

## Incidence and Clinical Presentation of Bowel Ischaemia After Aortoiliac Surgery — 2930 Operations from a Population-based Registry in Sweden\*

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**Objectives:** To study the incidence and clinical presentation of intestinal ischaemia after aortoiliac/femoral surgery, and to validate a vascular registry concerning a serious complication.

**Design and setting:** In the Swedish Vascular Registry (SWEDVASC) the outcome and complications of all vascular procedures are registered prospectively.

**Materials and methods:** All 2930 patients operated in 1987–93 were analysed for notified complications. A 5% random sample of all patients and a 20% random sample of fatal cases were analysed for un-notified complications. Of 415 requested patient records 413 were analysed.

**Results:** The estimated incidence of bowel ischaemia was 2.8%. Among patients operated on for a ruptured aneurysm in shock it was 7.3%. Of the 63 patients with intestinal ischaemia only 15 presented with early passage of bloody stools. In 60 patients (95%) the lesion affected the left colon within the reach of a sigmoidoscope. Bowel ischaemia was unnotified only in fatal cases, the estimated un-notified complication rate was 0.7%.

**Conclusions:** The incidence in this study on unselected patients did not differ from previous reports from specialised centres. Diagnosis is difficult and justifies a high index of suspicion and early use of sigmoidoscopy. The validity of the SWEDVASC registry was confirmed by a high report-rate for this complication.

### Introduction

Bowel ischaemia, in particular of the left colon, is a well known complication after aortoiliac surgery, with a high morbidity and mortality. The true incidence may be relatively high, indicated by the fact that prospective studies using routine sigmoidoscopy have reported 4.5–8.9% after elective surgery and 15–60% after surgery for ruptured aortic aneurysm.<sup>1–3</sup> In a study design using pH<sub>i</sub>-guided sigmoidoscopy we found 7.4% after elective and 29% after emergency aortic surgery<sup>4</sup> (pH<sub>i</sub> = intraluminal pH measured with an intraluminal balloon catheter). Intestinal ischaemia detected in a routine clinical setting has been reported in several retrospective studies from specialised centres to be between 1.1 and 10%.<sup>5–9</sup> In the largest series so far Brewster *et al.* reported a 9 year experience of 24 cases among 2137 patients (1.1%), but

only 147 of the patients were operated on for ruptured aneurysms.<sup>5</sup>

Since the classical experiment by Lillehei<sup>10</sup> in 1957 there has been mounting evidence that intestinal ischaemia plays a major role in the development of irreversible shock and multiple organ failure. Soong *et al.* found higher concentrations of endotoxin and cytokines as well as signs of organ dysfunction among patients with a subclinical sigmoid ischaemia defined as pH<sub>i</sub> levels below 7.0 after elective abdominal aortic aneurysm repair.<sup>11,12</sup> We found sigmoid ischaemia, defined as pH<sub>i</sub> levels below 7.1 for more than 2 h, to be highly predictive of all major complications and death after aortoiliac surgery.<sup>4</sup> Thus, low grade intestinal ischaemia after aortoiliac surgery seems to have a strategic importance on outcome.

The existence of a national vascular registry, where a large number of operations and complications are registered prospectively, offered an opportunity to study this infrequent but yet important complication, in an unselected setting. All types of hospitals participate in the registry. The aim of the study was to establish the incidence of clinically detectable bowel

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ischaemia. A further aim was to validate the SWEDVASC-registry in terms of a serious complication.

## Materials and Methods

The Vascular Registry in Sweden (SWEDVASC) was started in 1987 as a regional registry with a population base of 1.9 million, but it has gradually expanded and at present covers a population of 8.5 million (>90% of the Swedish population).<sup>13,14</sup> Participating hospitals report all vascular surgical procedures, including endovascular, with results after 30 days and 1 year. Validation against anaesthesia registries and reproducibility control of random samples of cases are performed regularly and have confirmed a 90% report-rate and 90% reproducibility of data. Reoperations and complications are reported. Details of the SWEDVASC-registry has been described in previous reports.<sup>15</sup> Mortality-data are cross-checked with the national population registry which makes patient survival analysis possible beyond the 1 year clinical follow-up.

From 1987 until September 1993, 20879 vascular operations were registered. In this study all procedures with in-flow from the abdominal aorta were included except those involving balloon dilatation or embolectomy only. Operations performed with the primary indication of intestinal ischaemia were excluded. A total of 2930 operations were identified as aortoiliac/femoral procedures and included in the present study. Among the 2930 operations 219 were coded for either relaparotomy, bowel resection or for "miscellaneous surgical complications, for instance intestinal ischaemia". The records of all 219 patients, treated at 28 different hospitals, were identified and analysed. Coding of the complications was prospective, whereas analysis of patient records was retrospective.

To estimate the frequency of clinically detectable intestinal ischaemia that had not been coded in the register a 5% random sample of the remaining operations was identified. Sampling was performed by the pseudo-random number generator of SPSS which generates a sample size of approximately the specified proportion. Hence 133 operations at 25 different hospitals were selected, and the patient records of all 133 cases were identified and analysed. The overall 30 day mortality was 11.8%, and among the patients who died a 20% random sample was identified: 63 operations from 27 hospitals were selected and of those 61 patients' records were identified and analysed. Data management and statis-

tical analysis were performed using the SPSS for Windows program package.

## Results

The 2930 patients analysed had a median age of 69 years (range 12–93) and 74% were male. In 61% of the operations the indication for surgery was an aortoiliac aneurysm, either ruptured (33%), symptomatic (24%) or asymptomatic (43%). Lower extremity ischaemia was the indication in 33%, either claudication (66%), chronic critical ischaemia (27%) or acute ischaemia (7%). In 3% of cases the indication was renovascular disease and in the remaining 3% miscellaneous indications such as postoperative occlusion, infection, micro-embolism or trauma were present. Emergency procedures were performed in 28%, and 3.4% were redo procedures.

Among the 219 patients reported with relaparotomy, bowel resection or miscellaneous surgical complications, 63 patients with postoperative intestinal ischaemia were identified. The indication for surgery had great influence on the frequency of the complication (Table 1), the highest incidence occurring after surgery for ruptured aortic aneurysm with the patient in shock. The median time from operation to diagnosis was two days (range 0–44 days). Table 2 shows at what stage in relation to the operative procedure the complication was identified. In five cases the diagnosis was evident at the primary operation, though in four additional cases a decision was made to perform a second look.

Table 3 reports the frequencies of presenting symptoms in the 58 patients where the diagnosis was not evident at the primary operation. In five cases the diagnosis was suspected as a result of intramucosal pH monitoring.<sup>4</sup> Uncommon symptoms were faecal odour from wound or drainage site, acidosis and faecal fistula. In a separate analysis we compared the 36 patients who presented with either early stools or haematoschisis with the 22 patients who lacked the cardinal symptoms. Although there was no statistical difference, there was a tendency for patients that lacked cardinal symptoms to be diagnosed later and less often by endoscopy. Their lesions affected the rectum less often and they suffered a higher 30 day mortality rate.

Fig. 1 illustrates the ischaemic involvement of the different parts of the colon and rectum. The small bowel was affected proximally in 6% and distally in 18%, and in one patient there was an isolated small bowel lesion. The median length of the ischaemic

Table 1. Thirty-day mortality and frequency of postoperative bowel ischaemia depending on indication for surgery

Indication for surgery	Patients (n)	30 day mortality rate % (95% C.I.)	Patients with bowel ischaemia (n)	Frequency of bowel ischaemia % (95% C.I.)
Ruptured aneurysm, in shock	412	43% (38-47)	30	7.3% (4.8-9.8)
Ruptured aneurysm, without shock	151	27% (20-34)	3	2.0% (0-4.2)
Acute aneurysm, without rupture	166	13% (8-19)	4	2.4% (0.1-4.7)
Elective aneurysm, symptomatic	274	6% (3-9)	1	0.4% (0-1.1)
Elective aneurysm, asymptomatic	786	5% (3-6)	10	1.3% (0.5-2.1)
Intermittent claudication	637	3% (1-4)	4	0.6% (0-1.2)
Critical ischaemia, chronic	265	5% (3-8)	9	3.4% (1.2-5.6)
Acute ischaemia	63	22% (12-33)	2	3.2% (0-7.5)
Renovascular disease	78	5% (0-10)	0	0% (0-0)
Miscellaneous indications	98	7% (2-12)	0	0% (0-0)
Total	2930	12% (11-13)	63	2.1% (1.6-2.6)

intestine was 40 cm (range 10-370). The ischaemic lesion was considered to be mucosal in 17 cases and transmural in 46, in five of whom perforation occurred. The depth of the ischaemia affected 30 day mortality significantly (1/17(5.9%) vs. 25/46(54%), Chi-square test  $p = 0.0005$ ).

Table 4 shows how the diagnosis was verified.

Among the six patients with autopsy diagnosis three had no clinical diagnosis prior to death: In one patient the diagnosis was not suspected, in another rectoscopy was performed but the gangrene was in the right colon, in the third sigmoidoscopy was performed and considered normal, but at autopsy gangrene of the descending colon was detected. Mortality

Table 2. Stage at which bowel ischaemia was identified

	Cases (n)
Ischaemia evident during primary operation	5
Ischaemia diagnosed postoperatively	53
Late diagnosis due to chronic diarrhoea	1
No clinical suspicion, ischaemia evident at reoperation due to haemorrhage or evisceration	3
No clinical suspicion, ischaemia evident at autopsy	1
Total	63

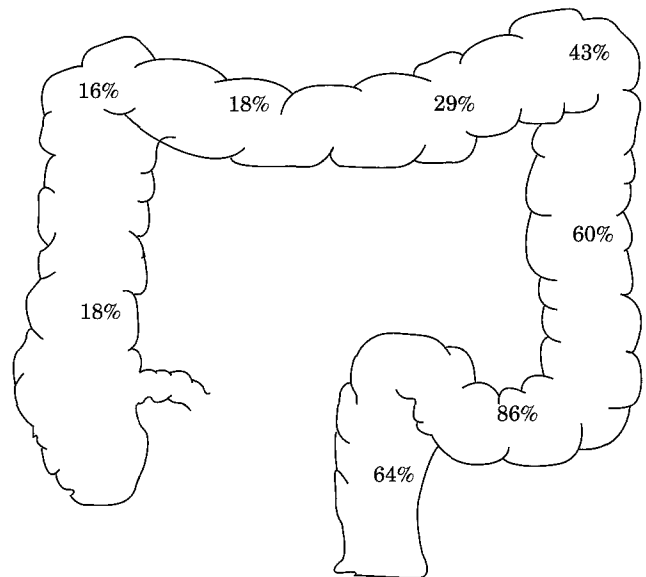


Fig. 1. Frequency at which different parts of the colon and rectum were affected by ischaemia among the 63 patients.

Table 3. Frequency of presenting symptoms

	Cases (n)	%
Early passage of stools (median 15h, range 1-48h)	30	52%
Early diarrhoea	24	41%
Haematoschisis	21	36%
Early stools and haematoschisis	15	26%
Early stools or haematoschisis	36	62%
Anuria or oliguria	14	24%
Unexplainable septicaemia	10	17%
Unexplainable circulatory instability	9	16%
Thrombocytopenia	9	16%
Peritonitis or intense abdominal pain	7	12%
Persistent diarrhoea after 5 <sup>th</sup> postoperative day	5	9%

Table 4. Mode of diagnosis and fatality rate of 63 cases of bowel ischaemia

	Cases (n)	30 day mortality	
		n	%
Sigmoidoscopy	22	4	18
Rectoscopy	12	3	25
Barium enema	3	0	0
Diagnosis at primary operation	5	5	100
Relaparotomy	15	8	53
Autopsy	6	6	100
Total	63	26	41

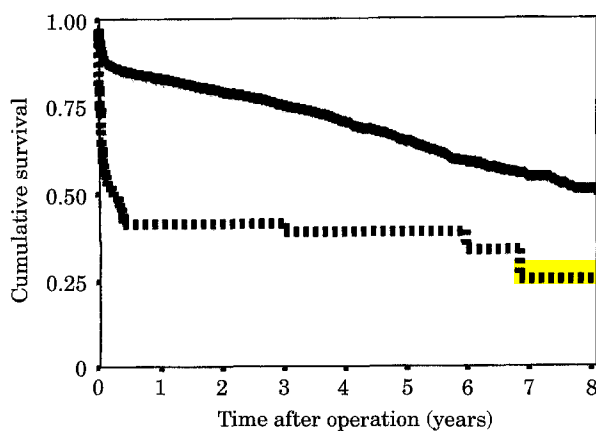
**Table 5. Treatment and outcome of 60 cases of bowel ischaemia**

	Cases	30 day mortality	
	(n)	n	%
Bowel resection with colostomy	35	15	43
Bowel resection without colostomy	1	0	0
Exploratory laparotomy, only	5	0	0
Operative treatment, total	41	15	37
Repeated sigmoidoscopy	6	0	0
Expectancy, only	7	2	29
No treatment	6	6	100
Non-operative treatment, total	19	8	42

was significantly higher among those diagnosed at primary operation or relaparotomy (13/20, 65%) than among those diagnosed by endoscopy or barium enema (7/37, 19%) (Chi-square test  $p = 0.0005$ ).

Table 5 shows the treatment of the 60 patients with a diagnosed ischaemic bowel. In the no treatment group the median survival was 2 days (range: 0–14 days). In the 36 patients treated with bowel resection the median length of resected intestine was 50 cm (range 15–270). Therapy was affected by the depth of the lesion. All patients treated with exploratory laparotomy only or with repeated sigmoidoscopy were considered to have superficial ischaemic lesions of the mucosa, as were five of the seven cases given expectancy only. Only one patient with superficial lesion was treated with bowel resection, due to chronic diarrhoea.

The serious nature of this complication is illustrated



No. at risk

Without	2867	2382	2271	1755	1206	768	451	250	110
With	63	26	26	19	15	11	6	3	1

Fig. 2. Survival after aortic surgery controlled for age. (—) 2867 patients without bowel ischaemia; (---) 63 patients with bowel ischaemia.

in Fig. 2. Whereas the 30 day mortality for the whole patient population was 12% (95% C.I. : 11–13), those who developed bowel ischaemia suffered a significantly higher 30 day mortality of 41% (29–54). At 1 year the corresponding mortalities were 18% (16–19) and 59% (47–71). Among the 412 patients who underwent surgery for ruptured aneurysms and were in shock 30 patients developed the complication with a mortality of 47% (29–67) at 30 days and of 67% (50–84) at 1 year. Twenty had a transmural ischaemic lesion with a mortality of 65% (44–86) at 30 days and 85% (69–100) at 1 year. The 382 patients with ruptured aneurysm and shock who did not develop bowel ischaemia suffered a mortality of 42% (37–47) at 30 days and 49% (44–54) at 1 year.

The records of the 133 control patients were scrutinised for clinical signs of bowel ischaemia and in six the diagnosis was suspected. In two of those the suspicion was ruled out by colonoscopy and in one at autopsy. In a fourth patient the diagnosis was suspected due to fever and lower abdominal pain, but rectoscopy to 20 cm was normal and recovery was prompt. In the remaining two patients there was a clinical suspicion, but colonoscopy was not performed, their symptoms subsided spontaneously and they returned home. Thus, among the 5% random control sample no case of verified bowel ischaemia was identified. Among the 61 randomly sampled control patients who died within 30 days, 10 died on the operating table, 30 underwent autopsy and 21 (34%) did not. Three cases of bowel ischaemia were verified at autopsy, but in two of the patients the diagnosis was evident prior to death. In another patient there was a clinical suspicion of ischaemic colitis, but neither colonoscopy nor autopsy was performed. These four patients were operated on for ruptured aneurysms.

## Discussion

Early bloody diarrhoea is considered the cardinal symptom of postoperative ischaemic colitis after aortoiliac surgery. In this large series only a quarter of cases presented with this combination and more than one-third were lacking both symptoms. In spite of the fact that a vast majority of the cases had a transmural ischaemic lesion only 12% presented with peritonitis or intense abdominal pain, which illustrates the difficulty in evaluating the abdomen in the early postoperative period. In the relatively common situation in which the cardinal symptoms were not present the surgeon was alerted by general signs of deteriora-



tion such as oliguria, circulatory instability, septicaemia and coagulopathy. This study verifies the fact that this complication most frequently affects the sigmoid colon and that sigmoidoscopy is usually able to make the diagnosis. Sixty of the ischaemic lesions (95%) affected either the rectum, the sigmoid or descending colon and were clearly within the reach of the sigmoidoscope. It also confirms the impression that isolated small bowel ischaemia is extremely rare with only a few cases having been reported previously.<sup>16</sup>

The 100% fatality rate among the patients where the ischaemic lesion was diagnosed at the primary operation probably reflects the serious nature of the pathology. An interesting question is whether or not exploratory relaparotomy in itself constitutes a risk to the patient? The patients diagnosed with endoscopy or barium enema did have a significantly better survival than those diagnosed at laparotomy. Also after exclusion of the five patients diagnosed at the primary laparotomy, who had a 100% mortality, the difference remained significant ( $p=0.01$ ). All 17 patients with a superficial ischaemic lesion were diagnosed at endoscopy and after exclusion of those patients with a better prognosis, the difference in survival was no longer significant ( $p=0.16$ ). We therefore conclude that the most important factor explaining the limited survival in the relaparotomy group was a more extensive lesion.

Sixty-three patients were prospectively notified for this complication in the SWED-VASC-registry, accounting for an incidence of 2.1%. To estimate the unnoticed incidence we first considered the 133 control patients (5% random sample of the entire patient population) where no case with the complication was identified. It therefore seems unlikely that the registry misses this serious complication in patients who survive the surgical procedure for 30 days. Secondly, we considered the 61 control patients who constituted a 20% random sample of the patients who died within 30 days of surgery. Two patients with clinically evident bowel ischaemia were identified, 3.3% (2/61). Considering the 30 day mortality of 11.8% these unnoticed cases account for 0.39% of all patients ( $3.3\% \times 0.118$ ). Thirdly, we tried to estimate the frequency at which the complication was not suspected but identified at autopsy. Among the 61 control patients this occurred in one of a total of 30 autopsies, 3.3%. If we assume that the same frequency would apply to those not examined post mortem and excluding the patients who died on the operating table, the incidence of unsuspected bowel ischaemia diagnosed at autopsy would be 2.8% ( $3.3\% \times 51/61$ ) among those who died within 30 days of surgery, accounting for an incidence of 0.35% of all patients

( $2.8\% \times 0.118$ ). Thus, our estimation of clinically relevant bowel ischaemia is 2.8% ( $2.1 + 0.39 + 0.35$ ) (95% C.I. 2.2–3.4). The estimated incidence remains within the incidences reported from specialised centres.<sup>5–9</sup> This analysis also shows that when serious complications are studied, a special check must be made among non-survivors.

With the relatively high frequency of post-mortem examinations few cases of transmural bowel ischaemia would escape detection. Of the 63 reported patients, 46 had transmural lesions, resulting in a frequency of 1.6%. All identified unnoticed cases among the controls were transmural, resulting in an estimated frequency of transmural bowel ischaemia of 2.3% ( $1.6 + 0.39 + 0.35$ ). The incidence of identified superficial ischaemic lesions is highly dependent on diagnostic activity. Three hospitals had a special interest in this complication and performed sigmoid pHi-monitoring and sigmoidoscopy on wide indications. Although these hospitals registered less than 7% of the operations they reported 16% of the transmural and 30% of the superficial ischaemic bowel lesions. Among the 133 control patients from 25 hospitals no endoscopy was performed in two patients (1.5%) and in another two cases merely rectoscopy was performed, in spite of a clinical suspicion of bowel ischaemia. In only two patients was diagnostic colonoscopy performed, indicating suboptimal diagnostic activity. Does the substantial differences in diagnostic activity between hospitals imply differences in awareness of the problem? Or does it imply that the higher diagnostic activity reflects a higher incidence of the complication due to less optimal surgical or anaesthesiological performance or to patient selection? Routine sigmoidoscopy after surgery for aortic aneurysm has revealed a high incidence of mucosal damage<sup>1,2,4</sup> but the clinical importance of this observation is still unclear. As demonstrated in Table 1, the frequency of postoperative bowel ischaemia is high after operation of patients in shock due to a ruptured aneurysm. The diagnosis is not always evident and a high degree of suspicion and willingness to perform sigmoidoscopy seems justified.

A second aim of this study was to validate the SWEDVASC registry for this serious complication. Validation was facilitated by the fact that out of a total of 415 patient records requested, 413 were obtained and analysed, reflecting a high level of participation among the surgeons. Only three patients with clinically evident bowel ischaemia escaped the registry. They were all fatal (several other complications and death had been registered). The present study therefore confirms the high accuracy of the registry. The

registry offered an opportunity to study this infrequent but important complication in an unselected setting. In spite of being the largest series reported, the limited number of patients made sub-group analysis impossible. This problem is illustrated by 16 different treatment strategies among the 63 treated patients. Within its limitations we consider the registry to be an important tool for elucidating uncommon clinical situations.

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