excellent cardiac and aortic valvular prosthetic functions demonstrated by echocardiography. He was discharged on foot on 23rd postoperative day.

Discussion and Conclusion

Ever since NOMI (non-obstructive mesenteric ischemia) was first described in literature in 1958,⁶⁾ it has been a rare and devastating disease. NOMI accounts for 10%–20% of all cases of acute mesenteric ischemia. It has been recognized as a difficult disease to treat because its onset of symptoms is so vague that the treatment tends to delay.⁷⁾ An early diagnostic workup and expeditious treatment is mandatory to improve clinical outcome.

The risk factors of NOMI have been reported such as older age, low cardiac output which leads to peripheral hypoperfusion, vasoconstrictors like ergotamine, diuretics like furosemide, digitalis, and causes which can lead to vasoconstriction such as shock, dehydration, hypotension, condition after hemodialysis and heart surgery or major abdominal surgery.^{1,5,8,9)}

Lacking clear clinical symptoms makes NOMI a difficult disease to diagnose. Early symptoms are frequently absent or limited to abdominal discomfort and/or restlessness. Howard and his colleagues described the diagnostic dilemma of NOMI. In their retrospective study, which included 113 patients with acute mesenteric ischemia, 12% of the patients were shown to have NOMI in whom abdominal pain was absent in 23%.⁷⁾ Our patients fortunately showed certain clear clinical symptoms at an early stage, which might contribute to expeditious treatment, which seemed vital for saving the life of the patient with NOMI.

Despite of technical evolutions of non-invasive modalities, such as CT, MR, ultrasonography, selective digital subtraction angiography (DSA) of the mesenteric arteries is still the gold standard for the diagnosis. Patent proximal mesenteric trunk without any signs of thrombotic/embolic occlusion, and diffuse peripheral vasospasm are characteristic and definitively diagnostic of NOMI.²⁾ Although blood markers such as elevation of lactic acid, LDH, and/or CK may help doubt the presence of on-going NOMI, these are nonspecific.^{1,10)} In case 1, we didn't observe much elevation of these measurement value as in case 2. In our experience, contrast-enhanced multi-detector CT (MDCT) scan was remarkably useful in the diagnosis of NOMI. The combined findings of mechanical intestinal obstruction (absence of mesenteric torsion), dilated intestinal segment with flaccid and thinned wall poorly dyed with the contrast medium, and patent proximal mesenteric trunk with no signs of thrombi and/or emboli were thought to be specifically characteristic. Mitsuyoshi and coworkers also reported that the early

diagnosis of NOMI was possible, using MDCT, and that the subsequent, selective swift infusion of prostaglandin E1 (PGE1) might increase survival in patients with NOMI.¹¹⁾ Selective mesenteric angiography and following continuous infusion of vasodilators such as papaverine¹²⁾ and prostaglandin E1¹¹⁾ are not only diagnostic of NOMI but also effective in containing ischemic process. Without these expeditious catheter treatments, patients with NOMI might not be able to survive.^{11,12)}

In terms of the duration of the PGE1 infusion, treatment was based on the patient's condition. Stockmann and colleagues reported survival of eight of their nine patients treated with PGE1 (60 µg/ 24 hours for 3 days).²⁾ Mitsuyoshi and colleagues reported that 0.01 to 0.03 µg/kg/min for maximum of 5 days (until abdominal symptoms had improved).¹¹⁾ We also had to decide the infusion period based on the patient's symptoms. In our cases, the first case was on the drug for 36 hours and second case was for 48 hours from the angiographic diagnosis of NOMI.

At the same time, however, we have to know that surgical intervention should not be hesitated nor delayed in patients with NOMI when intestinal ischemia seems remain and progress. Although swift catheter diagnosis and intervention described above may prevent the progression of ischemia,³⁾ necrosis in certain degree and extension may be unavoidable according to such factors as the timing of diagnosis, severity of mesenteric vasospasm, variation of collaterals, general circulatory status of the patient, etc. Many reports suggested that expeditious surgery was the key to succeed in treating NOMI.^{13,14)}

In conclusion, if patients, especially those with a high-risk condition, who had undergone a major cardiovascular operation, suffer from vague, abdominal symptoms early, postoperatively; NOMI, an almost fatal complication unless expeditiously treated, should be considered as one of the presumed causes. Although nonspecific, confusion/delirium, lactic acidosis, abnormal intestinal gas and distention on roentgenogram may help suspect its presence. A contrast-enhanced MDCT may give certain definitive diagnostic findings. Subsequent and swift selective angiography to find diffuse mesenteric vasospasm is definitive not only for the diagnosis but also for treatment with a vasodilator. If the necrotic process cannot be completely contained by the vasodilatation, an emergency laparotomy has to be performed without delay to remove the

necrotic segment.

There are no disclosure statements about potential conflicts of interest.

References

- 1) Allen KB, Salam AA, Lumsden AB. Acute mesenteric ischemia after cardiopulmonary bypass. *J Vasc Surg* 1992; **16**: 391-5; discussion 395-6.
- 2) Klotz S, Vestring T, Rotker J, et al. Diagnosis and treatment of nonocclusive mesenteric ischemia after open heart surgery. *Ann Thorac Surg* 2001; **72**: 1583-6.
- 3) Boley SJ, Sprayregan S, Siegelman SS, et al. Initial results from an aggressive roentgenological and surgical approach to acute mesenteric ischemia. *Surgery* 1977; **82**: 848-55.
- 4) Kaleya RN, Sammartano RJ, Boley SJ. Aggressive approach to acute mesenteric ischemia. *Surg Clin North Am* 1992; **72**: 157-82.
- 5) Wilcox MG, Howard TJ, Plaskon LA, et al. Current theories of pathogenesis and treatment of nonocclusive mesenteric ischemia. *Dig Dis Sci* 1995; **40**: 709-16.
- 6) ENDE N. Infarction of the bowel in cardiac failure. *N Engl J Med* 1958; **258**: 879-81.
- 7) Howard TJ, Plaskon LA, Wiebke EA, et al. Nonocclusive mesenteric ischemia remains a diagnostic dilemma. *Am J Surg* 1996; **171**: 405-8.
- 8) Moneta GL, Misbach GA, Ivey TD. Hypoperfusion as a possible factor in the development of gastrointestinal complications after cardiac surgery. *Am J Surg* 1985; **149**: 648-50.
- 9) John AS, Tuerff SD, Kerstein MD. Nonocclusive mesenteric infarction in hemodialysis patients. *J Am Coll Surg* 2000; **190**: 84-8.
- 10) Garofalo M, Borioni R, Nardi P, et al. Early diagnosis of acute mesenteric ischemia after cardiopulmonary bypass. *J Cardiovasc Surg (Torino)* 2002; **43**: 455-9.
- 11) Mitsuyoshi A, Obama K, Shinkura N, et al. Survival in nonocclusive mesenteric ischemia: early diagnosis by multidetector row computed tomography and early treatment with continuous intravenous high-dose prostaglandin E(1). *Ann Surg* 2007; **246**: 229-35.
- 12) MacCannell KL. Comparison of an intravenous selective mesenteric vasodilator with intraarterial papaverine in experimental nonocclusive mesenteric ischemia. *Gastroenterology* 1986; **91**: 79-83.
- 13) Welling RE, Rath R, Albers JE, et al. Gastrointestinal complications after cardiac surgery. *Arch Surg* 1986; **121**: 1178-80.
- 14) Huddy SP, Joyce WP, Pepper JR. Gastrointestinal complications in 4473 patients who underwent cardiopulmonary bypass surgery. *Br J Surg* 1991; **78**: 293-6.