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Review Article

Postoperative Intraabdominal Adhesions and Female Infertility

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Abstract

Postoperative adhesions are a common result of tissue trauma during abdominal or pelvic surgery, occurring in up to 97% of open gynaecologic procedures. They can lead to significant complications, such as small bowel obstruction and chronic pelvic pain, potentially contributing to 40% of female infertility cases. Laparoscopy is the gold standard for diagnosing adhesions due to its direct visualization capabilities. Preventive strategies emphasize microsurgical principles and minimally invasive techniques, which are linked to reduced adhesion risk. Current evidence does not support the efficacy of anti-inflammatory medications or routine use of anti-adhesion solutions like icodextrin. While anti-adhesion barriers may help, they cannot replace good surgical technique. Surgical intervention to address adhesions remains controversial, with inconsistent evidence regarding pain and infertility outcomes.

Keywords: Intraabdominal; Fertility

Introduction

Intraabdominal or peritoneal adhesions are fibrous bands that form connections between tissues and organs, often due to inflammation from infection or surgery. They significantly impact the reproductive tract, potentially causing subfertility through tubal blockage or ovarian encapsulation. Adhesions are common post-abdominal operations, with incidence rates ranging from 67% to 93% after general surgeries and up to 97% after open gynaecologic procedures. They contribute to approximately 5.7% of readmissions among patients who have undergone open abdominal or pelvic surgery.

Pathogenesis and causes

Adhesions arise from tissue injury due to sharp, mechanical, or thermal damage; infectious processes; radiation exposure; ischemia; drying; abrasion; or reactions to foreign materials [3]. This trauma triggers a sequence of events, starting with the disruption of stromal mast cells, which release vasoactive mediators such as histamine and kinins that enhance vascular permeability. Tissue hypoxia generates oxidative stress, and free radicals amplify the inflammatory cascade, leading to tissue injury. Fibrinous deposits develop, containing exudates from cells, leukocytes, and macrophages [4]. Healing involves a combination of fibrotic remodelling and regeneration of the mesothelium. Unlike cutaneous wounds that heal from the edges inward, repair of peritoneal defects progresses from the underlying mesenchyme. Both large and small peritoneal injuries tend to heal relatively rapidly [4]. Fibrin-rich exudates appear within approximately three hours post-injury, with most resolving by fibrinolysis within 72 hours. If peritoneal fibrinolysis is locally suppressed due to trauma, early fibrinous adhesions can form, leading to fibroblast invasion and neovascularization, which ultimately results in permanent adhesions, sometimes involving vascular structures.

Several factors impact adhesion development [5]: the complexity of the surgical procedure; the extent of peritoneal trauma; the patient's comorbid conditions such as malnutrition or diabetes; excessive suturing tension causing local ischemia and disrupting lymphatic drainage; and contact with foreign bodies like talc, glove powders, or disposable material fibers—all of which can provoke adhesion formation.

Abdominal surgery as a risk factor for adhesion formation

Postsurgical adhesions commonly develop from incisions, coagulation, suturing, and other tissue-damaging events where injured surfaces fuse and produce scar tissue. Abdominal adhesions may arise from any surgical procedure or inflammatory insult, including trauma. Surgery, particularly open surgery, is a widely recognized cause of adhesions [5]. This includes standard operations like appendectomy, cholecystectomy, gastrectomy, hysterectomy, and various abdominal vascular procedures [1]. Additionally, gynaecologic and obstetric interventions—such as myomectomy, tuboplasty, salpingectomy, oophorectomy, and caesarean section—are specifically linked to the formation of intraabdominal and pelvic adhesions [6].

Myomectomy: Across surgical approaches, myomectomy frequently leads to adhesions. The incidence after open abdominal myomectomy exceeds 90%, while adhesions occur in at least 70% of cases with laparoscopic myomectomy [7]. Laparotomies carry dehydration risks from dry techniques and heat, and mesothelial dehydration can occur from dry abdominal drapes [1]. Minimally invasive methods have consistently reduced adhesion-related morbidity and mortality [8]. Specific risk factors associated with laparoscopic surgery include peritoneal dehydration from dry gas and elevated insufflation pressures, as well as mesothelial hypoxia due to carbon dioxide exposure.

Individual predisposition and genetic factors

The probability and severity of adhesions following intraabdominal surgery vary significantly between patients [9]. Some individuals form dense adhesions after similar procedures performed by the same surgeon using comparable techniques, while others develop few or no adhesions. Adhesions tend to recur within the same patients, suggesting underlying physiological and genetic factors contributing to postoperative adhesions. Understanding these genetic influences may help identify individuals most likely to benefit from barrier therapies and aid in designing clinical trials by excluding higher-risk individuals who might skew outcomes toward the null.

Other causes of adhesions

Sexually transmitted diseases such as chlamydia, gonorrhoea, and trichomoniasis are linked to tubal adhesions and occlusions. Endometriosis stands out as a prominent cause of intraabdominal adhesions, with an incidence approaching 40%; among women presenting with infertility, the prevalence of endometriosis may reach as high as 50%. These factors contribute to the overall burden of adhesions and reinforce the multifactorial nature of adhesion formation in the abdominal cavity and pelvis

Effects on fertility

Pelvic adhesions account for a significant portion of chronic postoperative abdominal pain, representing about 80% of cases, 60% of intestinal obstructions, a decline in joint mobility, and contribute to 15–20% of female infertility, with estimates suggesting up to 40% may be due to these adhesions [1,11]. Their presence complicates subsequent abdominal or pelvic surgeries by increasing difficulty and extending operative times, leading to prolonged postoperative discomfort and functional impairment.

Para ovarian adhesions can affect the fimbria's ability to capture the oocyte [12]. Adhesions at the distal end of the fallopian tube can restrict the fimbrial grasping mechanism, increasing the risk of ovum loss into the peritoneal cavity. Adhesions on the inner or outer surfaces of the fallopian tube may cause partial or complete blockage, reducing conception likelihood and raising the risk of ectopic pregnancy. Adhesions involving the ovary can also hinder access for oocyte retrieval, affecting fertility outcomes.

Diagnosis

Symptoms: Patients may present with little to no obvious signs or with vague, mild symptoms that do not prompt immediate investigation; however, chronic pelvic pain, intermittent small bowel obstruction, or infertility may emerge as leading clinical manifestations [13].

- **Laparoscopy:** This technique remains the gold-standard diagnostic procedure because insufflation and magnification provide enhanced visualization of intra-abdominal structures, and smaller incisions typically result in less postoperative pain. Despite being invasive and requiring general anaesthesia, laparoscopy carries potential surgical risks and can provoke further adhesion formation. Nevertheless, it offers the most definitive confirmation of adhesions and allows for concurrent therapeutic interventions if necessary [14].
- **Transvaginal hydro-laparoscopy:** Access to the posterior cul-de-sac and pelvic cavity is achieved by introducing a single-needle, dilating trocar system through the posterior vaginal fornix. This approach can be performed under either general or local anaesthesia, and patients often qualify for same-day discharge. Compared to conventional laparoscopy, transvaginal hydro-laparoscopy is safer, more cost-effective, and less invasive for diagnosing pelvic adhesions. The technique's low complication rate may be minimized further by employing transabdominal ultrasound guidance, especially advantageous for patients with a retroverted uterus. This method also detects mild ovarian adhesions more accurately than standard laparoscopy. However, it cannot assess abdominal adhesions outside the pelvic region [15,16].
- **Visceral sliding sign:** This assessment involves observing whether intra-abdominal organs glide freely beneath the abdominal wall during respiration or manual compression. Non-mobility in these observations suggests adhesion presence and has been evaluated through transabdominal ultrasonography and cine MRI. Although these modalities exhibit limited sensitivity for diagnosing adhesions, they demonstrate reasonable specificity in identifying regions that are adhesion-free. The visceral slide test applied to the periumbilical area has shown a high negative predictive value for ruling out peritoneal adhesions near the bowel in at-risk patients. Given variability in the sliding sign across different pelvic regions, it is recommended as an adjunct to surgical assessment, enhancing overall evaluation when combined with other clinical data. Preoperative ultrasound may help reduce complications and aid in optimal trocar placement during laparoscopy [1].
- **The sliding sign:** A positive sliding sign occurs when the anterior rectum and rectosigmoid colon glide freely across the posterior cervix and upper posterior uterus, correlated with metrics such as the endometriosis fertility index (EFI) (6-9) [18]. A negative sign, indicating adhesions with at least one attachment between the colon and uterus-cervix, is typically seen in older patients with longer-standing infertility and more severe endometriosis, associated with a lower EFI (2-6). The sliding sign has demonstrated a sensitivity of 96.3% and a specificity of 92.6% for predicting pelvic adhesions. When mapping adhesions, sensitivity and specificity around 80.4% and 86.1% have been reported. These data underscore the sliding sign's value as a non-invasive adjunct that informs the likelihood and distribution of pelvic adhesions, complementing other diagnostic modalities in management planning.

Prevention

Surgical technique

Utilizing microsurgical principles leads to lower rates of adhesions and better fertility outcomes [20]. Key practices include: (a) gentle tissue manipulation, careful bleeding control, and preventing contamination from talcum gloves or lint-laden pads; (b) regular irrigation with heparinized fluids during surgery, complete removal of abnormal and necrotic tissues; (c) precise alignment and joining of tissue layers, ensuring separation of exposed surfaces with temporary suspensions of the adnexa or ovary; (d) minimizing ischemia and drying while using fine, non-reactive sutures. These strategies are aimed at reducing peritoneal injury and subsequent scar formation that leads to adhesions.

Laparoscopy

A systematic review and meta-analysis indicate that adhesions are less frequent after laparoscopic procedures compared to open laparotomy [21]. Several factors contribute to this difference: First, shorter abdominal incisions in laparoscopy lower the risk of anterior abdominal wall adhesions. Second, reduced manipulation of tissues and organs minimizes trauma. Third, there is no exposure to foreign bodies like glove powder or lint that can instigate adhesions. Fourth, laparoscopy allows for more precise tissue handling due to the magnified view. Fifth, the pneumoperitoneum created can help control bleeding and enhance haemostasis. Sixth, using warmed, humidified CO2 might further reduce adhesion formation. Lastly, postoperative infection rates, another risk for adhesion, tend to be lower with laparoscopic methods.

However, laparoscopy does not guarantee fewer adhesions than laparotomy; the main determinant is the degree of tissue injury rather than the surgical approach itself [22]. In some instances, the serosal surface area impacted by wounds can be comparable between both procedures. Additionally, CO2 pneumoperitoneum might contaminate the peritoneal surface more extensively, promoting adhesions at distant sites [21]. The combination of increased intra-abdominal pressure from CO2 and laparoscope illumination can lead to peritoneal ischemia and reduced fibrinolysis, heightening the risk of adhesions in certain situations.

No parietal peritoneal closure

Research shows that the adhesion incidence at closure sites after laparotomy is about 22% when the peritoneum is closed, compared to roughly 16% when it is left open [23]. In ovarian cancer surgeries, closing the pelvic and periaortic peritoneum tends to yield more adhesions than keeping dissected areas open. On the other hand, closing the parietal peritoneum during primary cesarean deliveries correlates with significantly fewer dense and filamentous adhesions [24].

Adjuncts to surgical technique

- **Anti-Inflammatory Agents:** Various local and systemic anti-inflammatory medications and adhesion-reducing compounds, such as dexamethasone and promethazine, have been evaluated, but none have reliably decreased postoperative adhesions [25].
- **Peritoneal Instillation:** Peritoneal lavage with antibiotic solutions does not lessen adhesions and may, in some cases, encourage their formation [26]. Hydro flotation methods, which utilize agents like 32% dextran 70 or crystalloid solutions (normal saline or Ringer's lactate), either alone or with heparin or corticosteroids, have been tried to separate peritoneal surfaces but lack evidence of efficacy in reducing adhesion formation [27]. Icodextrin, a 4% solution (Adept Adhesion Reduction Solution, Baxter Healthcare Corp.), acts as a colloid osmotic agent to retain fluid in the peritoneal cavity for approximately 3–4 days; however, sufficient evidence supporting its role as an adhesion-preventing agent remains lacking, despite its FDA approval. Irrigating the peritoneum with heparin solution does not seem to decrease peritoneal adhesions after pelvic surgeries [28].
- **Surgical Adhesion Barriers:** Barriers are effective during the critical 3 to 5 days post-surgery when mesothelial repair occurs, helping to prevent adhesion formation, though they cannot make up for poor surgical technique. The FDA has approved three types:

Modified Sodium Hyaluronate–Carboxymethyl Cellulose (HA–CMC) Barrier (Seprafilm, Genzyme Corp.): This clear, absorbable membrane physically separates opposing tissue surfaces for about 7 days. There is limited evidence regarding its effectiveness in preventing adhesions following myomectomy [29].

Oxidized Regenerated Cellulose (Intercede, ETHICON): An absorbable barrier that does not require suturing, degrading to monosaccharides within two weeks. Studies indicate it may reduce adhesion formation by approximately 50%–60% [29]. It might be more effective than having no barrier for reducing pelvic adhesions, and higher postoperative pregnancy rates were seen in women treated with this barrier compared to those untreated; however, complete hemostasis is crucial, as the product loses effectiveness when saturated with blood.

Treatment

Adhesiolysis

- **Techniques:** Various approaches for adhesiolysis include sharp dissection, electrosurgical methods, and laser modalities such as CO2 and Nd:YAG lasers. Each technique aims to sever abnormal fibrous connections while minimizing damage to surrounding tissues; however, their relative efficacy and safety profiles can differ based on the adhesion characteristics and surgical context.
- **Timing:** The likelihood of adhesions reforming after lysis seems influenced by their initial quality. Thin, filmy adhesions seen during early postoperative laparoscopy—conducted within a few days to weeks post-surgery—generally recur less frequently than denser, more vascular adhesions typically found during later second-look laparoscopy [32]. This suggests that the biological maturity and vascularity of adhesions at the intervention time affect reformation risk.
- **Fertility outcomes:** The effect of adhesiolysis on fertility and pregnancy outcomes remains contentious. Some data indicate no significant pregnancy benefit from short-interval lysis of mild, filmy adhesions performed within 3–4 weeks after surgery compared with expectant management. Conversely, other studies report improved pregnancy rates following adhesiolysis, suggesting benefits may depend on adhesion severity, location, and patient-specific factors. In cohorts followed for approximately five years post-tubal surgery, term pregnancy rates inversely correlated with adhesion scores measured at surgery using the American Society for Reproductive Medicine classification system, implying higher adhesion burdens predict poorer fertility outcomes [34].
- **Complications:** Adhesiolysis carries significant risks. New adhesive formation following laparoscopic adhesiolysis has been documented in about 20% to 97% of patients, reflecting variability in technique, patient factors, and follow-up duration [35]. Unintentional enterotomy occurs in around 19% of cases, with risks extending to bowel injury during pneumoperitoneum access or during adhesiolysis itself. Diathermy-related bowel lesions are particularly concerning, as perforation may not be immediately evident, necessitating vigilance for delayed complications.
- **Limitations**: The value of adhesiolysis must be weighed against alternative fertility interventions. In vitro fertilization (IVF) can achieve comparable pregnancy rates to surgical adhesiolysis while avoiding operative risks, though not universally so for all patients [37]. The surgeon's expertise is critical, and benefits of peri-tubal adhesiolysis may be limited when intraluminal ciliary trauma persists after pelvic inflammatory disease (PID). The greatest benefit appears in neo-salpingostomy scenarios, with less impact on peri-tubal adhesions not involving the fimbriae, and limited ability to restore normal intraluminal function when the endosalpinx is irreversibly damaged.
- **Physical therapy; mechanical treatment, "site-specific manual soft-tissue therapy":** This non-surgical, non-invasive manual approach targets the pelvic region and fallopian tubes to disrupt established adhesions, aiming to create microfailures in collagen cross-links. Reports suggest a pregnancy rate of about 71.4% among infertile women and IVF patients treated with this modality compared to others. However, study quality varies: many participants lacked confirmed adhesions, with sites inferred from history rather than imaging. Consequently, while promising signals exist, robust controlled data are lacking to draw definitive conclusions on efficacy regarding fertility outcomes.

Ozone

Ozone therapy has emerged as a potential complementary approach for female infertility and pelvic adhesions, theoretically reducing adhesion formation or progression by modulating oxidative

stress and inflammatory pathways. Proposed mechanisms include enhancement of antioxidant enzyme activity and alterations in reactive oxygen species implicated in adhesion pathogenesis. While animal studies suggest beneficial effects, human data remain sparse, highlighting the need for well-designed clinical trials to evaluate ozone therapy's impact on postoperative adhesion rates and fertility outcomes in women undergoing adhesiolysis or at risk of pelvic adhesions

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Conflict of Interest

None.

Author Contributions

Review of literature.

Data Availability

Any inquiries regarding supporting data availability of this study should be directed to the corresponding author.

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