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Long-term follow-up and cost analysis following surgery for small bowel obstruction caused by intra-abdominal adhesions

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Background: This study examined the natural course of patients following surgery for small bowel obstruction (SBO) caused by abdominal adhesions. In addition, a cost analysis was performed.

Methods: A retrospective analysis was undertaken of 102 patients who underwent surgery between 1987 and 1992 for intestinal obstruction due to abdominal adhesions.

Results: Median follow-up was 14 years. The 102 patients experienced 273 episodes of intestinal obstruction after the index operation, of which 237 involved inpatient readmissions; 47.3 per cent of the episodes resulted in further surgery. Single band adhesions were more common in patients with no previous abdominal surgery ($P<0.001$). Some 52.0 per cent of the patients had undergone only one operation for SBO. A mean of 2.7 episodes per patients occurred after the index operation. The cost of adhesion-related problems in this study is €1 588 594 or €6702 per inpatient episode.

Conclusion: The readmission rate in a selected cohort of patients with proven intra-abdominal adhesions was higher than reported previously. The annual cost of adhesion-related problems in Sweden was estimated as €39.9–59.5 million, and the cost of inpatient readmissions was almost equal to that for gastric cancer.

+A: Introduction

The development of adhesions could be considered as a normal reaction of peritoneal surfaces following mechanical damage. Adhesion formation is a consequence of the inflammatory response and the subsequent healing process[1], and postsurgical adhesions occur after more than 90 per cent of all laparotomies[2]. Most adhesions are not symptomatic, but they may cause small bowel obstruction (SBO), either complete or incomplete, as well as pain. The frequency of relaparotomy due to SBO is relatively well known[3], but there have been few studies of the impact of adhesions on abdominal pain[4–6].

It is well documented that adhesions are associated with morbidity at an individual level and have a substantial impact on the national health economy[7]; in one study from Finland the cost was found to be equal to that for rectal cancer[8]. A large follow-up study found a mean of 2.1 readmissions after open abdominal or pelvic surgery in the third of the patients who were readmitted for "direct or possible" adhesion-related problems[9]. The recurrence rate of adhesive SBO is also increased with the number of previous episodes[10,11]. A major problem when studying the natural course and related costs of adhesions is the coding system (International Classification of Diseases (ICD) 9 and 10), as reported by Wilson *et al*.[12], who found that only 34 per cent of adhesion-related problems had been coded correctly. It is also difficult to ascertain whether patients' problems are related to adhesions or some other pathology. In the Scottish Surgical and Clinical Adhesions Research (SCAR) Study[9], published in 1999, the classification 'probably related to adhesions' was six times more common than 'directly related to adhesions', highlighting the problem of research in this field.

The aim of the present study was to study the natural course, including episodes of pain, of patients with defined, clinically relevant, intra-abdominal adhesions over a median follow-up interval of at least 10 years, and to assess the costs associated with treatment.

+A: Patients and methods

Lund University Hospital serves a primary population of approximately 270 000 individuals. The Department of Surgery provides care only for those aged 16 years or more. All patients operated on for abdominal adhesions causing SBO between 1987 and 1992 were reviewed retrospectively. This timespan was chosen in order to achieve a median follow-up of at least 10 years. By using all codes for adhesions in ICD-9 and ICD-10, as well as operating codes for all adhesion-related surgery, a total of 134 patients were identified.

Patients' medical histories before and after the first operation for SBO were analysed. When a patient had undergone another operation for abdominal adhesions before 1987, this was defined as the 'first SBO operation'. The last laparotomy performed before the initial SBO episode was termed the 'index operation'. Patients with SBO episodes between laparotomies performed for other reasons before the index operation were not to be included in the study. In practice, no patient was excluded for this reason.

Every episode for SBO or non-specific abdominal pain was included, for inpatients as well as outpatients, when it was considered likely that the hospital visit was related to adhesions. Gynaecological patient charts were also reviewed as some women with pelvic or even obvious abdominal pain seek help from gynaecologists. SBO or recurrence of adhesion related problems was defined when no cause for abdominal pain other than adhesions could

be diagnosed following laboratory and microbiological results, and clinical and radiological examination.

So that the natural course of solely adhesion-related pain and resource utilization could be studied, 13 patients with cancer, inflammatory bowel disease and possible irradiation injury were excluded. The criterion of at least 6 months' follow-up led to the exclusion of a further six patients who died from diseases unrelated to abdominal adhesions. Some 13 patients moved to another county and were thus lost to follow-up and excluded. The remaining study population comprised 102 patients.

Data investigated included patient demographics, type of surgery before the first operation for SBO, number of inpatient and outpatient episodes with bowel pain, duration of hospital stay, number of operations and radiological examinations, type of adhesion, anaesthetic and operating theatre time, and complications. Adhesion type was determined from the operation notes. The decision to operate was made by the surgeon on call.

Total costs per patient were calculated, including anaesthetic and operating costs, ward expenses (normal, intermediary intensive care unit (ICU) and ICU), radiological expenses and outpatient costs. Sick-leave days were retrieved from the medical records as far as possible. Costs for sick leave were obtained from the National Social Insurance Office[13]. Costs for loss of production during sick-leave days were calculated as determined by healthcare economists[14]. The costs for additional care in the community, geriatric care and rehabilitation were not included. Costs are presented at rates for the year 2004.

+B: Statistical analysis

As the data showed skewed distributions, median values are given and non-parametric tests were used. Mann–Whitney, Wilcoxon rank sum and χ^2 tests, and logistic regression, were used to analyse the data. $P<0.050$ was considered statistically significant. SPPS© for Windows 11.0 (SPSS inc. Chicago, Il, USA) was used for statistical analyses.

+A: Results

Of the 102 patients in the study, 55 were women and 47 men; their median age was 64 (mean 59.7) years at the time of the index operation. The median length of follow-up was 14 (mean 12.4; range 1–29) years. Forty-three patients died during follow-up. Autopsy was not performed on all patients, but none died from adhesion-related problems. No patient died during an inpatient stay.

Of a total of 273 episodes (admissions and hospital appointments), 30 visits were made to the outpatient emergency department for abdominal pain with nausea and interval pain, and six were to the outpatient clinic for pain-related problems and consequent deteriorating social circumstances. The remaining 237 were hospital admissions. There was a mean of 2.7 episodes per patient after the index operation.

+B: Operations

There was variation in the number of operations performed before the first operation for adhesions (*Table 1*). Sixty-one (59.8 per cent) of the patients had previously had lower gastrointestinal tract surgery, including appendicectomy and colorectal operations.

Some 129 (47.3 per cent) of the 273 episodes involved surgical treatment, that is, 129 operations were performed on 102 patients. Bowel resection was required in 17 (13.2 per

cent) of the operations. Postoperative complications during hospital stay were documented following 40 operations (31.0 per cent) (*Table 2*).

Conservative treatment was employed for the 144 episodes (52.7 per cent) that did not lead to surgery, and only one complication (cardiac infarction) was noted in these patients.

+B: Adhesions

Types of adhesion and operations are shown in *Table 3*. Bowel resection was performed in 3 of 46 patients (6 per cent) of patients with matted adhesions, compared with 8 (16 per cent) of the 49 patients with single band adhesions (P=0.078). The mean number of episodes for patients with matted adhesions was 3.3, compared with 2.1 for patients with single band adhesions (P=0.071). Patients who had not been operated on before their first SBO operation all had single band obstructions ($P<0.001$). Matted adhesions seemed to be more common after surgery in the lower gastrointestinal tract. 38 patients had matted adhesions (62 per cent) after lower gastrointestinal surgery compared to 5 (42 per cent) and 6 (40 per cent) patients with gynecological operations or other gastrointestinal surgery, respectively (p=0.082). There was no difference in the frequency of complications following surgery for matted or single band adhesions (16 versus 13 patients; (P=0.640).

+B: Recurrence

Most patients (53 patients; 52.0 per cent) had only one operation after the index operation. Forty-four patients (43.1 per cent) had between two and five recurrences during the follow-up interval. A small proportion (five patients; 4.9 per cent) developed severe problems and had ten or more recurrences.

Before the first SBO operation, 17 (16.7 per cent) of the 102 patients had abdominal pain that was probably due to adhesions, as indicated by dilated bowels on plain abdominal radiography and clinical examination.

The time from the index operation to the first SBO operation varied from 8 days to 21 years (*Table 4*), with a median of 13 (mean 44) months.

The 144 episodes that resulted in conservative treatment all involved clinical signs of pain considered to be due to adhesions, although only 102 (70.8 per cent) had clear radiological signs of SBO. The remaining 42 (29.2 per cent) had radiological signs of air in the small bowel, described as 'partial small bowel obstruction'.

For every additional recurrence of abdominal adhesion-related problems, the time interval between episodes was reduced (*Table 5*), although statistical analysis failed, probably owing to the small numbers of patients.

+B: Costs

The total number of hospital inpatient days amounted to 2060, with a median (range) of 14 (4–163) days per patient, and 4 (1–10) and 12 (4–21) days for inpatient admissions involving conservative and surgical management respectively. Of the total hospital days, 61 (3.0 per cent) and 155 (7.5 per cent) days were spent in the ICU and intermediary ICU respectively. Patients received total parenteral nutrition for a total of 94 days. Mean anaesthesia and operating times per patient were 200 and 147 min respectively. There was extensive use of diagnostic radiological facilities: 422 examinations were performed (*Table 5*) at a mean cost of €444 per episode. The total inpatient hospital cost was €1 588 593 (*Table 6*), with a cost of €6702 per inpatient episode. Total outpatient costs were €6511, or €180 per outpatient episode.

Forty-nine patients (48.0 per cent) aged 18–65 years were eligible for sick leave. Details of sick-leave days for 42 of these patients were available; five of them did not take any sick leave. A total of 1406 sick-leave days was taken, with a median of 12 (mean 21) days in

hospital and a median of 7 (mean 10.5) days after discharge from hospital. The overall cost for the 1406 sick-leave days was €70 300, based on an average compensation of €50 per day from the National Social Insurance Office[13,14].

The cost for indirect loss of production based on the average wage of €12 per h corresponds to €261 per day according to health care economists[15], giving a total cost for loss of production of €366 782 for the present cohort during the study interval and a total cost overall of €2 032 338 (*Table 6*).

+A: Discussion

Abdominal adhesions are reported to occur in 67–95 per cent of patients after laparotomy[2,16]. Clinically important adhesions, leading to intestinal obstruction, are responsible for 0.9 per cent of all hospital admissions and 3.3 per cent of all laparotomies[3]. In a large retrospective cohort study (SCAR)[9], 5.7 per cent of all readmissions after abdominal surgery were classified as being directly connected to abdominal adhesions; a mean readmission rate of 2.1 per patient was found. For surgery of the lower gastrointestinal tract, the incidence of clinically relevant adhesions is higher[9], and after ileal pouch reconstruction 25 per cent of patients have been reported to suffer from SBO[17].

The present findings support those of previous studies[10,11,18] regarding the demographics of patients operated on for SBO, including the number and types of previous operations. Colorectal surgery, including appendicectomy, results in a higher incidence of abdominal adhesions[8–11,16,19,20]. Colorectal and gynaecological operations would also benefit from the preventive use of antiadhesive agents[21,22], as indicated by the present study which showed that

previous lower gastrointestinal and gynaecological surgery had been performed before 71.6 per cent of operations for SBO.

Results from the present study, although not significant, also support previous studies that showed matted adhesions to be more common after colorectal procedures, to result in more readmissions, and to carry a higher risk of bowel resection[10,11].

Some 47.3 per cent of episodes in the present study resulted in surgical treatment, compared with previously reported rates of 27–60 per cent, with a lower rate (36 per cent) in a more recent study[11]. The high number of episodes treated surgically in the present study could be explained by the fact that operation was an inclusion criterion to establish that the patients truly had adhesions; this was also the case in the study in Norway by Fevang *et al.*[10], in which 83 per cent of readmitted patients were treated surgically.

The high proportion of the present patients, 83 (81.3 per cent), who only had one operation for SBO, compared with the 63 per cent reported by Miller *et al.*[11], could also be explained by the operative inclusion criteria and the use of conservative treatment for SBO, as increasingly adopted in later years[23–25].

The number of episodes per patient in this study (2.7) was higher than that of 2.1 reported in the large SCAR Study[9], and to the authors' knowledge is the highest rate reported in a population with abdominal adhesion-related problems. The different approach of this study, with surgery for adhesions as an inclusion criterion, could explain the difference in comparison with the SCAR Study and others with a similar readmission rate[11]. One explanation for this could be selection bias for patients having operative adhesiolysis. These

patients are known to be more prone to recurrence and reoperation[10]. However, the present study focused on defining every episode of abdominal pain that could be attributed to adhesions, excluding other causes of pain when there was doubt. It is possible that the greater number of episodes in the present study could reflect a greater problem of pain and recurring episodes among patients with adhesion related disorders.

Whether pain is precipitated by adhesions is a debated question[5,26,27]. Even though there is evidence of sensory nerve fibres in adhesions[6], their importance and actual role are uncertain because not all patients with abdominal adhesions experience pain. Laparoscopic adhesiolysis has been reported to result in fewer postoperative adhesions[28] and is favoured by some in selected patients[29], although a blinded randomized study by Swank *et al*.[26] showed that laparoscopic adhesiolysis had no effect on subsequent pain levels.

Matted adhesions have been suggested to give rise to more pain[10], and this has been demonstrated indirectly by a significantly higher rate of readmission for this subgroup in previous studies[10,11].

A major problem when discussing pain and adhesions involves the issue of defining the true incidence of underlying abdominal pain in a 'normal' population, which has been proposed to be 20 per cent[30]. The corresponding rate in a population with abdominal adhesion-related problems has been suggested as 40 per cent[10].

The mean cost of treating the patients in this cohort amounted to €6702 per inpatient episode. The equivalent figure for treating a patient with gastric cancer at the authors' hospital is €7345, including operative costs. Extrapolating from this study to the annual mean of 120

admissions and 15 outpatient visits for patients in Lund (derived from the years 1999–2004), the cost would be € 806 940 for 2004. Including the extrapolated costs for sick leave and loss of production, the total amount would be €1 198 771 annually for the county of Lund with its primary catchment area of 270 000 people.

If the same readmission rates and treatment patterns were extrapolated to the whole of Sweden, with a population of 9 million, this would give an annual cost of about €39.9 million. However, it is always difficult, even within a particular country, to extrapolate costs, recurrence rates, treatment patterns, and so on, because of regional differences in age, sex, access to hospital and social distribution.

Using the database of the National Health Care administration[31], and given the problems of coding through ICD-10, the cost would be even higher. This database, in which all inpatient episodes coded for adhesion-related problem are recorded, contains more episodes than would be expected by extrapolation from the numbers in the present study. The annual cost based on the information in this database would be €59.5 million for Sweden, with a cost per inpatient episode almost equal to that for gastric cancer.

The analyses performed in this study did not include indirect costs for eventual death, possible infertility, community healthcare and rehabilitation, which would result in a substantially higher overall cost for the management and consequences of abdominal adhesions. Costs incurred as a result of subsequent prolonged abdominal operations, owing to technical problems caused by adhesions, were not included either. When this is added to the cost of adhesions, the expenses and resources required, and, not least, the extensive patient

discomfort caused by abdominal adhesions, the need for effective antiadhesive agents is highlighted.

In summary, this study of patients operated on for SBO caused by abdominal adhesions over a median follow-up of 14 years showed a higher rate of recurrent episodes than reported in previous studies, suggesting that adhesion-related problems might be even greater than previously assumed. The retrospective nature of this study calls for modesty in drawing conclusions, but treatment patterns and results were similar to those found in other studies of adhesion-related problems during long-term follow-up[10,11].

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Table 1. Types and frequency of surgery prior to the first SBO operation.

None	14
1	53
2	20
3	13
4	2
Lower gastrointestinal surgery	61
Other gastrointestinal surgery	15
Gynecological surgery	12
No surgery	14

Table 2. Postoperative complications after surgery for adhesions.

Delayed gastrointestinal function	16
Wound infection	7
Pneumonia	5
Urinary tract infection	3
Other respiratory	3
Cardiac	2
Wound dehiscence	2
Intra abdominal abscess	1
Deep vein thrombosis	1

Delayed gastrointestinal function defined as more than 10 days before oral intake.

Table 3. Description of adhesion and operations.

Matted	46
Band	49
Both	7
Adhesiolysis	42
Cutting of band	41
Adhesiolysis and cutting of band	8
Adhesiolysis and bowel resection	3
Cutting of band and bowel resection	8
1	83
2	13
3	4
4 or more	2

Table 4. Time for recurrence after index operation and between recurrences.

Within 30 days	8
< 1 year	15
1-5 years	21
5-10 years	10
> 10 years	34
No previous operation	14
After index operation	13
After first SBO operation	11
After second SBO operation	7
After third SBO operation	4

Table 5. Cost for different radiological examinations.

Plain abdominal films	229	249	57 125
Plain films with contrast	153	344	52 639
Abdominal computed tomography	10	189	1 892
Elective small bowel examination	15	433	6 497
Ultrasound	3	132	396
Colonic double contrast	12	235	2 825

Table 6. Total cost for study group.

Radiological	121 377
Hospital days	817 493
ICU days	70 289
Intermediary ICU days	112 863
Total parental nutrition	21 456
Anaesthesia cost	267 750
Operating cost	177 365
Total inpatient cost	1 588 593
Out patient cost	6 511
Cost for sick leave	70 452
Loss of production	366 782
	2 032 338