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SURGICAL ENDOSCOPY
and Other Interventional Techniques

Abdominal adhesions

Intestinal obstruction, pain, and infertility

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Abstract. Adhesions cause bowel obstruction, chronic abdominal pain, and infertility. In this review, the incidence, clinical signs, diagnostic procedures, and treatment of these sequels of abdominal surgery are discussed. Laparoscopic treatment of bowel obstruction, chronic pain, and infertility is feasible in selected patients and has been reported to cause fewer newly formed adhesions. Randomized controlled trials to compare open and laparoscopic surgery for adhesions should be executed with long-term follow-up to assess the success rates of adhesiolysis and compare the morbidity and mortality.

Key words: Adhesions — Adhesiolysis — Bowel obstruction — Chronic abdominal pain — Infertility — Laparoscopy

Adhesions are abnormal fibrous structures in the abdominal cavity. Surgery is the most common cause of adhesions. Mechanical injury of the peritoneum and peritoneal ischemia due to manipulation and retraction of abdominal tissues during surgery predispose to formation of adhesions [16, 44, 50, 58]. Exposure of the peritoneum to foreign material such as powder, gloves or intraabdominal prosthetic meshes is another source of adhesions [16, 34, 50]. Peritoneal adhesions can also develop in the absence of surgery. Inflammatory diseases of the peritoneum, gut, or ovarian tubes are known to induce adhesions in the abdomen as well, but they rarely cause intestinal obstruction [58, 59]. Adhesions are responsible for the majority of bowel obstructions in the Western world [1, 3, 58]. Chronic abdominal pain and infertility are other manifestations of abdominal adhesions [40, 55, 66].

One-third of the patients who have undergone open general surgery of the abdomen are readmitted to the hospital for causes related to abdominal adhesions [17]. Gynecologic procedures carry a similar risk; more than one-third of women are hospitalized for adhesive disease after gynecologic surgery [48]. The costs of surgery for abdominal adhesions exceed one billion dollars annually in the United States [71, 72]; therefore, adhesive disease is a considerable societal burden [30, 33, 92].

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Adhesiolysis for intestinal obstruction

Adhesions after abdominal surgery account for ≤ 79% of acute intestinal obstructions, depending on the duration of follow-up and the type and number of previous surgeries [1, 4, 10, 11, 16, 53, 64, 94]. Bowel obstruction due to adhesions can occur as early as within 1 month after surgery, but intervals up to 20 years have also been reported [17]. The highest number of reoperations for intestinal obstruction is associated with colorectal surgery [3]. Bowel perforation or opening of the bowel have been suggested to lead to an increased risk of small bowel obstruction due to adhesions [94].

The management of small bowel obstruction caused by adhesions is controversial because surgery can induce new adhesions, whereas conservative treatment does not remove the cause of the obstruction [3]. Conservative treatment involves nasogastric intubation, intravenous fluid administration, and clinical observation. Strangulation of the bowel requires immediate surgery, but intestinal ischemia can be difficult to determine clinically. Tachycardia, fever, focal tenderness, increased white blood cell counts, and elevated lactate levels can indicate intestinal ischemia, but these indicators are not very specific [41]. When intestinal ischemia is unlikely, a conservative approach can be followed for 24–48 h. Meagher et al. have suggested that surgery is unavoidable in patients with small bowel obstruction after previous appendectomy or surgery on the fallopian tubes or ovaries [56].

Table 1. Outcome of adhesiolysis in patients with chronic abdominal pain with no other cause than adhesions

First author (date) [ref.]	*n*	Cured/Improved	Unchanged/worse	No response	Follow-up (mo)	Method
Cnan (1985) [8]	43	28 (65.1%)	14 (32.5%)	1 (2.4%)	minimum, 6	laparoscopy
Francois (1994) [21]	35	28 (80%)	5 (14%)	2 (6%)	22 ± 4	laparoscopy
Freys (1994) [22]	58	46 (80%)	12 (20%)	—	≤ 30	laparoscopy
Hallfeldt (1995) [24]	16	14 (87%)	2 (13%)	—	4–18	laparoscopy
Howard (1994) [28]	11	9 (82%)	—	2 (18%)	Mean 10.7 ± 3.8	laparoscopy
Jung (1986) [35]	27	16 (59%)	11 (41%)	—	?	laparotomy
Klingensmith (1996) [38]	19	14 (75%)	5 (25%)	—	3	laparoscopy
Kolmorgen (1991) [39]	153	58 (38%)	42 (27%)	54 (35%)	12–96	laparoscopy
Lavonius (1999) [42]	24	17 (71%)	5 (21%)	2 (8%)	4–43	laparoscopy
Mecke (1988) [57]	52	23 (44%)	16 (31%)	13 (25%)	6	laparoscopy
Miller (1996) [60]	19	16 (84%)	3 (16%)	—	mean, 18	laparoscopy
Mueller (1995) [61]	45	30 (67%)	6 (13%)	9 (20%)	6–36 (median, 10)	laparoscopy
Nezhat (1996) [62]	48	22 (46%)	24 (50%)	2 (4%)	≤ 60	laparoscopy
Nezhat (2000) [63]	48	67%	33%	—	2–5 yr	laparoscopy
Peters (1992) [67]	24	11 (46%)	13 (54%)	—	9–12	laparotomy
Saravelos (1995) [74]	123	82 (67%)	41 (33%)	—	2–53 (mean, 14)	laparotomy/laparoscopy
Schietroma (2001) [76]	45	34 (75%)	7 (16%)	4 (9%)	12–41 (mean, 18)	laparoscopy
Schmidbauer (2001) [77]	44	37 (84%)	7 (16%)	—	4–18 (mean, 12)	laparoscopy
Steege (199l) [80]	30	19 (63%)	11 (37%)	—	6–12 (mean, 8.2)	laparotomy/laparoscopy
Sutton (1990) [85]	65	53 (82%)	10 (15%)	2 (3%)	1–5 yr	laparoscopy
Tschudi (1993) [89]	23	15 (65%)	4 (17%)	4 (17%)	5–36 (mean, 18.3)	laparoscopy
Wipfli-Funke (1995) [93]	105	63 (60%)	35 (33%)	7 (7%)	6	laparoscopy

Surgical lysis of adhesions that have caused ileus relieves the intestinal obstruction, but the effect can be temporary. Recurrence of adhesive bowel obstruction has been reported at different rates. Barkan et al. [3] observed recurrences in 53% of patients after an initial episode of bowel obstruction, irrespective of conservative or operative treatment. Landercasper et al. [41] recorded recurrences of small bowel obstruction after surgical lysis in 29% vs 53% after conservative treatment. Operative treatment did cause more complications (51% vs 14%), but the mortality rate (4.7% vs 5.3%) was comparable. Therefore, the authors recommended early operative treatment of severe small bowel obstruction, although the importance of other patient-related factors was emphasized.

Adhesiolysis carries a mortality risk of 5% for a simple obstruction and a risk of ≤ 30% for patients with strangulated or necrotic bowels [16, 36, 43]. Small bowel intubation is a therapy that can be performed in addition to adhesiolysis. It involves the temporary insertion of a catheter into the small intestine to prevent renewed kinking of the bowel by the formation of adhesions. Recurrence of obstruction occurs in 4–25% of patients after this procedure, with a mortality rate of 25%. Small bowel intubation is only recommended in case of severe adhesions [37]. One-third of English surgeons use this method occasionally [78].

The extent of adhesiolysis is a matter still under debate. The approaches to adhesiolysis for bowel obstruction among general surgeons in the United Kingdom were established in 1993 [78]. Half of all surgeons divided all adhesions to prevent recurrence of bowel obstruction, whereas the other half limited adhesiolysis to only the adhesions responsible for the obstruction.

The role of laparoscopy in the management of acute bowel obstruction is still unclear. The potential advantages of laparoscopic surgery may include less postoperative adhesion formation, as well as fewer wound infections and less postoperative pain. However, particularly in patients with severely distended bowels and extensive dense adhesions, limited working space is available, rendering the procedure technically difficult. Until now, no comparative studies have been available comparing adhesiolysis via either laparotomy or laparoscopy. Recently, Fischer and Doherty [20] published an overview of 14 reports of laparoscopic adhesiolysis for small bowel obstruction. Laparoscopy was performed in 918 patients with small bowel obstruction. In 71.5% of them, adhesions were the cause of the bowel obstruction. Successful lysis of adhesions was described in 35–87% of patients; the mean conversion rate was 32.2%. Reasons for conversion to laparotomy included failure to identify the obstructing adhesion (41.3%); nonviable intestine, requiring bowel resection (22.6%); iatrogenic perforation during laparoscopy (18%); and other causes, such as patient intolerance of pneumoperitoneum (18.5%). Suter et al. described a series of laparoscopic adhesiolysis in 83 patients with a complication rate of 31% and a reoperation rate of 9%. Mortality in this series was 2.4%. Accidental bowel perforation and the need for conversion were associated with an increased complication rate [84].

Laparoscopic adhesiolysis is associated with a considerable risk of bowel perforation [21, 22, 32, 46, 47, 73]. Bowel perforation can occur during the establishment of pneumoperitoneum or during adhesiolysis itself. Diathermic lesions of the bowel are of particular concern because perforation does not occur immediately. One-third of complications in laparoscopic surgery were reported to occur during establishment of the pneumoperitoneum [9, 25]. The use of an open technique to gain access to the abdomen for a laparoscopic procedure has an undeniable advantage because it reduces visceral injuries and major vascular injuries; it is therefore advocated in laparoscopic surgery [7, 26]. This technique is of great value in laparoscopic adhesiolysis because bowels

that are adherent to the anterior abdominal wall and prone to iatrogenic perforation are common during such procedures.

Bowel perforations during laparoscopic adhesiolysis are not always detected preoperatively. Gastrointestinal injury is recognized during the operation in only 35% of patients. After surgery, the mean delay for the recognition of bowel injury is 4 days in the majority of patients [9]. It is assumed that delayed perforation of bowel is the result of thermal lesions.

Adhesiolysis for chronic abdominal pain

Chronic abdominal pain is another sequela of adhesions. Chronic abdominal pain may present as continuous or colicky pain. Continuous pain is considered to occur when adhesions retract the viscera without obstructing them. Recently, sensory nerve fibers have been found in adhesions, suggesting the possibility of conducting pain after appropriate stimulation [82]. In patients with continuous pain, other causes of abdominal pain, such as gastritis, galbladder stones, diverticulosis, pancreatitis, renal concrements, arteriosclerosis of visceral arteries, parasitic disease, or lactase deficiency, should be ruled out. In patients with colicky pain, obstruction is more likely. Auscultation of the abdomen or plain radiographs of the abdomen at the time of colicky pain can render intestinal obstruction more likely. When obstruction of the gut is suspected, enteroclysis combined with either colonoscopy or barium enema is necessary to exclude inflammatory bowel disease, tumors of the bowel, or volvulus.

Thorough investigations to exclude other pathology are of paramount importance to ensure the proper selection of those patients with chronic abdominal pain who can benefit from adhesiolysis. Laparoscopy is most commonly used to assess and take down adhesions. Once adhesions have been found at surgery, it is difficult to determine which adhesions are liable to cause pain. To address this problem, Leidig and Krakamp performed laparoscopy using local anesthesia, enabling the patient to indicate which adhesions were causing the pain upon stretching [45].

The success rate of adhesiolyis varies from 38% to 87%, while failure occurs in 13% to 54% (Table 1). Interpretation of the outcomes of available studies is difficult since selection of patients, assessment of pain, extent and technique of adhesiolysis, and length of follow-up varied greatly. To prevent adhesions, Ringer's lactate was occasionally left behind in the abdomen [8, 61, 62, 76, 80]. The extent of adhesiolysis was not described clearly in the reviewed studies.

The extent of adhesions did not correlate to the preoperative symptoms [22, 70, 81]. The site of chronic abdominal pain correlated well with the location of adhesions according to Stout et al. [81], but Rapkin et al. [70] failed to find any such correlation. The pathophysiology of chronic abdominal pain is still poorly understood [68]. Supposedly, psychosocial factors play a role in chronic abdominal pain [29]. The success rate of

Table 2. Outcome of patients with infertility who underwent second-look laparoscopy (SLL) after adhesiolysis of adnexa

First author (year) [ref.]	*n*	Adhesiolysis	Measures for adhesion prevention intraabdominally	Postoperative interval for SLL	Recurrence of adhesions	Method of initial surgery	Pregnancy
Barbot (1987) [2]	172	electrosurgery/laser	dextran	8 d	[53 (31%)]	laparotomy	?
Daniel (1983) [12]	10	sharp	Ringer's solution, dextran	28–42 d	100%	laparotomy	3 (30%)
DeCherney (1984) [13]	11	?	dexamethasone, promethazine dextran	1–19 mo	[75–76%]	laparotomy	?
Diamond (1984) [15]	88	laser	dextran	Within 12 wk	100%	laparotomy	?
OLSG (1991) [66]	68	sharp/ laser/ electrosurgery	—	8–86 d (mean, 39 ± 2)	66 (97%)	laparoscopy	?
Raj (1982) [69]	22	?	dexamethasone promethazine dextran, Ringer's solution	1 wk–2 yr	[60% improvement, 35% comparable, 5% worse]	laparotomy	?
Serour (1989) [79]	22	sharp/electrosurgery	Ringer's solution hydrocortisone	9–12 mo	12 (55%)	laparoscopy	?
Surrey (1982) [83]	31	electrosurgery	dextran, heparine, hydrorcortisone	6 wk	22 (71%)	laparotomy	16 (52%)
Trimbos-Kemper (1985) [88]	41	electrosurgery via laparotomy	steroids, dextran	8 d	? (70%)	laparotomy	20 (48%)

adhesiolysis decreases with time [39, 42, 74, 80, 85, 89, 93]. The highest reported recurrence rate was 26% [74], and the longest pain-free interval was 2 years [39]. A longer duration of preoperative symptoms predisposes for a lower success rate [57]. Unfortunately, no validated pain scores were used in most series, and the duration of follow-up was not given in precise terms by most authors. The (re)formation of adhesions are to be expected after adhesiolysis [66], and the severity of adhesions increases with time [90]. This suggests an explanation for the recurrence of pain. The temporary relief of pain might also be explained by the placebo effect [6].

Adhesiolysis for infertility

Postoperative adhesion formation is an important factor in the failure of reconstructive tubal surgery. The aim of reproductive surgery is to restore the normal anatomy of the fallopian tubes so as to allow passage of the ovum. Less traumatic microsurgical techniques, which were introduced in reproductive surgery during the past two decades have reduced adhesions by 30% [65].

If a second-look laparoscopy is to be performed after adhesiolysis, the interval between these operations is uncertain. Some gynecologists advocate an early second look after 1 week to prevent the transformation of fibrinous attachments into permanent adhesions [2, 12, 54, 83, 86, 88]. Others postpone second-look laparoscopy for 3–12 months because if pregnancy occurs during this time, secondary surgery is obviously unnecessary to establish the presence of adhesions and to perform lysis [79].

Second look after 1 week showed recurrence of adhesions in 31–70% of patients; late second look revealed adhesions in 55–100% of patients. Pregnancy rates, which were reported in only three studies, varied from 30% to 52% (Table 2).

Surgical technique

Reduction of surgical trauma decreases the formation of adhesions, as was shown in tubal surgery. Hence, laparoscopy is likely to induce fewer adhesions than conventional laparotomy [21, 22, 27]. In experimental studies, laparoscopy caused fewer adhesions than laparotomy [19, 23, 31, 49, 75, 87]. Lundorff et al. also observed fewer adhesions after laparoscopic tubal surgery than after open surgery [51]. DeWilde [14] performed a second-look laparoscopy 3 months after either open or laparoscopic surgery for acute appendicitis; 80% of the patients who underwent open appendectomy had abdominal adhesions, whereas after laparoscopic appendectomy, adhesions were found in only 20% of patients.

Adhesiolysis can be performed employing various techniques. In two nonrandomized studies in patients undergoing periadnexal adhesiolysis, the success rates of CO_2 laser surgery and electrosurgery did not differ at second-look laparoscopy. In an animal study, Luciano et al. [49] found no differences in the effectiveness of Nd:YAG laser, CO_2 laser, and electrosurgery, although they concluded that Nd:YAG laser surgery was slower and caused more tissue damage.

The role of adjuvants in preventing postoperative adhesion formation has been demonstrated in various clinical experiments. Hyaluronic acid–based materials reduced adhesions after intestinal and gynecologic surgery [5, 52, 91]. Mechanical barriers are considered effective in surgery for subfertility. In a clinical study [18], adjuvants such as dexamethasone, Ringer's lactate, and dextran never proved effective.

Conclusion

The best treatment of adhesions is their prevention. Laparoscopic surgery appears to induce fewer adhesions than open surgery. To confirm this, patients who have been enrolled in randomized trials comparing open and laparoscopic surgery should be followed closely over a longer period of time to assess for the late morbidity of adhesions in both groups. The value of antiadhesive agents requires further study before their routine use can be advocated.

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