Adhesions are the major cause of complications in operative gynecology

Anja Herrmann, Research Assistant *, Rudy Leon De Wilde, Professor

Clinic of Gynecology, Obstetrics and Gynecological Oncology, University Hospital for Gynecology, Pius-Hospital Oldenburg, Medical Campus, University of Oldenburg, Germany

Keywords:
adhesions
complications
laparoscopy
bowel injury
vascular injury
ureteral injury

Adhesion formation has been found to be highly prevalent in patients with a history of operations or inflammatory peritoneal processes. These patients are at a high risk of serious intraoperative complications during a subsequent operation if adhesiolysis is performed. These complications include bowel perforation, ureteral or bladder injury, and vascular injury. In order to minimize the risk of these complications, adhesiolysis should only be performed by experienced surgeons, and intraoperative strategies must be adopted. The reduction of the overall incidence of adhesions is essential for subsequent surgical treatments. Anti-adhesion strategies must be adopted for preventing the reoccurrence of adhesions after abdominopelvic operations. The strategies employed to reduce the risk and the overall incidence of adhesions have been elucidated in this article.

Introduction

In abdominopelvic surgery, the term ‘adhesions’ refers to the connective tissue strands between anatomic structures that are normally not attached to each other. The extent of adhesions can vary from single adhesions with less or no clinical symptoms to adhesions of the whole abdomen and/or pelvis that especially develop after extended previous operations or infections and can be the cause of a variety of intra- and postoperative complications.

* Corresponding author. Clinic of Gynecology, Obstetrics and Gynecological Oncology, University Hospital for Gynecology, Pius-Hospital Oldenburg, Medical Campus, University of Oldenburg, Germany. Tel.: +49 4412291501; Fax: +49 4412291525.
E-mail address: gyn-sekretariat@pius-hospital.de (A. Herrmann).
Many studies have revealed important insights into the pathogenesis of adhesions, although the diverse influences on adhesion development are still not fully understood. It is well known that the basis of adhesion development is an imbalance between fibrin deposition and fibrinolysis. Fibrin is deposited at a surgical site in a normal response to a surgical trauma. However, factors such as tissue hypoxia or an increased inflammatory reaction contribute to a cytokine environment that hinders the lysis of the deposited fibrin through an interaction between the cytokines and the components of the fibrinolytic system. As a consequence, the fibrin clot is not degraded after a few days (as usual). The following invasion of fibroblasts and other cells causes a reorganization of the clot to a stable strand of connective tissue that may contain vessels and nerves [1–3].

Because of the complex influences on adhesion development, it can neither be predicted with a sufficient degree of certainty which patients develop adhesions after an operation nor in which patients adhesions are present before an operation. Data about the incidence of adhesions considerably differ depending on the regarded study which makes a general statement about the improbability of the incidence. However, in most of the studies, the incidence varies between 20% and 93% [4–8]. These significant variations may be explained by diverse operation and entry techniques as well as by different underlying diseases. The presence of adhesions is more probable in patients with a history of laparotomy or extended operation. However, patients are likely to develop adhesions after laparoscopic surgery, as the latter can reduce the risk of adhesion development but cannot prevent it completely [5]. Furthermore, it is known that some operations such as myomectomy, endometriosis surgery, ovarian and tubal surgery as well as adhesiolysis are high-risk procedures concerning adhesion development and reformation of adhesions irrespective of whether they are performed laparoscopically or by laparotomy [9] (REF34, cave search for original REF!). Even a 20% incidence of adhesion development, and therefore the presence of adhesions in one-fifth of the patients, is alarming and should be the reason for every surgeon to be familiar with strategies to avoid complications during an operation in patients with existing adhesions and also to avoid adhesion in general.

Intraoperative complications through adhesions and approaches to avoid them

In daily routine, every abdominopelvic surgeon is confronted with patients who have adhesions, wherein these can be the cause of the patients’ discomfort, for example, in the case of chronic pelvic pain [10–12], infertility [13–16], or bowel obstruction [17], or are found coincidentally while performing an operation for another underlying disease. In both situations, an adhesiolysis must be performed, in the first case to solve the clinical problem and in the second to restore the normal anatomy to make the operation of the underlying disease successful. Adhesiolysis, however, is associated with a high risk of intraoperative complications such as inadvertent bowel, bladder, ureter, and vessel injury. But before performing adhesiolysis, the first critical step, that is, access to the abdominal cavity, carries a significant risk of organ injury due to adhesions. Particularly in the case of laparotomies by a longitudinal incision in the anamnesis, the presence of adhesions in the area of the previous incision in the abdominal wall must be considered (Fig. 1). In a minimally invasive surgery, such as laparoscopy, the presence of umbilical adhesions is of special interest as the insertion of the trocar can lead to organ injury, especially injury of the bowel, due to the adhesions that attach the organs to the abdominal wall (Fig. 2). In a study of 814 patients, umbilical adhesions were found in 0.68% of patients with no previous abdominal surgery (group 1; n = 469), 1.6% with prior laparoscopic surgery (group 2; n = 125), 19.8% with previous laparotomy with a horizontal suprapubic incision (group 3; n = 131) and 51.7% with a previous laparotomy with a midline incision. Although the presence of severe adhesions in the bowel was much less compared with the overall incidence of umbilical adhesions in the single groups, a high number of patients with previous laparotomy were at a potential risk of bowel injury if the umbilical trocar was inserted blindly (group 1: 0.42%, group 2: 0.80%, group 3: 6.87%, and group 4: 31.46%) [18]. Another study investigated the presence of umbilical adhesions in patients with a history of laparoscopy through an umbilical incision. Patients with a history of other surgeries were excluded. Of the 151 patients studied, 32 (21.2%) had umbilical adhesions and 4 (2.6%) bowel adhesions. As a
consequence, in patients with a history of laparoscopy or laparotomy, an alternative access to the abdominal cavity such as the Palmer’s point (3 cm below the left costal margin in the mid-clavicular line; Fig. 3) should be considered to minimize the risk of inadvertent organ perforation during trocar entry. The occurrence of adhesions at the Palmer’s point after previous operations is unlikely because most abdominopelvic operations are conducted farther from this anatomical region. A first impression of the extent of adhesions in the abdomen can be obtained safely from the Palmer’s point and a decision on how to further operate can be taken. If adhesions are present, a structured approach is recommended. As adhesiolysis is a highly demanding procedure with a high risk of complications, only surgeons with sufficient skill and expertise should perform it. Furthermore, not every possible adhesiolysis should be conducted. Adhesions that do not cause pain, infertility, or future bowel obstructions should only be lysed if they hinder the progress of the operation. However, in many operations, adhesiolysis is inevitable to obtain access to the pelvis as well as to restore normal anatomy to facilitate further operation steps. In such situations, a careful lysis of abdominal wall adhesions should be done firstly for better visibility of the lesser pelvis. The pre-operative preparation along the sidewalls of the lesser pelvis enables orientation of extensive adhesions. The adnexa can often be localized in this way and serves as a further orientation point. The
first step of preparation near the uterus includes the lysis of adhesions between the uterus and the bowel to mobilize the bowel out of the operation field, thereby minimizing the risk of bowel injury during further preparation steps. The ovaries are localized by further dissecting along the fallopian tubes. In general, adhesions formed between the visceral and the parietal peritoneum can be lysed more easily along the avascular plane, thus ensuring minimal bleeding. The application of traction and countertraction forces sets the tissue under tension and allows easier identification of the avascular plane. Adhesiolysis can be performed by both sharp and blunt dissection techniques in a single operation. Sharp dissection is preferred for dense adhesions as blunt lyses may lead to peritoneal tear and defect. Following sharp adhesiolysis of dense adhesions, the remaining adhesions are lysed by the blunt technique. Aquadissection is an alternative method for blunt adhesiolysis. However, it should be applied carefully as the correct anatomical layers become blurred, making preparation in the correct layer more difficult. Another critical aspect of adhesiolysis is the use of electrocoagulation. Nevertheless, extensive coagulation leads to tissue contraction which, like aquadissection, does not permit precise preparation of the correct layer. Furthermore, the spread of the applied current suggests an increased risk of injury to the surrounding structures. The magnifying effects of the laparoscope enable accurate identification of the adhesion blood vessels and also selective coagulation before lysis. This ensures minimal bleeding during operation which, in turn, reduces the total use of electrocoagulation. However, in the case of adhesions in the omentum majus electrocoagulation is often employed for preoperative preparation, because care must be taken to ensure adequate hemostasis immediately due to increased blood circulation in the omentum majus. In case of inadequate hemostasis, it can be difficult to identify rebleeding in the adipose tissue. In any event, the visualization of the bowel and/or, where necessary, the ureter is of utmost importance.
Adhesiolysis and the associated risk in detail

Bowel perforation

During adhesiolysis, the risk of bowel injury (enterotomy) is particularly high due to the presence of adhesion-associated bowel obstructions. Furthermore, the bowel can be located outside its natural anatomical position due to the adhesions and thus may unexpectedly appear in the operation field. The presence of dense adhesions between the bowel and the abdominal wall does not facilitate lysis, thereby increasing the risk of injury during adhesiolysis. In addition to the direct injury of the intestine during sharp adhesiolysis, coagulation of blood or anatomical structures prior to sharp dissection can cause thermal damage to the intestine (Figs. 4a, b, and 5). The incidence of bowel injury during adhesiolysis varies from 3% to 24% [19–23]. A meta-analysis conducted to estimate the disease burden of the most important complications of postoperative abdominal adhesions identified 16 studies (2565 procedures) in which the need for adhesiolysis was confirmed. The overall incidence of enterotomy was 5.8% (95% confidence interval: 3.7–7.9%). It seemed to depend on the type of surgery and was found to be highest in lower gastrointestinal tract surgery (8.7%, 3.8–3.6%), followed by gynecological surgery (4.8%, 0.6–9.1%). It was significantly lower in 30 laparoscopic cohorts (1.8%, 1.2–2.4%) than in eight open cohorts (8.9%, 4.2–13.6%). A similar pattern was observed in two studies that compared laparoscopic and open surgery (odds ratio: 0.21, 0.05–0.90) [24]. Another study identified four predictors of adhesiolysis-related bowel injury, namely the number of previous laparotomies, anatomical site of the operation (highest risk in the lower gastrointestinal tract followed by the abdominal wall), the presence of bowel fistula and laparotomy via a preexisting median scar [21]. It is essential to develop a strategy to minimize the risk and incidence of inadvertent bowel injury. The bowel should be held at a sufficient distance from the surgical field for the prevention of injury. This is done using an atraumatic bowel grasper. In case of extensive adhesions, the correct preparation layer between the visceral and parietal peritoneum can be identified through careful traction and countertraction. The taut adhesions are then snipped on the side facing away from the bowel. Vascular adhesions should be coagulated before dissection. A bowel injury through an incision is at best detected immediately
through visualization of the exposed muscle layer or release of intestinal fluid, so that suturing of the defect can be performed. Thermal damage to the bowel is often detected only after a few days, because the opening of the damaged intestinal part occurs after a latency period of hours to a few days. If adhesions are expected to develop preoperatively and an adhesiolysis is planned, it is advisable to prepare the bowel through laxative measures, since this reduces the germ load which, in turn, minimizes the risk of infection in case of an injury. During the postoperative period, care must be taken on the appearance of signs of peritonitis and the course of inflammatory parameters in order to detect any perforation with subsequent peritonitis as early as possible. In this case, an immediate reoperation is necessary. Peritonitis poses a serious threat to the patients, and hence the risk of its occurrence must be reduced. Therefore, lysis of intestinal adhesions should always be performed with care and only by an experienced surgeon.

**Ureteral injury**

The overall incidence of ureteral injuries is low, for example, 0.16% (12/10,345 laparoscopic gynecologic surgeries) [25] or 0.34% (4/1163 classic intrafascial supracervical hysterectomy procedures) [26], but can also be up to 2.7% in patients after a previous laparotomy (4/146) [23]. Most of the injuries were detected immediately and could be repaired laparoscopically. However, although rare, ureteral injury can lead to serious consequences in the affected patient. For example, in a case reported, ureteral injury was not detected postoperatively resulting in a laparoscopic nephrectomy caused by a nonfunctioning kidney 3 years after the initial operation [26]. In all studies, adhesions were considered as a predisposing factor for ureteral injuries [23,25,26]. In order to reduce the incidence of ureteral damage, the possibility of injury to the ureter during adhesiolysis should always be considered, and appropriate precautionary measures should be taken. In the case of extensive adhesions of the pelvis that also includes the pelvic wall, particular attention must be paid to the location of the ureter during adhesiolysis. The positioning of the ureter in or near the surgical area is associated with an increased risk of intraoperative injury, which includes both direct injury during sharp adhesiolysis and thermal damage during electrocoagulation. While direct sharp dissection injuries can often be noticed immediately after the operation, the more frequent thermal damages are often clinically apparent only after a latency period of days to weeks by urine leakage or stricture of the damaged ureter with subsequent urinary obstruction. Therefore, to minimize the risk of injury in the presence of extensive pelvic wall adhesions, the ureter should be clearly visible during the course of the operation or should be dissected along the pelvic side.

![Fig. 5. Bowel attached to the uterus. The attachment must be lysed prior to coagulation or further operation steps to minimize the risk of bowel injury. B: bowel [45].](image-url)
wall before adhesiolysis. The first surgical incision should be in a healthy tissue and not in the zone of the existing adhesions. The intersection of the ureter and the common iliac arteries at the level of the infundibulopelvic ligament is considered to be the first point of incision for the surgical preparation of the ureter. Localization of this point is often possible because adhesions are usually located deeper in the pelvis. The ureter is dissected over a long distance starting from the point of intersection and laterally along the infundibulopelvic ligament (Fig. 6). This enables direct visualization of the ureter and thus minimizes the risk of unintentional injuries during subsequent adhesiolysis. However, regardless of whether the ureter was visualized during the operation, the integrity of the ureter is confirmed by performing cystoscopy along the course of the ureter after every extensive adhesiolysis. At cystoscopy, both orifices of the ureters should be examined and the secretion of clear urine should be noted. If the ureters do not secrete urine or if the urine contains blood, it must be assumed that they were injured during operation. In this case, the surgeon must carefully insert a double J ureteral stent under laparoscopic vision. If this is successful, there is probably only a minimal defect of the ureter, which may heal within 6 weeks whereby the ureteral stent remains in the ureter during this time. After this period, the urethral stent is removed after previous radiological control. If it is not possible to insert a ureteral stent in the damaged ureter, it must be assumed that the damage to the ureter is severe. This defect must be repaired in the same session.

Vascular injuries

The injury of venous and arterial vessels also represents a possible complication of adhesiolysis. To the best of our knowledge, there is no report in the literature about the incidence of vascular injury during adhesiolysis. The injury of smaller vessels can be prevented by dissection along the avascular plane. Visible, not “necessary” vessels and anatomical structures in which blood vessels are expected should be directly coagulated to avoid uncontrolled bleeding. While arterial bleeding can be detected even during laparoscopy, it is difficult to detect venous bleeding when the pressure generated by the laparoscopic pneumoperitoneum exceeds the venous pressure. The veins collapse when the patient is in the Trendelenburg position, so that there is often no visible bleeding after venous vessel injury during laparoscopy. Therefore, if a vessel injury is suspected or if an extensive adhesiolysis with the potential risk of vessel injury is performed, the patient should be placed in a horizontal position and the laparoscopic pressure should be reduced to <10 mmHg by discharging the gas. Subsequently, a detailed inspection of the entire abdominal cavity should be performed to

Please cite this article in press as: Herrmann A, De Wilde RL, Adhesions are the major cause of complications in operative gynecology, Best Practice Research Clinical Obstetrics and Gynaecology (2015), http://dx.doi.org/10.1016/j.bpobgyn.2015.10.010

Fig. 6. Ureter visualization by dissection of the lateral peritoneum prior to adhesiolysis [46].
detect possible bleeding, which can then be sutured laparoscopically by an expert surgeon. If an injury cannot be excluded with certainty, drainage without suction enables early detection of postoperative bleeding.

Costs

A study explicitly examined the inpatient burden of adhesiolysis in the United States (i.e., number and rate of events, cost, and length of stay [LOS]). Hospital discharge data for patients with primary and secondary adhesiolysis were analyzed using the 2005 Healthcare Cost and Utilization Project’s Nationwide Inpatient Sample. They could identify 351,777 adhesiolysis-related hospitalizations: 23.2% for primary and 76.8% for secondary adhesiolysis. The average LOS was 7.8 days for primary adhesiolysis. They found that 967,332 days of care were attributed to adhesiolysis-related procedures, with inpatient expenditures totaling $2.3 billion ($1.4 billion for primary adhesiolysis and $926 million for secondary adhesiolysis). Hospitalizations for adhesiolysis increased steadily by age and were higher for women. Of secondary adhesiolysis procedures, 46.3% involved the female reproductive tract, resulting in 57,005 additional days of care and $220 million in attributable costs. They concluded that adhesiolysis remains an important surgical complication in the United States and that hospitalization for this condition leads to high direct surgical costs, which should be of interest to providers and payers [27].

Approaches to prevent adhesions

As described earlier, adhesions can have serious consequences if they are present during an operation and must be lysed in order to conduct the planned operation. The majority of adhesions develop as a consequence of surgery. Hence, the prevention of adhesion formation during the course of the operation is of utmost importance to reduce the incidence of adhesions in general and thereby the probability of complications during future operations. There are several approaches to adhesion prevention based on our current understanding of adhesion development whereby a combination of different approaches seems to have synergistic effects.

Operation techniques

At present, it is not possible to predict which patient may develop adhesions. Therefore, surgeons should adopt adhesion reduction strategies to be implemented in every operation [28]. The surgeons can follow the recommendations provided by the Expert Adhesions Working Party of the European Society of Gynaecological Endoscopy (ESGE) to check whether any improvement is

---

**Table 1**
Steps for reduction of adhesions [9].

- Carefully handle tissue with field enhancement (magnification) techniques
- Focus on planned surgery and, if any secondary pathology is identified, question the risk benefit of surgical treatment before proceeding
- Perform diligent hemostasis but ensure diligent use of cautery
- Reduce cautery time and frequency and aspirate aerosolized tissue following cautery
- Excise tissue, reduce fulguration
- Reduce duration of surgery
- Reduce pressure and duration of pneumoperitoneum in laparoscopic surgery
- Reduce risk of infection
- Reduce drying of tissues (limit heat and light)
- Use frequent irrigation and aspiration in laparoscopic and laparotomic surgery
- Limit use of sutures and choose fine non-reactive sutures
- Avoid foreign bodies such as materials with loose fibers
- Minimal use of dry towels or sponges in laparotomy
- Use starch- and latex-free gloves in laparotomy

---

Please cite this article in press as: Herrmann A, De Wilde RL, Adhesions are the major cause of complications in operative gynecology, Best Practice & Research Clinical Obstetrics and Gynaecology (2015), http://dx.doi.org/10.1016/j.bpobgyn.2015.10.010
necessary (Table 1). Careful tissue handling and a more restrained use of electrocoagulation are indispensable. Manipulation of the peritoneum should be done only if required, as peritoneal cells are extremely sensitive to the slightest trauma. Furthermore, the frequent surgical humidification of the peritoneum, reduction of heat and light, and avoidance of use of (dry) towels during laparotomy are prerequisites for reducing the level of desiccation and abrasion and thus the damage caused to the peritoneal cells. Prevention of foreign bodies is another significant aspect. Foreign bodies can lead to a chronic inflammatory reaction that promotes adhesion formation. In order to avoid foreign body reactions, fine nonreactive sutures should be used and, where possible, the use of materials with loose fibers and particles should be avoided [9]. Compared to laparotomy, laparoscopy is a minimally invasive procedure with the ability to reduce peritoneal trauma and thereby adhesion formation. However, formation of adhesions cannot be prevented completely [5]. The increased intra-abdominal pressure during laparoscopy leads to a compression of blood vessels that supply the peritoneal cells, which may lead to hypoxia [29]. The use of non-humidified gas can also lead to cell damage by desiccation of the peritoneal cells [30]. Reduction of pressure and the duration of pneumoperitoneum, as well as a frequent irrigation of the peritoneal cells are therefore recommended to reduce the additional adverse effects caused by laparoscopy. Regardless of whether the surgery is performed by laparotomy or laparoscopy technique, adhesions may form despite careful attention and adherence to the abovementioned recommendations. Therefore, the application of an adhesion barrier should be considered as a complementary adhesion reduction strategy.

Adhesion barriers

There are a variety of adhesion barriers or anti-adhesion agents, and it is extremely difficult to make a decision on the appropriate one to be applied. Some surgical procedures, such as myomectomy, treatment of endometriosis, ovarian and tubal surgery, or adhesiolysis, are high-risk operations with regard to the formation and reformation of adhesions [9,31]. Therefore, the use of an adhesion barrier can be highly recommended in such operations. However, it is not possible to predict which patient would develop adhesions due to the beneficial effects of using such barriers. The general use of adhesion barriers is currently hindered by the insufficient and contradictory data regarding the efficiency of some products. Moreover, these are not generally reimbursed by health insurance. The uncertainty about the effectiveness of the agents may affect their use in the daily routine. Currently, no pharmacological agents have been approved for adhesion prevention. The effect of the currently available products is based on mechanical separation of the injured tissue during the healing period [32]. While some of these products have been available in the market for several years and their effectiveness has been demonstrated in larger studies, the efficiency of other products are often based on data obtained from a few smaller studies, which further complicated the decision for the use of an adhesion barrier. Although the products cannot prevent the formation of adhesions completely, the rate of incidence of adhesions may be reduced. In a large study (n = 546), the effectiveness of an adhesion barrier after laparoscopy and myomectomy via laparotomy was investigated. The use of the product reduced the formation of adhesions after both surgical techniques. The rate of incidence of adhesions was in the following order: abdominal myomectomy without adhesion barrier (28.1%, n = 154), laparoscopic myomectomy without adhesion barrier (22.6%, n = 155), abdominal myomectomy with adhesion barrier (22%, n = 154), and laparoscopic myomectomy with adhesion barrier (15.9%, n = 157) [5]. Another randomized double-blind study investigated the occurrence of de novo adhesions after instillation of Ringer’s lactate solution compared with the instillation of an anti-adhesion agent. In the control group (Ringer’s lactate solution, n = 199), 57% of the patients developed de novo adhesions compared to 47% in the treatment group (n = 203) [33]. Several meta-analysis studies have conducted in this regard [34–36]. Further research is required on the development of new anti-adhesion products for reducing the rate of the incidence of adhesions. In addition, large-scale studies have to be conducted in order to evaluate the effectiveness of the existing products and to facilitate the selection of the appropriate antiadhesion products.
Full conditioning

In 2013, a research group reported about a translational study that aimed to investigate the transferability of the results of years of intensive research in adhesion formation and prevention from animal experiments to the human. Over the last decades, the investigators detected several factors that enhance and reduce adhesion formation. Moreover, they found that a combination of some of the reduction strategies has a synergistic effect on adhesion reduction leading to the concept of full conditioning (FC) of the peritoneal cavity. FC refers to the use of a combination of several factors that have the potential to reduce adhesion formation, including 86% CO₂ + 10% N₂O + 4% O₂ for the pneumoperitoneum, humidification, cooling of the peritoneal cavity to 30°C by sprinkling 2–3 ml/min of Ringer’s lactate with 1000 IU of Heparin/L at room temperature, heparinized rinsing solution, and 5 mg of dexamethasone.

In animal studies, FC was found to reduce adhesion formation by 85%. When an additional barrier was given, adhesions were reduced by >95% [37]. It is well known from many studies, which investigate a single adhesion reduction strategy in humans, that all strategies can only reduce the occurrence of adhesions but cannot prevent it completely. Therefore, it was a logical step to test the concept of FC in humans. Hence, a randomized controlled trial was performed comparing standard laparoscopy with FC along with an adhesion barrier (Hyalobarrier®, Nordic Pharma) in a 2/3 ratio in 44 women undergoing deep endometriosis surgery. The primary aim was the reduction of adhesions assessed by a second-look laparoscopy. The secondary aims were CO₂ resorption, postoperative pain, and recovery. In the FC group (n = 16), complete prevention of adhesion formation was achieved in 12/16 women, whereas in the control group (n = 11) all women had severe adhesions (P < 0.0005). Besides, the area, density, and severity of adhesions were less (P < 0.001). In the control group, severity, density, and area of adhesions were strongly interrelated (P = 0.0001 for all areas) suggesting a common enhancing factor. In the FC group, CO₂ resorption (P < 0.001), postoperative pain (P < 0.001), and C-reactive protein (CRP) concentrations (P < 0.01) were lower, while clinical recovery was faster (P < 0.0001) and the time to first flatus (P < 0.002) shorter. Therefore, this translational research confirms the efficacy of FC in reducing CO₂ resorption and adhesions in humans. Furthermore, patients in the FC group experienced less postoperative pain and had lower postoperative CRP concentrations and an accelerated recovery [37]. However, one critic on the study is suggests N₂O as a gas component of the pneumoperitoneum. Mynbaev et al. state that there is evidence that N₂O has metabolic, procoagulant, and DNA-damaging properties and that a spectrum of beneficial and undesirable effects of N₂O being insufflated intraperitoneally under pressure have not yet been fully appreciated. However, the clinical relevance of the unfavorable side effects of N₂O remains undetermined [38] so that more research is needed to prove the safety of N₂O as a gas component in laparoscopic surgery in humans.

Reformation of adhesions

The probability of reformation of adhesions at the same site is high in the majority of patients. Various studies demonstrate reformation rates of 55–100% [11,39,40]. However, the extent and severity of adhesions can be reduced after adhesiolysis. In a study of 38 patients, the extent and severity of adhesions were reduced by 23.3% and 26.3%, respectively. According to the classification system of the American Fertility Society, the extent of adhesions is defined by the proportion of organs involved (<1/3, 1/3–2/3, > 2/3), and the severity by the consistency of adhesions (filmy avascular adhesions or dense organized cohesive vascular adhesions) [41]. Another study also showed a significant reduction in the extent and severity of adhesions after adhesiolysis [40]. However, this may not be the case in all patients and the growth of adhesions may also worsen [39]. Hence, adhesiolysis is recommended only for therapeutic reasons or as a prerequisite for safe surgery. Besides the reformation of adhesions after adhesiolysis, the occurrence of de novo adhesions is also significant. The term “de novo adhesions” refers to the formation of adhesions at sites that were not previously affected by adhesions. In the aforementioned studies, de novo adhesions after laparoscopic adhesiolysis formed in five of 24 [40] and in 22 of 38 patients [41]. Given the high reformation rate and the possibility of the formation of de novo adhesions, the need for the prevention of adhesions is highlighted again.

Please cite this article in press as: Herrmann A, De Wilde RL. Adhesions are the major cause of complications in operative gynecology. Best Practice & Research Clinical Obstetrics and Gynaecology (2015), http://dx.doi.org/10.1016/j.bpobgyn.2015.10.010
Conclusion

On the basis of the abovementioned facts, it can be concluded that the adhesions are the major cause of complications in gynaecological surgery. Infertility [13–16], chronic pelvic pain [10–12], or bowel obstruction [17] are well known and often discussed complications of adhesions. It is evident that the majority of bowel obstructions are clearly associated with adhesions. However, whether adhesions cause infertility or chronic pelvic pain is still a matter of debate. Besides, the current literature lacks adequate information on the need for adhesiolysis in subsequent operations and the associated complications. Adhesions are often identified in surgical patients with history of operations or peritoneal inflammatory processes, and the surgeons recommend adhesiolysis in such cases. The affected patients are at high risk of serious intraoperative complications such as bowel perforation, ureteral or bladder injury, and vascular injuries. Therefore, adhesiolysis is a challenging procedure and should only be performed by an experienced surgeon. Moreover, surgeons should adopt strategies to minimize the risk of complications during every adhesiolysis. The surgeons must adopt anti-adhesion strategies to reduce the incidence of adhesions. This not only includes intraoperative guidelines to be followed but also the use of an adhesion barrier where appropriate. The concept of FC of the peritoneal cavity as described earlier is a promising approach to reduce the incidence of adhesions and may be a further step to minimize the burden of adhesions for the patients and the health-care system. At present, however, it is likely that adhesions remain to be a major contributing factor to patients’ morbidity. Therefore, adhesions and the related consequences should always be discussed with patients preoperatively. Surveys investigating the awareness of adhesions among physicians and patients clearly showed that even well-informed physicians fail to educate their patients adequately. This could potentially lead to successful filing of medical malpractice lawsuits against the physicians [42–44].

Practice points

- Adhesiolysis is associated with serious complications such as bowel perforation, ureteral or bladder injury, and vascular injuries.
- In order to minimize the risk of inadvertent bowel perforation, the Palmer’s point should be considered as the point of access to the abdominal cavity in patients with a history of laparotomy.
- Visualization of potentially endangered anatomical structures during adhesiolysis is necessary in order to minimize the risk of injury.
- In order to minimize the risk of inadvertent thermal damage during coagulation, endangered structures should be positioned far away from the coagulation site.
- Adhesiolysis is a demanding procedure and should only be performed by experienced surgeons.
- Surgeons should adopt anti-adhesion strategies during every abdominopelvic surgery.

Research agenda

- Incidence of vascular injuries during adhesiolysis.
- Burden of adhesiolysis for patients and the health-care system.
- Concept of FC for prevention of adhesions.
Conflict of interest

The authors have no conflict of interest to declare.

References


Please cite this article in press as: Herrmann A, De Wilde RL, Adhesions are the major cause of complications in operative gynecology, Best Practice & Research Clinical Obstetrics and Gynaecology (2015), http://dx.doi.org/10.1016/j.bpobgyn.2015.10.010


Hirschelmann A, De Wilde RL. Operative Strategien bei Adhäsionen. Frauenheilkunde up2date 2012;221–36.