

# Thrombolysis with intra-arterial urokinase for acute superior mesenteric artery occlusion: Outcome analysis

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## Research article

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## Abstract

## Background

The aim of this study was to evaluate the outcome of intra-arterial urokinase thrombolysis for acute superior mesenteric artery (SMA) occlusion.

## Methods

Ten patients with acute SMA occlusion who underwent intra-arterial urokinase therapy between 2008 and 2019 were retrospectively evaluated.

## Results

Among the 10 patients, 7 were men and 3 were women (median age, 75.5 years). The median time from onset of abdominal pain to emergency department admission was 11 hours (interquartile range [IQR], 4.9 hours). None of the patients presented with shock in the triage screening or acute peritonitis on physical examination, and 4 (40%) had bloody stools. On angiography, 6 patients presented with complete SMA occlusion and the other 4 patients had incomplete occlusion. The median time from abdominal pain to attempting urokinase thrombolysis was 15.5 hours (IQR, 8.0 hours). During the course of the urokinase therapy, all the patients showed various degrees of recanalization (near-total,  $n = 2$ ; partial,  $n = 8$ ) on follow-up angiography. The median urokinase therapy duration was 39.0 hours (IQR, 48.0 hours). After urokinase therapy, bowel perfusion was restored with bowel preservation in 4 patients; however, in the other 6 patients, bowel perfusion was not restored. Comparison between the 4 patients with restored bowel perfusion and 6 patients with unrestored bowel perfusion revealed that the degree of SMA occlusion was statistically significant (complete vs. incomplete,  $p = 0.012$ ). Of the 6 patients with complete SMA occlusion, 5 underwent bowel resection, of whom 2 died, and the remaining patient died of shock due to delayed surgery. Of the 4 patients with incomplete SMA occlusions, no bowel resection was performed except a partial omentectomy. Of the 3 deaths, one was attributed to delayed surgery, and the other two developed short bowel syndrome with sepsis and multiple-organ failure, with a 30% in-hospital mortality rate. The median hospital stay was 20.0 days (IQR, 32.0 days).

## Conclusion

In our experience, thrombolysis with intra-arterial urokinase may serve as an adjunctive treatment modality to preserve the bowel and obviate surgery for incomplete SMA occlusion. However, it was not suitable for complete SMA occlusion, which requires surgery.

## Background

Acute mesenteric ischaemia (AMI) accounts for 1–2% of acute abdominal emergencies [1, 2]. If untreated, AMI will cause mesenteric infarction, intestinal necrosis, an overwhelming inflammatory response and death. Despite the progress of diagnostic and treatment strategies for this vascular emergency, it remains a life-threatening disease with an overall mortality of 50–70% [3, 4, 5]. Superior mesenteric artery (SMA) occlusions by embolism (50%) and thrombosis (15–25%) are the most common causes of acute mesenteric ischemia. For the restoration of SMA blood perfusion to preserve the bowel, intra-arterial thrombolysis was reported as an adjunctive treatment modality to surgery for acute SMA occlusion. However, cases were reported sporadically; even in a large case series, the number of cases was scant [6, 7, 8, 9, 10]. The aim of this study was to present our experience with thrombolysis with local intra-arterial urokinase in 10 patients with acute SMA occlusion and analyze the outcome.

### Methods

This retrospective study was approved by the institutional review board of the Chang Gung Memorial Hospital and the committee waived the requirement for informed consent for the use of anonymized and retrospectively analyzed data. Patients who underwent thrombolysis with intra-arterial urokinase for acute SMA occlusion between October 1, 2008, and December 31, 2019, were identified in the registry. **Indication of thrombolysis:** Patients who presented as acute abdomen and diagnosed as acute SMA occlusion on abdominal computed tomography (CT).

### Exclusion criteria

Patients presented with shock in the triage screening, acute peritonitis on physical examination, intramural gas, mesenteric or portal venous gas on abdominal CT were all excluded for the thrombolysis. During the study period, 11 patients were diagnosed as having acute SMA occlusion on abdominal computed tomography (CT) and were scheduled for intra-arterial urokinase treatment. One patient who underwent intra-arterial fragmentation alone due to mesenteric contrast extravasation on angiography was excluded. The remaining 10 patients, who received intra-arterial urokinase infusions, were selected for this study.

### Procedure

The thrombolysis procedures were performed by experienced interventional radiologists. Under local anaesthesia, the right femoral artery was punctured in accordance with the Seldinger technique, and a 6-Fr sheath (Terumo, Tokyo, Japan), 10 cm in length, was implanted. Selective catheterization of the SMA was performed with 4-Fr catheter (J curve 80-cm, Terumo, Tokyo, Japan). The SMA angiography was performed to identify the filling defect. Thrombolysis was performed using a 5-Fr multiple-sideport infusion catheter (100 cm with sideport of 7 cm, 14 ports or 100 cm with sideport of 15 cm, 30 ports, Cook, Bloomington, IN, U.S.A). The tip of the microcatheter was embedded in the thromboembolism, which was fragmented at the time of thrombolysis. Thrombolysis was performed locally in the SMA with a bolus of urokinase (Urokinase-GCC Injection 250,000 IU) 300,000 IU in the first 3 patients and

250,000 IU in the next 7 patients), followed by a continuous infusion of urokinase (50,000 IU/hour) for 3 days, and intravenous heparin was administered simultaneously and under close monitoring and surveillance at the surgical intensive care unit. Follow-up angiography was usually performed once daily for 3 days or discontinued when clinical deterioration developed. The patients were discharged with a warfarin prescription. Data on age, sex, clinical presentation, imaging studies such as abdominal CT and angiography, location and degree of SMA occlusion, time and response to urokinase treatment, and clinical outcomes were evaluated retrospectively.

### Definition

SMA occlusions were distinguished into proximal and distal occlusions, defined as thromboembolisms proximal and distal to the middle colic artery, respectively. The degree of SMA occlusion may be defined as complete (Fig. 1A, B) and incomplete (Fig. 2A, B), which refers to the main trunk of the SMA occlusion without and with distal branches, respectively. The degree of recanalization after intra-arterial urokinase therapy was described as total, near-total (Fig. 3A, B), partial (Fig. 3, C, D), and absent, referring to the dissolution of the thromboembolism with total, near-total, partial, and no restoration of blood flow on angiography, respectively.

## Statistical analysis

Categorical data are presented as numbers, while continuous data are presented as median (interquartile range [IQR]) values. For comparisons of categorical data, the Fisher exact test or Pearson  $\chi^2$  test was used as appropriate. For continuous data, the Mann-Whitney *U* test was used. All statistical analyses were performed using SPSS version 20.0 (IBM, Armonk, New York, USA). A *P* value of < 0.05 (two-sided) was considered statistically significant.

## Results

Among the 10 patients, 7 were men and 3 were women (median age, 75.5 years). The median time from onset of abdominal pain to emergency department admission was 11 hours (IQR, 4.9 hours). All had various degree of acute abdomen, but none of the patients presented as acute peritonitis on physical examination, and 4 (40%) had bloody stools. A medical history review revealed that hypertension (90%) and atrial fibrillation (AF; 60%) were the most common comorbidities. Laboratory data revealed an initial median serum white cell blood count of 13,500 U/L (IQR, 11,750 U/L), median haemoglobin level of 13.6 g/dL (IQR, 3.4 g/dL), and median serum amylase level of 121 U/L (IQR, 78 U/L; Table 1). In this report, all 10 patients underwent contrast-enhanced abdominal CT for diagnosis of SMA occlusion, which revealed an additional renal infarct in 1 patient and a synchronous spleen and renal infarct in another. On angiography, the SMA occlusion was located proximally in 3 patients and distally in the remaining 7 patients. Complete and incomplete SMA occlusions were observed in 6 and 4 patients, respectively (Table 1). The median time from the onset of abdominal pain to initiation of urokinase infusion was 15.5 hours (IQR, 8.0 hours). At the initiation of urokinase infusion and fragmentation for the thromboembolism, early partial recanalisation could be observed on angiography in 4 patients. During the course of the urokinase therapy, all the patients showed various degrees of recanalization (near-total, *n* = 2; partial, *n* = 8) on follow-up angiography. However, owing to clinical deterioration, the urokinase therapy was discontinued in 7 patients. The median urokinase therapy duration was 39.0 hours (IQR, 48.0 hours). Details of the demographic characteristics, responses to urokinase treatment, and outcomes of the 10 patients are presented in Table 2. After urokinase therapy, bowel perfusion was restored with bowel preservation in 4 patients; however, in the other 6 patients, bowel perfusion was not restored (Table 2). Comparison of the demographic data and clinical characteristics of the patients with restored and unrestored bowel perfusion revealed that the occlusion location (*p* = 0.324), time from abdominal pain to initiation of urokinase administration (*p* = 0.357), and degree of recanalisation (*p* = 0.259) were not statistically significant, and only the degree of SMA occlusion was statistically significant (complete vs. incomplete, *p* = 0.012; Table 3). Of the 6 patients with complete SMA occlusion, 5 underwent bowel resection, of whom 2 died, and the remaining patient died of shock due to delayed surgery. Of the 4 patients with incomplete SMA occlusions, no bowel resection was performed except a partial omentectomy. Of the 3 deaths, one was attributed to delayed surgery, and the other two developed short bowel syndrome with sepsis and multiple-organ failure, with a 30% in-hospital mortality rate (Table 1). The median hospital stay duration was 20.0 days (IQR, 32.0 days; Table 1).

Table 1  
Demographic data and clinical characteristics of the 10 patients with superior mesenteric artery (SMA) occlusion

Characteristics	Patients (n = 10)
Gender	
Male, <i>n</i> (%)	7 (70.0)
Female, <i>n</i> (%)	3 (30.0)
Age (years) Median (IQR)	75.5 (42.0)
History	9 (90.0)
Hypertension, <i>n</i> (%)	
Atrial fibrillation, <i>n</i> (%)	6 (60.0)
Heart disease (CAD, CHF etc.), <i>n</i> (%)	4 (40.0)
CVA, <i>n</i> (%)	3 (30.0)
Diabetes mellitus, <i>n</i> (%)	3 (30.0)
Time from abdominal pain to emergency department (hours) Median (IQR)	11 (4.9)
Shock at triage, <i>n</i> (%)	0 (0)
Bloody stool, <i>n</i> (%)	4 (40.0)
Initial serum WBC (U/L) Median (IQR)	13500 (11750)
Initial serum hemoglobin (g/dL) Median (IQR)	13.6 (3.4)
Initial serum amylase (U/L) Median (IQR)	121.0 (78.0)
Synchronous intra-abdominal organ infarct on CT,	2, (20%)
Site of occlusion from SMA origin (cm) Median (IQR)	4.8 (2.1)
Location of occlusion <sup>a</sup>	
Proximal, <i>n</i> (%)	3 (30.0)
Distal, <i>n</i> (%)	7 (70.0)
Degree of SMA occlusion <sup>b</sup>	
Complete, <i>n</i> (%)	6 (60.0)
Incomplete, <i>n</i> (%)	4 (40.0)
Time from abdominal pain to urokinase (hours) Median (IQR)	15.5 (8.0)
Degree of SMA recanalization after urokinase	
Total, <i>n</i> (%)	0
Near-total, <i>n</i> (%)	2
Partial, <i>n</i> (%)	8
Duration of urokinase (hours) Median (IQR)	39.0 (48.0)
Surgery, <i>n</i> (%)	6 (60.0)
Bowel resection, <i>n</i> (%)	5 (50.0)
Partial omentectomy, <i>n</i> (%)	1 (10.0)
Laparoscopy <sup>c</sup> , <i>n</i> (%)	4 (40.0)
Repeated surgery, <i>n</i> (%)	3 (30.0)
Overall in-hospital mortality rate, <i>n</i> (%)	3 (30.0)
Length of stay (days) Median (IQR)	20 (32.0)
<i>IQR</i> interquartile range, <i>CAD</i> coronary artery disease, <i>CHF</i> congestive heart failure, <i>CVA</i> cerebrovascular accident, <i>CT</i> computed tomography, <i>SMA</i> superior mesenteric artery, <sup>a</sup> located proximal or distal to the middle colic artery, <sup>b</sup> complete and incomplete occlusion, which refers to the main trunk of the SMA occlusion without and with distal branches, respectively, <sup>c</sup> two patients underwent further laparotomy.	

Table 2  
Clinical data and outcomes of the 10 patients with superior mesenteric artery (SMA) occlusion

No.	Age	Sex	History	Bloody stool	Synchronous infarct on CT	SMA occlusion		Intra-arterial urokinase		Laparotomy		Outcome	H (d)
						To orifice (cm)	Degree	Time <sup>a</sup> (hours)	Recanalization	Time <sup>b</sup> (hours)	Procedure		
1	50	M	H/T	No	No	D, 5.0	Incomplete	9	Partial	32	Omenectomy	Alive	
2	80	M	H/T, AF, CVA	Yes	No	D, 8.0	Complete	15	Partial	24	Bowel resection	Alive	
3	88	M	H/T, CVA	No	No	D, 5.5	Complete	16	Partial	55	Bowel resection	Alive	
4 <sup>c</sup>	83	F	H/T, AF, CHF	No	kidney	P, 3.5	Complete	19	Partial		No	Dead	
5 <sup>d</sup>	77	F	H/T, AF, CAD	Yes	No	D, 4.0	Incomplete	28	Near-total		No	Alive	
6	68	M	H/T	Yes	No	D, 5.0	Complete	26	Partial	126	Bowel resection	Dead	
7 <sup>d</sup>	67	M	AF, AAA	No	Spleen, kidney	D, 4.5	Incomplete	15	Near-total		No	Alive	
8	73	F	H/T, CVA, DM	Yes	No	P, 3.5	Complete	21	Partial	47	Bowel resection	Dead	
9	78	M	H/T, AF, CAD	No	No	D, 6.0	Incomplete	14	Partial		No	Alive	
10	78	M	H/T, AF, DM	No	No	P, 1.5	Complete	15	Partial	60	Bowel resection	Alive	

CT computed tomography, H/T hypertension, AF atrial fibrillation, CVA cerebrovascular accident, CHF congestive heart failure, DM diabetes mellitus, CAD coronary artery disease, AAA abdominal aorta aneurysm, D distal to middle colic artery, P proximal to middle colic artery, <sup>a</sup>time from abdominal pain to urokinase, <sup>b</sup>time from pain to surgery, <sup>c</sup>died of shock due to delayed surgery, <sup>d</sup>underwent laparoscopic examination alone.

Table 3

Comparison of demographic data and clinical characteristics between the 4 patients with restored bowel perfusion and the 6 patients with unrestored bowel perfusion after urokinase therapy

Characteristics	Restored bowel perfusion	Unrestored bowel perfusion	<i>P</i> value
No. of patients	4 <sup>a</sup>	6 <sup>b</sup>	
Gender			> .999
Male, <i>n</i> (%)	3 (75.0)	4 (66.7)	
Female, <i>n</i> (%)	1 (25.0)	2 (33.3)	
Age (years) median, IQR	72 (24)	79 (13)	.133
Bloody stool	1/4 (25)	3/6 (50)	.895
Initial serum WBC (U/L) median, IQR	9700 (8450)	16950 (10775)	.157
Initial serum hemoglobin (g/dL) median, IQR	14.1 (3.2)	12.6 (4.4)	.510
Synchronous intra-abdominal organ infarct on CT,	1 (25.0)	1 (16.7)	> .999
Location of SMA occlusion			.324
Proximal, <i>n</i> (%)	0 (0)	3 (50)	
Distal <i>n</i> (%)	4 (100)	3 (50)	
Degree of SMA occlusion			.012
Complete, <i>n</i> (%)	0 (0)	6 (60)	
Incomplete, <i>n</i> (%)	4 (40)	0 (0)	
Time from abdominal pain to urokinase (hours) Median (IQR)	14.5 (15.0)	17.5 (7.0)	.357
Degree of SMA recanalization after urokinase			.259
Near-total	2 (50)	0 (0)	
Partial	2 (50)	6 (100)	
Length of stay (days) median, IQR	8 (9)	32 (33)	.114
Mortality, <i>n</i> (%)	0 (0)	3 (50)*	.324

*IQR* interquartile, *CT* computed tomography, *SMA* superior mesenteric artery, <sup>a</sup>one underwent partial omentectomy, <sup>b</sup>including one patient died of shock due to delayed surgery.

## Discussion

The high morbidity and mortality of acute mesenteric ischaemia are mainly attributed to late diagnosis and treatment in elderly and debilitated cardiac patients, who are poor candidates for surgery [4, 5, 11, 12]. The median age of our patients was 75.5 years (range, 50–88 years). All our patients had a cardiovascular disease (hypertension, *n* = 9; AF, *n* = 6; cerebrovascular accident, *n* = 3; congestive heart failure, *n* = 2; coronary artery disease, *n* = 2; Table 2). To date, specific markers for establishing or excluding the diagnosis of SMA occlusion are lacking [4, 5, 13, 14]. Laboratory data such as leucocytosis, metabolic acidosis, hyperamylasaemia, and elevated lactate phosphate are not specific and are suggestive of intestinal ischaemia. The most important diagnostic tool is abdominal enhanced CT, which can not only facilitate the diagnosis of SMA occlusion but also show other findings of ischaemic bowel, such as bowel dilatation, intramural gas, mesenteric or portal venous gas, lack of bowel wall enhancement, and infarction of other abdominal organs [4, 5, 15, 16, 17]. In the past 20 years, many reports described cases of successful reperfusion of SMA occlusion using several endovascular strategies such as percutaneous intra-arterial thrombolysis, aspiration embolectomy, percutaneous transluminal angioplasty, SMA stenting, and a combination of these therapies [1, 10, 18, 19]. The first case of intra-arterial thrombolysis for acute SMA occlusion was reported by Jamieson in 1979, with successful infusion of streptokinase directly into the SMA [20]. In our report, the first patient was a 45-year-old man who presented with abdominal pain, and abdominal CT revealed a non-enhanced filling defect in the distal part of the SMA on October 1, 2008. SMA angiography revealed an incomplete SMA occlusion, 5 cm distal to the SMA root (Fig. 4A). Thus, intra-arterial urokinase was administered at a loading dose of 300,000 IU, followed by a continuous dose of 50,000 IU/hour. The follow-up angiography performed the next day revealed partial recanalisation of the previous occlusion with distal branches (Fig. 4B). However, the abdominal pain was aggravated, and emergent laparotomy was performed. During laparotomy, the small bowel and colon were normal, and only a fibrotic omentum mass measuring 5 · 5 cm in size was found. The infarcted omentum was resected, and the patient was discharged uneventfully. We chose urokinase as the thrombolytic agent because it does not influence the surgery owing to its short half-life of only 16 minutes in blood. In a literature review from 1966 to 2003 by Schoots et al. [9], 48 patients with acute SMA thromboembolism were managed with intra-arterial thrombolysis and 38 patients (79%) were treated with urokinase therapy. Of our patients, intra-arterial fragmentation of thromboembolism was performed at the initiation of urokinase administration, but only 4 patients showed early partial recanalisation on angiography. Our experience revealed that the role of intra-arterial fragmentation of thromboembolism is limited. With urokinase therapy, despite the decrease in the size of the thromboembolism, all patients could achieve various degrees of SMA recanalisation on follow-up angiography (near-

total,  $n = 2$ ; partial,  $n = 8$ ; Table 2). However, only 4 patients attained restoration of adequate bowel perfusion with bowel preservation, and the other 6 patients failed to attain restoration of bowel perfusion, of whom 5 underwent bowel resection and 1 died of shock due to delayed surgery. Of the 48 patients in Schoots's case series [9], excluding 3 patients in whom technical approach failed, 39 (86.7%) attained bowel preservation. It revealed that under thrombolysis for SMA occlusion, the restoration of bowel perfusion with bowel preservation were not clearly correlated in all the patients and may be attributed to many factors such as occlusion duration and timing of thrombolysis; degrees of occlusion; presence or absence of collateral circulation; influence of splanchnic autoregulation; and presence of associated atherosclerotic lesions [4, 5, 21]. In our report, the occlusion location, time from abdominal pain to initiation of urokinase administration, and degree of recanalisation were not associated with bowel preservation (Table 3). The degree of occlusion was the only factor associated with bowel preservation (complete vs. incomplete,  $p = 0.012$ ; Table 3). Acute thrombosis of the SMA is generally localised in a stenosis at the origin of the SMA, which is often a result of chronic atherosclerosis. Emboli are typically dislodged to the periphery of the SMA in an atherosclerosis-free segment. Of our 10 patients, 3 presented with a proximal location and all had complete occlusion and could only achieve partial recanalization after urokinase therapy (Table 2), which may reflect the lower effect of urokinase in chronic atherosclerosis. Previous studies suggested initiating thrombolysis within 8 to 10 hours of appearance of abdominal symptoms [22]. In our patients, the median times from the onset of abdominal pain to initiation of urokinase administration in 4 patients with restored bowel perfusion and in 6 patients with unrestored bowel perfusion were 14.5 and 17.5 hours, respectively ( $p = 0.357$ ). In addition, in Schoots's case series [9], of the 48 patients, 7 (14.6%) had a successful thrombolysis even at presentation  $\geq 24$  hours (range, 24–72 hours) before angiography and 4 (8.3%) had a failed thrombolysis even at  $\leq 6$  hours before angiography. This discrepancy may suggest a longer window of opportunity for initiating thrombolysis of acute SMA occlusion. In our report, 4 patients with incomplete SMA occlusion recovered well without bowel resection, except omentectomy in 1 patient (Table 2). Conversely, of the 6 patients with complete occlusion, 5 underwent bowel resection and 1 died of shock due to delayed surgery. Our report revealed that the most important factor for bowel preservation is the degree of occlusion (Table 3). In this report, laparoscopic examination was performed in 4 patients with equivocal clinical presentation, and 2 showed normal bowel and could obviate further laparotomy. In our report, two patients died of short bowel with multiple-organ failure, and another died of shock due to delayed surgery, with a 30% mortality rate. Our experience in the management of acute SMA occlusion with intra-arterial urokinase revealed that urokinase therapy may serve as an adjunctive treatment modality to preserve the bowel and obviate surgery in incomplete SMA occlusion, but it was not suitable for complete SMA occlusion.

## Limitation

This study is the small sample size, which reduced the possibility of an appropriate multivariate analysis.

## Conclusion

In our experience, thrombolysis with intra-arterial urokinase may serve as an adjunctive treatment modality to preserve the bowel and obviate surgery in incomplete SMA occlusion, but it was not suitable for complete SMA occlusion. In complete SMA occlusion, surgery is warranted.

## Abbreviations

### SMA

superior mesenteric artery

### IQR

interquartile range

### AMI

Acute mesenteric ischaemia

### CT

computed tomography

### AF

atrial fibrillation

## Declarations

### Ethical Approval and Consent to participate

IRB of the Chang Gung Memorial Hospital approved the study on March 16, 2020, with number 202000381B0

### Consent for publication

Not applicable

### Availability of supporting data

The authors are responsible for the data described in the manuscript and assure full availability of the study material.

### Competing interests

The authors declare that they have no competing interests

### Funding

Not applicable

### Authors' contributions

Conception and design: BCL, CHW, YCW, SCH

Analysis and interpretation: BCL, CHW, YCW, SCH

Data collection: BCL, MCH

Writing the article: BCL

Critical revision of the article: BCL, CHW, YCW, SCH, MCH

Final approval of the article: BCL, CHW, YCW, SCH, MCH

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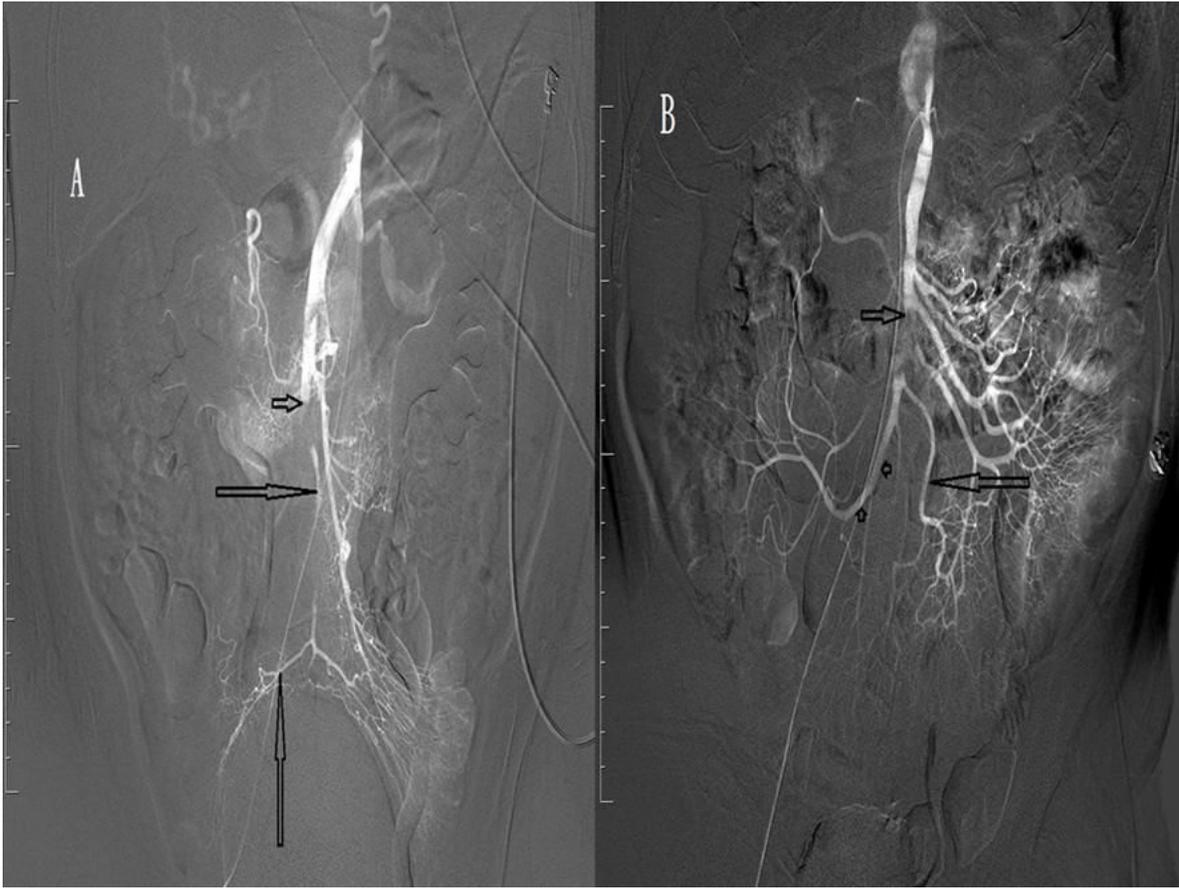
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## Figures

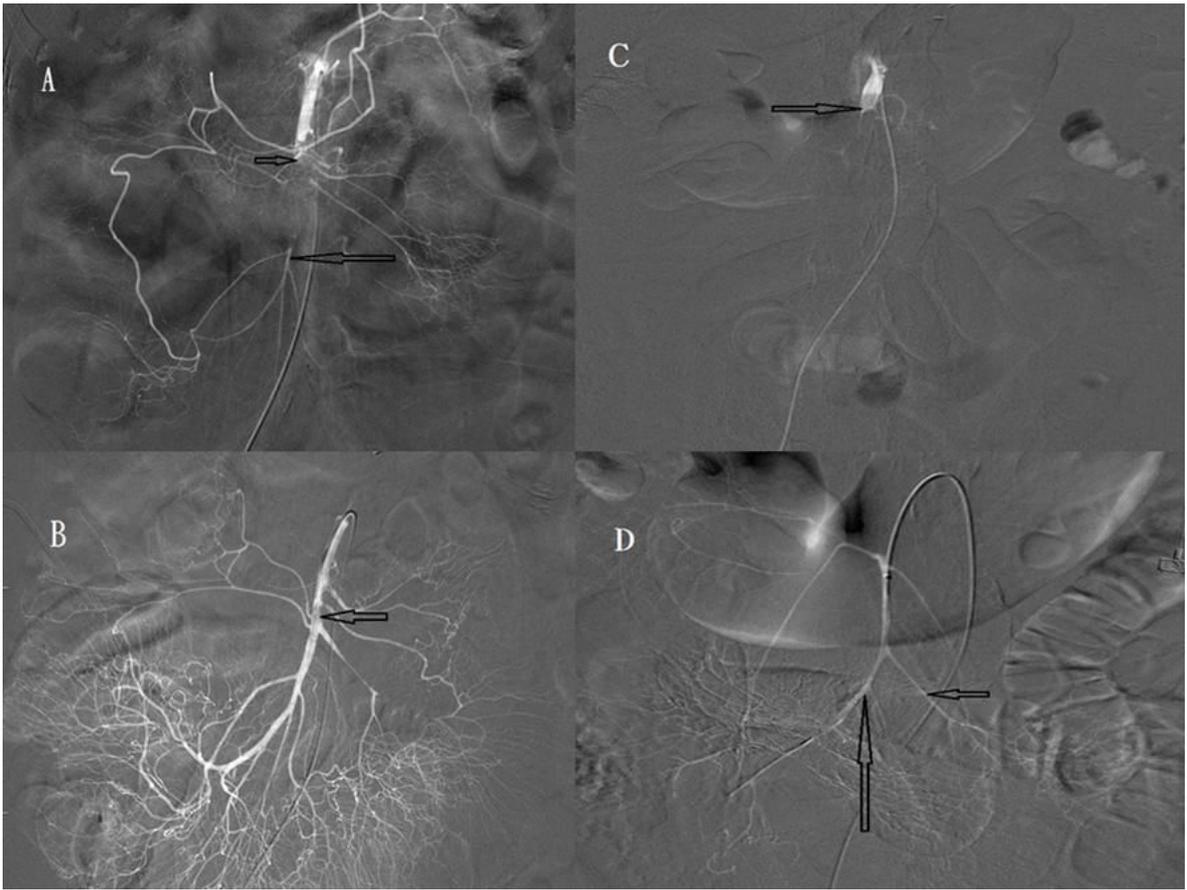


**Figure 1**  
A, Angiography of an 83-year-old woman, showing complete occlusion (arrow) of the superior mesenteric artery (SMA) around the proximal jejunal arteries (arrowheads). Distal main trunk of the SMA is not visible. B, Angiography of an 80-year-old man, showing complete occlusion (short arrow) of the SMA. The middle colic artery (arrowhead) and right colic artery (long arrow) are visible.



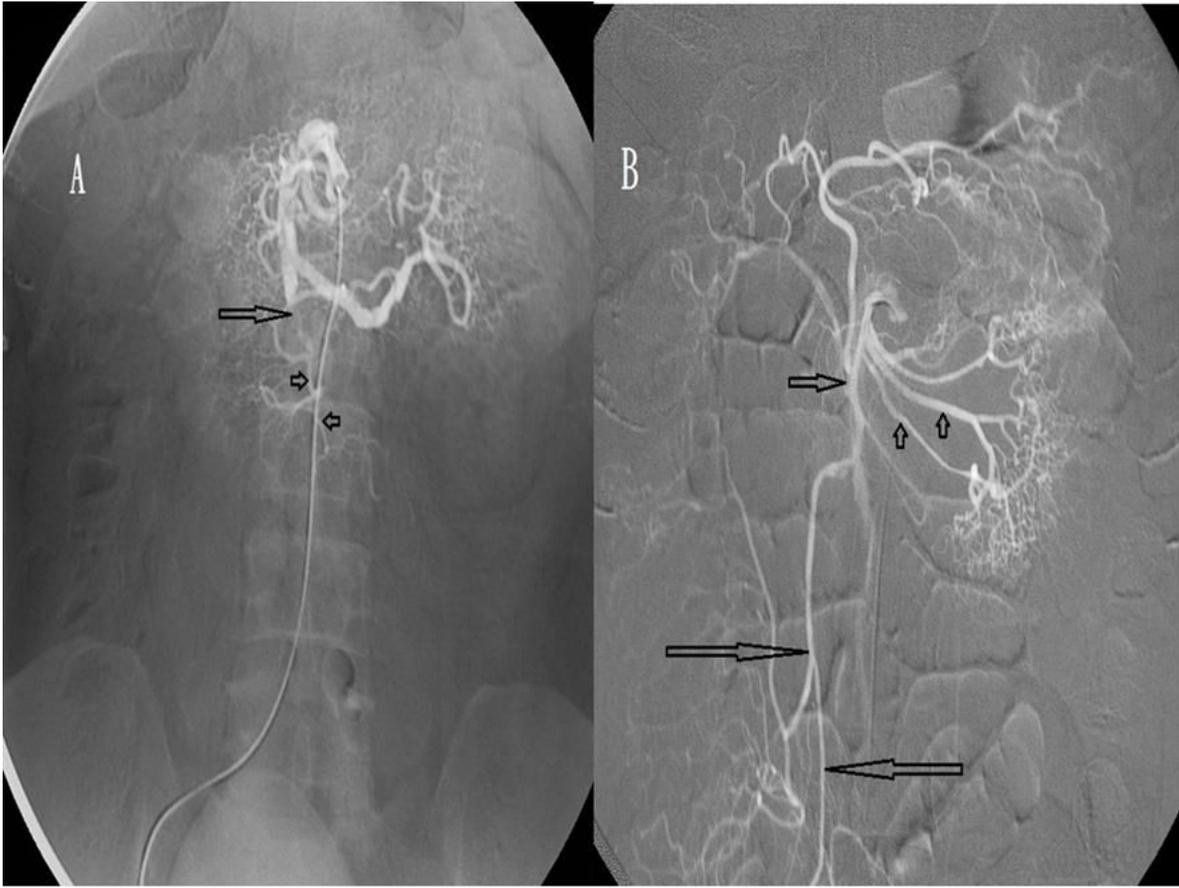
**Figure 2**

A, Angiography of a 67-year-old man, showing incomplete occlusion (short arrow) of the superior mesenteric artery (SMA). Distal main trunk of the SMA and ileocolic artery (long arrows) are visible. B, Angiography of a 78-year-old man, showing incomplete occlusion (short arrow) of the SMA. The ileal artery (long arrow) and ileocolic artery (arrowheads) are visible.



**Figure 3**

A, Angiography of a 77-year-old man, showing incomplete occlusion (short arrow) of the superior mesenteric artery (SMA). Distal main trunk of the SMA (long arrow) is visible. B, Angiography obtained after one day of urokinase infusion, showing near-total recanalisation of the SMA with appearance of the distal branches. The thrombus decreased in size, but remained (arrow). C, Angiography of a 78-year-old man, showing complete occlusion (arrow) of the superior mesenteric artery (SMA). Distal main trunk of the SMA is not visible. D, Angiography obtained after 26 hours of urokinase infusion, showing partial recanalization of the SMA. The ileal artery (short arrow) and ileocolic artery (long arrow) are visible, but most of the jejunal arteries are not visible.



**Figure 4**  
A, Angiography of a 50-year-old man, showing incomplete occlusion (arrow) of the superior mesenteric artery (SMA). Distal main trunk of the SMA is visible (arrowheads). B, Angiography obtained after one day of urokinase infusion, showing partial recanalisation of the previous occlusion (short arrow). Most of the jejunal arteries (arrowheads) and colic arteries (long arrow) are visible.