

Belgian consensus on adhesion prevention in hysteroscopy and laparoscopy

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Abstract Intrauterine and intraabdominal adhesions are a major cause for infertility. The most recent investigations have demonstrated the potential of intraperitoneal adhesion barriers combined with good surgical technique to reduce adhesion formation. For intrauterine adhesions we suggest to minimize unipolar and bipolar instrumentation whenever possible. We advocate the use of estrogens for 10 days after adhesiolysis: 2dd two tablets of estradiol 2 mg. Instillation of Hyalobarrier Gel Endo actually is not reimbursed but may have a beneficial effect after myomectomy or adhesiolysis. Concerning laparoscopic and laparotomic prevention of adhesion also, meticulous surgical technique is of the utmost importance. Residual

blood should be avoided by careful hemostasis and rinsing with Ringer's lactate with heparin. Preferably braided sutures are not to be left in the abdominal cavity. We advise to avoid unipolar and bipolar cauterization when possible and to replace with ultrasonic or laser energy. The use of floatation barriers does not seem to add substantial benefit in the prevention of adhesions. Gel barriers (Hyalobarrier Gel Endo[®] or Intercoat[®]) are proven to have a significant effect on adhesion prevention. As for sheets, there is enough evidence that they prevent adhesions. The use of NSAID in the prevention of pain and/or corticosteroids in the prevention of postoperative nausea is already mainstay after surgery and can be further endorsed in the prevention of adhesions.

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Introduction

Adhesions are fibrous bands between tissues and organs and are one of the most underestimated problems which may occur following surgery. Adhesions are not restricted to one type of organ or tissue but can involve any kind of tissue or even foreign material. A synonym of adhesions is synechias, coming from the Greek word synechia meaning continuation.

A study published in Digestive Surgery showed that adhesions developed in more than 90 % of patients who underwent open abdominal surgery and in 55–100 % of women who underwent pelvic surgery [1]. Adhesions from prior abdominal or pelvic surgery can decrease visibility and access at subsequent abdominal or pelvic surgery. In a very large study (29,790 participants) published in The Lancet, 35 % of patients who underwent open abdominal or pelvic surgery were readmitted to the hospital on an average of two times after their

surgery due to adhesion-related or adhesion-suspected complications [2]. Over 22 % of all readmissions occurred in the first year after the initial surgery and were linear over time. In the SCAR trial, it was demonstrated that the risk of readmission due to adhesions was 5 % over a 10-year period following an initial open surgical procedure for a gynecological condition [3]. Of the readmissions, about 40 % was readmitted between two and five times. This suggests that a great number of adhesions formed after surgery occur without symptoms.

Intrauterine adhesions (IUAs) are fibrous strings between opposing walls of the uterus. A randomized controlled trial reported the following incidences of postsurgical IUAs at second-look hysteroscopy: 3.6 % after polypectomy, 6.7 % after resection of uterine septa, and 31.3 % after myomectomy [4]. These adhesions are also referred to as Asherman syndrome when the endometrium is not functioning adequately (amenorrhea or painful menstruation due to hematometra).

The duration of the endometrial wound healing differs according to the type of pathology as reported by Yang and coworkers in a prospective cohort study of 163 women undergoing operative hysteroscopy [5]. At second-look hysteroscopy 1 month after operative hysteroscopy, more women achieved a full healing of the endometrial cavity after removal of endometrial polyps (32/37 women or 86 %) compared to adhesiolysis (30/45 women or 67 %), metroplasty (3/16 women or 19 %), or myomectomy (12/65 women or 18 %) ($P < 0.05$). Significantly more women suffered from de novo IUAs at second-look hysteroscopy after metroplasty (14/16 women or 88 %) or adhesiolysis (34/45 women or 76 %) compared to removal of submucous fibroids (26/65 women or 40 %) or endometrial polyps (0/37 women or 0 %). Women with de novo IUAs were less likely to achieve full endometrial wound healing within 1 month compared with those without adhesions (23/74 women or 31 % versus 54/89 women or 61 %, $P = 0.0003$). The authors conclude that the time needed for a complete recovery of the endometrium ranges from 1 to 3 months, following, respectively, the hysteroscopic removal of endometrial polyps and submucous fibroids.

With this consensus, we aim to help the gynecologist in discussing the problem of adhesions with their patients and in offering them easy and everyday care to prevent adhesions when possible.

Clinical significance of postoperative adhesions

Hysteroscopy

Significance depends on the degree and the location in the uterine cavity. Typical signs of IUAs such as menstrual abnormalities (irregular bleeding, hypomenorrhea, amenorrhea) can be masked by hormonal therapy, and dysmenorrhea or cyclic pelvic pain can be masked by use of oral contraceptives.

IUAs are associated with a poor reproductive outcome. Infertility rate has a prevalence as high as 43 % (922 of 2151 women) according to a large review of observational studies [6]. Recurrent miscarriage is increased ranging from 5 to 39 % in women with IUAs according to a review of observational studies [7]. Major and, at times, devastating obstetric complications may occur, e.g., placenta accreta/increta and higher risks for preterm delivery, uterine rupture, and peripartum hysterectomy [8].

Postabortion/retention: resection of placenta

Surgical treatment of placental remnants traditionally consists of dilation and curettage (D&C) using vacuum aspiration and/or a metal curette. In this context, it is well established that “blind” removal of tissue causes destruction or damage to healthy surrounding tissue, which may lead to IUAs. The interval after pregnancy at which trauma to the endometrium occurs is the most important factor in the risk of IUA formation [9]. In women undergoing secondary procedures to remove placental remnants after delivery or repeat curettage, IUAs are found in 40 % [10]. The results of a recent systematic review of IUA after miscarriage are in line with previous findings [11]. In a cohort study, hysteroscopic cold loop resection of placental remnants showed a lower rate (4.2 %) of IUAs at routine second-look hysteroscopy as compared with ultrasound-guided curettage using a metal curette (30.8 %) [12]. A similar rate of IUAs (4.4 %) was found in a retrospective series on hysteroscopic morcellation of placental remnants, where routine second-look hysteroscopy was performed in part of the patients [13]. Routine second-look hysteroscopy should be performed after surgical interventions for removal of placental remnants to further assess the risk of IUA formation [14]. Hysteroscopic treatment, allowing for selective removal of placental remnants and thus minimizing the risk of unnecessary trauma to the uterine cavity, may be the preferred surgical treatment [11].

Laparoscopy

Major complications of adhesions will depend on localization of the adhesion, causing chronic pelvic pain, bowel obstruction, or infertility [1–3]. Adhesion-related complexity at reoperation added significant risk to subsequent surgical procedures [15–17].

Pathophysiology of adhesion formation

Hysteroscopy

Any trauma to the basal layer of the endometrium may lead to the formation of de novo IUAs; nearly 90 % of all cases of

IUAs are associated with postpartum or postabortion dilatation and curettage [18]. The etiological role of infection in the formation of IUAs is, with the exception of genital tuberculosis, controversial [8]. IUA formation is the major long-term complication of hysteroscopic surgery in women of reproductive age.

The mechanisms of tissue repair in the human endometrium are poorly understood despite several hypotheses on the origin of cells for endometrial regeneration [19].

Laparoscopy–laparotomy

The classic model: a local phenomenon between opposing lesions

Adhesion formation is mediated through different mechanisms. Damage to peritoneal surfaces induces a response starting with an acute inflammatory reaction and a process involving mesothelial cells; macrophages; and exudate with cytokines and coagulation factors, neutrophils, and leukocytes [20]. Within hours, a peritoneal defect (i.e., caused by a trauma during surgery) is covered with macrophages and mesothelial cells [21].

If mesothelial cells are capable in covering the lesion, then fibrinolysis will be complete within a few days and reepithelialization will result in a smooth healed tissue surface.

If the normal repair fails or when repair is delayed, fibroblasts invading the fibrin scaffold start to proliferate, leading invariably to adhesion formation.

The updated model: the important role of the peritoneal cavity

The origin of the mesothelial cells involved in the repair of a serosal injury (cfr. supra) remains somehow unclear. Free-floating mesothelial cells are present at all times, and their number increases 12 times within 2 to 5 days after injury [22]. Also, these cells were demonstrated to implant and extensive lavage with removal of these free-floating cells slows down peritoneal healing [23].

The entire peritoneal cavity is exposed to the laparoscopic gas and to air during laparotomy, and the mesothelial cells are thus influenced as homeostasis is disrupted. The direct relation between CO₂ insufflation, acidification of the peritoneum, and decreased immunoprotection might thus result in an altered adhesion formation [24]. Identified so far are as follows: (1) hypoxia of the mesothelial cells due to the inner pressure of the CO₂ pneumoperitoneum, (2) desiccation of cells, and (3) tissue manipulation or combinations of these factors. Also, the CO₂ pneumoperitoneum itself has been demonstrated to increase adhesions and this increase is time- and pressure-dependent [25, 26].

Prevention of adhesions in hysteroscopy

IUD

There is no evidence on the effectiveness of any IUD in the prevention of intrauterine adhesions (IUAs) or on recolonization of the endometrial layers.

An IUD represents a physical barrier and might be helpful in separating the uterine walls and the endometrial layers. The ideal IUD for preventing adhesions should have a large surface; therefore, a simple T-shaped model is not ideal [27]. A Cu-IUD provokes a local inflammatory response and might thus even have a negative effect on the endometrial recolonization [28]. Progesterone IUDs have a suppressive effect on the endometrium and can therefore not be used. One small RCT showed no difference in reformation of adhesions between IUD plus hormone therapy and hormone therapy alone [29]. Moreover, introducing an IUD after adhesiolysis presents an extra risk of infection and perforation [30, 31].

Barriers

Five randomized studies have assessed the effectiveness of barriers (Hyalobarrier and Intercoat) in hysteroscopic surgery and were recently reviewed in a meta-analysis [32–37]. There is no evidence for an effect favoring the use of any barrier gel following operative hysteroscopy for the key outcomes live birth or clinical pregnancy (relative risk (RR) 3.0, 95 % confidence interval (CI) 0.35 to 26, $P=0.32$, one study, 30 women, very-low-quality evidence). The use of any gel following operative hysteroscopy decreases, however, the incidence of de novo adhesions at second-look hysteroscopy at 1 to 3 months (RR 0.65, 95 % CI 0.45 to 0.93, $P=0.02$, five studies, 372 women, very-low-quality evidence). After using any gel following operative hysteroscopy, there are more AFS 1988 stage I (mild) adhesions (RR 2.81, 95 % CI 1.13 to 7.01, $P=0.03$, four studies, 79 women) and less stage II (moderate) adhesions (RR 0.26, 0.09 to 0.80, $P=0.02$, three studies, 58 women) or stage III (severe) adhesions (RR 0.46, 95 % CI 0.03 to 7.21, $P=0.58$, three studies, 58 women) (all very-low-quality evidence).

Gynecologists might use any barrier gel following operative hysteroscopy for suspected uterine cavity abnormalities in infertile women: its use may decrease de novo adhesion formation [38] (very-low-quality evidence). If de novo adhesion formation occurs, there are less moderate or severe adhesions and more mild adhesions by using any anti-adhesion gel. Hyalobarrier is, for the moment, the only gel officially indicated for this purpose. Infertile women nevertheless should be counseled that there is, at present, no evidence for higher live birth or pregnancy rates by using any barrier gel following operative hysteroscopy (very-low-quality evidence); further randomized studies are needed to assess the direction and

the magnitude of the treatment effect for these key reproductive outcomes.

Medical prevention

There is no evidence from randomized studies that the use of estrogen will prevent adhesion formation.

Since its first use in 1964, several regimens have been proposed to promote the reepithelialization of the endometrium after adhesiolysis [31, 39]. No data exists on the ideal dose and length of the therapy. Preoperative estrogen therapy has been suggested to optimize the endometrial growth before surgical intervention; however, evidence on its effectiveness is lacking [40]. Moreover, the possible adverse effects of hormonal therapy (nausea, thromboembolic disease) should be taken into account when considering its use.

There is no significant evidence from any published study to recommend the use of steroids (such as dexamethasone, hydrocortisone, and prednisolone) in humans, and several side effects still have to be ascertained [41, 42].

Some case reports describe the use of other medication (aspirin, sildenafil citrate, and nitroglycerin) to promote the perfusion of the endometrium [31]. At present, no evidence exists on its efficacy, and therefore, its use cannot be sustained.

Surgical aspects: technique/equipment

There are no randomized trials comparing the use of different surgical instruments regarding postoperative adhesions.

Cold scissors Mechanical separation is the most accessible mean of adhesiolysis. There are several possible advantages: direct view without destruction of the normal endometrium and easier insertion of a small barrel hysteroscope (3.8-mm outer diameter in median), without dilatation of the cervical canal allowing adhesiolysis without anesthesia or sedation.

Unipolar electrical energy Be aware that electrical energy engenders passage into the tissues to a depth of 0.6 mm in median causing a slower recuperation to *restitutio ad integrum*. The current has to travel to the recuperation plate where the patient remains within the circuit. An anionic distention medium is indispensable. Dilatation of the cervix up to Hegar 10.5 for the 27-French resectoscopes and up to Hegar 8 for the 25-French resectoscopes is needed as well as general anesthesia.

Bipolar electrical energy Bipolar electrical energy is in fact a monopolar cutting electrical current with the advantage that the current travels between two poles at some 8-mm distance from one another. The distention medium is ionic. There is direct view without passage of the energy into the tissues,

hence less destruction of the normal endometrium except for the endometrium in the immediate vicinity of the impact. Dilatation of the cervix up to Hegar 10.5 for the 27-French resectoscopes is also needed here. There are no small barrel resectoscopes available, thus necessitating general anesthesia. When using specific bipolar 4–5-French needle sounds (available in reusable or disposable versions), bipolar energy can be used through small barrel hysteroscopes of 3.8 mm with 5-French working channel. This way, it can be used without anesthesia or sedation.

Laser light The only available laser is the YAG laser where heat is diffused deep into the tissues causing thermal damage up to 1 cm in depth. The fibers are very fragile and expensive to replace. It can be used through small barrel scopes and can therefore be used without anesthesia or sedation [43].

Prevention of adhesion formation in laparoscopy and laparotomy

Surgical aspects

Surgical manipulation

Meticulous surgical technique is a means of preventing adhesions. The main approaches in preventing adhesions include adjusting surgical techniques to minimize trauma to intraabdominal structures, minimizing the risk of infection, avoiding contaminants and use of foreign materials, and achieving optimal hemostasis [44, 45]. Other foreign materials such as glove powder can cause a peritoneal inflammatory reaction. Controversy exists over the benefits of the use of sponges, as there are no randomized trials. When the bowel needs to be packed, an atraumatic bag might reduce injury to the serosa. Principles of gentle tissue handling and meticulous hemostasis prevent the presence of free blood and ischemic tissues [1]. Fibrin plays an important role in the pathophysiology of adhesions. When possible, a laparoscopic approach is generally preferred over laparotomy [45]. However, up till now, there is no evidence from randomized controlled trials to sustain this.

Blood

There are no randomized trials comparing the presence of blood to the formation of adhesions in the human. Animal experiments however showed that leaving blood in the abdominal cavity after surgery is a risk factor for adhesion formation [46]. It therefore is advised to clean the abdominal cavity with saline or Ringer's lactate. The addition of heparin (5000 IU/l) can be advised to keep the blood from clotting and making it easier to aspirate. In the absence of peritoneal injury,

small clots did not contribute to adhesion formation in animal studies, while large clots did so [47].

Threads and meshes

There are no randomized trials comparing neither meshes nor threads to the formation of adhesions in the human. Leaving a mesh exposed to the abdominal cavity (not covered by peritoneum) will result in an increased risk of adherence to the mesh, with the risk of bowel obstruction. The presence of suture material and tightening the sutures to the point of ischemia promote adhesion formation [48].

Equipment

There is no evidence of any instrument causing fewer adhesions. Consensus is, however, to minimize tissue damage, which can possibly be achieved by using ultrasonic or laser energy rather than bipolar energy. Unipolar energy is likely to cause the most tissue damage.

Altering the peritoneal environment

The insufflation gas with carbon dioxide used for laparoscopy is known to have an effect on the total cavity resulting in inflammation. There is evidence from small trials in human that switching to a mixture of carbon dioxide with 10 % nitrous oxide and 4 % oxygen can decrease adhesions [49]. In a trial with 44 women undergoing laparoscopic resection of endometriosis, adhesions were significantly decreased ($P < 0.0005$). Women in the study group also received dexamethasone, rinsing with heparin and control for humidity and temperature. No trials are available to support the use of the sole gas mixture in clinical practice regarding efficacy and safety [50].

Local products

Floation barriers (Ringer's lactate, saline, Hartman's solution)

The instillation of such large-volume isotonic solutions (normal saline, Ringer's lactate, etc.) into the peritoneal cavity at the end of the surgery to produce a "hydrofloation" effect has represented the most popular and economic agent used for adhesion prevention in gynecological surgery. However, a meta-analysis of clinical trials has shown that crystalloids do not reduce the formation of postsurgical adhesions whether in laparoscopy or in laparotomy [51, 52]. This seems to be due to rapid absorption rate of the peritoneum (30–60 ml/h) which ensures a nearly complete assimilation of the fluid into the vascular system within 24–48 h, far too short to influence adhesion formation.

Adept® (4 % icodextrin solution, Baxter Biosurgery, Baxter International, Deerfield IL, USA) seemed to have a sufficient long intraperitoneal residence in animal and peritoneal dialysis patients [53]. It has to be used throughout the surgery, and 1.000 ml has to be left in the abdominal cavity [54, 55]. In a randomized, controlled pilot study, lavage plus instillation with 4 % isodextrin was well tolerated and reduced incidence, extent, and severity of adhesion formation and reforming after laparoscopic adnexal surgery even if the group sizes were not powered for statistical significance [56]. A recent randomized double-blind trial confirmed the previous results by demonstrating that icodextrin 4 % was effective and safe in reducing adhesions in patients undergoing gynecological laparoscopy involving adhesiolysis [57]. In a study by Trew et al., there was no evidence of a clinical effect, but various surgical covariates including surgery duration, blood loss, number and size of incisions, suturing, and number of knots were found to influence de novo adhesion formation [58]. Occasional adverse effects include vulvar edema, allergic reactions (allergy to starch-based polymers or maltose and isomaltose intolerance), fluid leakage through the wounds, and some abdominal distention and discomfort [59].

Gel barriers

Hyaluronic acid In a large multicenter randomized trial, Intergel® (ferric hyaluronate, Ethicon–J&J, Somerville, NJ, USA) was effective in reducing the extension and severity of postoperative adhesions in comparison with Ringer's solution in patients undergoing peritoneal cavity surgery by laparotomy with a planned second-look laparoscopy [60]. But, due to unacceptable postoperative complications, the gel is no longer available [61].

Auto-cross-linked hyaluronic acid gels (ACP gel, Hyalobarrier® Gel Endo, Nordic Pharma) are particularly suitable for preventing adhesion formation because of their higher adhesivity and prolonged residence time on the injured surface than unmodified HA. A prospective randomized controlled study showed that in 36 patients treated by laparoscopic myomectomy, application of the ACP gel reduced the rate of patients who developed postoperative adhesions significantly [62]. The same authors also demonstrated that the application of ACP in infertile patients undergoing a laparoscopic myomectomy was associated with an increased pregnancy rate [63]. The favorable safety profile and the efficacious anti-adhesive action of the adjunct following laparoscopic myomectomy have been confirmed in a blinded, controlled, randomized, multicenter study [64]. Hyalobarrier is fairly easy to use in laparoscopic surgery and should be used at the end of surgery, as further rinsing can remove the gel.

Solution of hyaluronic acid, Sepracoat® coating solution (HAL-C; Genzyme Corporation, Cambridge, USA), is a liquid composed of 0.4 % sodium hyaluronate in phosphate buffered

saline and is applied intraoperatively, prior to dissection, to protect peritoneal surfaces from indirect surgical trauma or postoperatively to separate surfaces after they are traumatized. No studies evaluating Sepracoat® in preventing adhesions following laparoscopic gynecological procedures are available in the literature, although efficacy in laparotomy was well established [65].

Hydrogel, Spraygel®, or SprayShield® (Covidien, Dublin, Ireland) consist of two synthetic liquid precursors that, when mixed, rapidly cross-link to form a solid, flexible, absorbable hydrogel. The solid polymer should be applied by laparoscopy, but the abdomen should be inflated with air which may cause air embolisms. It is sprayed over the affected area and remains for approximately 5 to 7 days. After that period, it is degraded and absorbed. One of the components contains a blue food colorant, so there is an intraoperative visualization where the SprayShield® was used. The currently available evidence does not support the use of SprayShield® neither by decreasing the extent of adhesion nor in reducing the proportion of women with adhesions. Mettler et al. randomized 64 women undergoing a myomectomy by laparoscopy or laparotomy. Only 22 returned for a second-look laparoscopy. Although the treated patients were more adhesion-free at second-look laparoscopy compared with the control group, the difference was not significant [66]. Further research is needed to evaluate the efficacy of SprayShield in multicenter randomized controlled trials.

Other gel barriers Intercoat® (Ethicon–J&J, Somerville, NJ, USA) is a viscoelastic absorbable gel composed of polyethylene oxide and carboxymethylcellulose stabilized by calcium chloride. Functioning as a mechanical barrier during the healing process, Intercoat is applied as a single layer at the end of the procedures. Lundorff et al. published the results of a randomized third-party blinded multicenter European trial showing that viscoelastic gel did significantly reduce adnexal adhesions in patients undergoing gynecological laparoscopic surgery [67]. Simultaneously, Young et al. (2005) performed a prospective randomized study evaluating the efficacy of Oxiplex® gel (FzioMed, San Luis Obispo, CA) and reported that the gel was safe, was easy to use with laparoscopy, and produced a reduction of adnexal adhesions [68].

There is considerable experience with CoSeal® (resorbable hydrogel polyethylene glycol polymer solutions, Baxter Biosurgery, Deerfield, IL, USA) in vascular reconstruction over 200,000 patients since 2002. When used together with good surgical technique in both open and laparoscopic surgery, the agent reduces significantly the incidence, severity, and extent of postoperative adhesions [69].

Sheets

Expanded polytetrafluorethylene nonabsorbable barrier Gore-Tex surgical membrane (Gore-Tex surgical

membrane; W. L. Gore & Associates, Inc., Flagstaff, USA) has a microscope structure preventing cellular growth. It is noninflammatory and nonabsorbable. In patients undergoing gynecological surgery by laparotomy for adhesions or myoma, Gore-Tex surgical membrane was shown to decrease the severity, extent, and incidence of adhesions in treated areas [70]. Its usefulness is limited by the nature of the product: it must be sutured in place, and in most cases, it should be removed at a subsequent surgery. It is very difficult to apply at laparoscopy.

Oxidized regenerated cellulose (Interceed®, Ethicon–J&J, Somerville, NJ, USA) is the most widely used adhesion prevention agent and has been shown to reduce adhesion formation in both animal and human studies. It works by transforming into a gelatinous mass covering the damaged peritoneal surfaces and forming a barrier, physically separating the adjacent raw peritoneal surfaces. The efficacy of Interceed® has been studied in more than 13 clinical trials that included 600 patients. A meta-analysis of ten randomized, controlled studies reported a 24.2 % reduction in adhesion formation on the side treated with Interceed [71]. Despite this report, concerns about Interceed® continue, especially regarding its efficacy in preventing adhesions and its apparent ineffectiveness in the presence of blood. In this setting, Interceed® may aggravate rather than prevent adhesion formation.

Sodium hyaluronate and carboxymethylcellulose (Seprafilm®, Genzyme Genzyme Biosurgery, Bridgewater, USA) is a hyaluronate–carboxymethylcellulose membrane, which is placed over a suture or an injured area without stitches and remains in place for 7 days. In contrast to Interceed®, no loss of efficacy in the presence of blood has been reported. Several studies have demonstrated the efficacy of Seprafilm® mainly in general surgery. It is one of the most widely studied adhesion barriers, with more than 20 published studies that included over 4600 patients [70]. In gynecological surgery, the efficacy of Seprafilm® has also been demonstrated for some procedures, but it is not easy to use in all procedures. Seprafilm is fragile and, therefore, difficult to handle particularly in laparoscopy.

Drugs

Ketorolac is an NSAID that has shown some evidence in animals to prevent adhesions [72]. Dexamethasone was tested in 126 patients who have been operated upon by microsurgery and by second-look laparoscopy 3 to 6 months later [73]. Mean improvement on adhesion score was 23.2 in the corticosteroid group and 10.2 in the control group. Forty percent of patients in the corticosteroid group versus 19 % in the control group ($P < 0.02$) became pregnant. No adverse effect has been noted.

Conclusion—general recommendations

Intrauterine and intraabdominal adhesions are a major cause for infertility. The most recent investigations have demonstrated the potential of intraperitoneal adhesion barriers combined with good surgical technique to reduce adhesion formation. The reduction of postoperative adhesions may be associated with clinically significant benefits such as improved fertility, reduction in pelvic pain, and improved quality of life.

Regarding adhesion prevention, available data show some improvement with different approaches. Taking into account data with strong and weak evidence, we have reached the following consensus:

For IUAs, we suggest to minimize unipolar and bipolar instrumentation whenever possible (i.e., cutting uterine septum with scissors). We advocate the use of estrogens for 10 days after adhesiolysis: 2dd two tablets of estradiol 2 mg. Instillation of Hyalobarrier Gel Endo may have a beneficial effect after myomectomy or adhesiolysis.

Concerning laparoscopic and laparotomic prevention of adhesion also, meticulous surgical technique is of the utmost importance. Residual blood should be avoided, and this can be obtained by careful hemostasis and rinsing with Ringer's lactate with heparin. The proper sutures should be used, and preferably braided sutures are not to be left in the abdominal cavity. Regarding instruments, we advise to avoid unipolar and bipolar cauterization when possible and to replace with ultrasonic or laser energy. The use of floatation barriers does not seem to add substantial benefit in the prevention of adhesions. Gel barriers (Hyalobarrier Gel Endo® or Intercoat®) based on hyaluronic acid are proven to have a significant effect on adhesion prevention and are reimbursed in some procedures. We advocate the proper use of these barriers. As for sheets, there is enough evidence that they prevent adhesions. The use of NSAID in the prevention of pain and/or corticosteroids in the prevention of postoperative nausea is already mainstay after surgery and can be further endorsed in the prevention of adhesions.

Altering the laparoscopic gas to a mixture of carbon dioxide +10 % nitrous oxide+4 % oxygen may be a future option, as this is an easy way to prevent adhesions, but further studies are needed to provide stronger data regarding efficacy and safety.

Our consensus is not a systematic review and does not provide guidelines with strengths of recommendation according to level of evidence. This consensus is intended as a supporting tool for gynecologists to give them a broad range of possible actions to be taken to reduce postoperative adhesions.

Conflict of interest Verguts Jasper, Bosteels Jan, Corona Roberta, Hamerlynck Tjalina, Mestdagh Greet, Nisolle Michelle, Puttemans Patrick, Squifflet Jean-Luc, Van Herendael Bruno, and Weyers Steven declare that they have no conflict of interest.

Ethical standard This article does not contain any studies with human or animal subjects performed by the any of the authors.

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