Gynecol Surg (2015) 12:271–274
DOI 10.1007/s10397-015-0897-1

ORIGINAL ARTICLE

Extensive peritoneal lavage decreases postoperative C-reactive protein concentrations: a RCT

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Received: 6 May 2015 / Accepted: 12 May 2015 / Published online: 6 June 2015

Abstract Although extensive lavage is useful in peritoneal infections as diverticulitis, the extent of peritoneal lavage that should be used at the end of surgery is unclear. A randomised controlled trial comparing standard lavage with 0.5 litre (L) with extensive 8-L lavage was performed in 20 consecutive patients, following a full thickness resection of the rectum for deep endometriosis. Randomisation was done by the research nurse using sealed envelopes. Endpoints were C-reactive protein (CRP) concentration, white blood cell (WBC) count, temperature and the occurrence of complications. After lavage with 8 L, the CRP concentrations were consistently lower than that after lavage with 0.5 L and this from day 1 to day 7 after surgery (P=0.01). Rigorous peritoneal lavage seems preferable when a risk of pelvic contamination exists. Clinicaltrials.gov registration: NCT00930696

Keywords Peritoneal lavage · Bowel perforation · Peritonitis · Endometriosis · Laparoscopy · Adhesion formation

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Introduction

Extensive peritoneal lavage was introduced 100 years ago [1] to decrease the mortality of diffuse peritonitis following appendicitis, and repeated lavage by laparotomy was introduced in 1990 for four-quadrant peritonitis [2]. Although lavage during laparoscopy is more efficient than during laparotomy [3], its usefulness remains controversial [4–7]. Over the last years, extensive peritoneal lavage during laparoscopy was reported to be useful for the treatment of complications following colorectal surgery and for diverticulitis [8–16]. In animal models, lavage decreases adhesion formation following peritonitis [17].

Peritoneal lavage, although widely used, is poorly defined. It is a good clinical practice to rinse the abdominal cavity at the end of surgery in order to remove blood and/or debris. It seems common sense that lavage should be more rigorous following massive contamination to treat or prevent peritonitis. There are no data, however, that document how extensive peritoneal lavage should be.

Peritoneal lavage thus has a series of effects, some of which can be assumed to be beneficial, whereas others might be detrimental. Lavage obviously decreases the microbial load of an infection, although bacteria sticking to the mesothelial cells are not removed [18]. The importance of removing debris and blood for the prevention of adhesion formation, although logic, has not been proven. Negative consequences of the removal of immunocompetent cells as macrophages, natural killer cells and neutrophils were not reported. Although saline is routinely used for historical and economic reasons, saline was demonstrated to be harmful to mesothelial cells [19].

Since it was unclear whether a more extensive lavage was useful for minimal contamination of the abdominal cavity,, we conducted a RCT in women following a full thickness resection of bowel endometriosis.

Materials and methods

Deep endometriosis surgery

The technique used for excision of deep endometriosis was described recently [20]. In summary, patients received a full bowel preparation with 6 L of Prepacol (Codali SA, Belgium). Endometriosis was excised completely. Following a full thickness resection, the bowel opening was sutured transversally in two layers with a running suture of poliglactyn 3/0. Leakage of the suture was controlled with 150 mL of methylene blue for rectal defects. Following lavage of the pelvis, a drain was left in the pouch of Douglas and another in the right paracolic gutter. Postoperative care consisted of full spectrum antibiotics and nil by mouth for seven days and daily monitoring of CRP concentrations and WBC count. Immediately after surgery, all surgical data were entered into our database.

Peritoneal lavage in deep endometriosis surgery

After excision of deep endometriosis, peritoneal lavage of the pelvis was performed with 200 to 400 mL of saline. In women with a late bowel perforation and a beginning peritonitis, extensive peritoneal lavage was performed [21]. Extensive peritoneal lavage was started in the upper abdomen with the patient in anti-Trendelenburg position; subsequently, the patient was put horizontally to rinse the bowels, and finally with the patient in slight Trendelenburg, lavage of the pelvis was performed. Lavage was continued until the liquid was transparent clear. This generally required 3 up to 5 L for the upper abdomen and 3 up to 5 L for the pelvis.

Randomised controlled trial

Management of full thickness resection of endometriosis still is a matter of debate, centred on the consequences of opening the bowel and pelvic contamination. Some groups prefer to do a bowel resection or a discoid excision with a circular or linear stapler. Some prefer to leave a rim of fibrosis or even some endometriosis in order not to open the bowel. Our standard surgery since the early 1990s has been complete excision resulting in some 10 % full thickness resections especially in larger nodules.

Since an open bowel is always associated with some bacterial contamination, more extensive lavage was considered.

Following IRB approval and registration (NCT00930696), a trial was performed in 20 women in whom a full thickness resection for deep endometriosis was performed at the University Hospital Gasthuisberg, University of Leuven, Belgium. The only exclusion criterion was concomitant diseases jeopardising the outcome of surgery. Following informed consent of the patient and randomisation by the trial nurse using sealed envelopes, lavage was performed either as done routinely or until the liquid was clear. In order to standardise lavage during this trial, either 0.5 or 8 L of warmed saline was used. Using CONSORT guidelines, all women scheduled to undergo deep endometriosis surgery consented to participate; 20 women were randomised during surgery; there were no losses to follow up, and all 20 women were analysed. The endpoints of the trial were CRP concentrations and white blood cell count, the clinical follow-up and eventual postoperative complications.

Statistics

Since full thickness resections of deep endometriosis are not that frequent, a larger sample size would have taken unrealistically long. Since the number of patients is small, median and ranges, are given for demographic data. CRP and WBC values were analysed for significance with repeated measurement ANOVA. For the figure, mean and SE are used for clarity.

Results

Both groups were comparable for age, weight, duration of surgery and size of deep endometriosis nodules. Women in the extensive lavage group and in the control group were 34.4 years (range, 28–47 years) and 34.8 years (range, 27–42 years) old, respectively. Duration of surgery was 273.5 min (range, 153–391 min) and 226.5 min (range, 83–354 min), respectively. The deep endometriosis nodules were big in both groups, with a mean diameter of 33.7 mm (range, 18–41 mm) and 26.8 mm (range, 10–40 mm), respectively.

Postoperative CRPs were systematically lower in the lavage group from day 1 onwards to day 7 (P=0.01) (Fig. 1). Moreover, in the lavage group, CRP declined faster, being less than 13 mg/L on day 5, whereas in the control group, CRPs

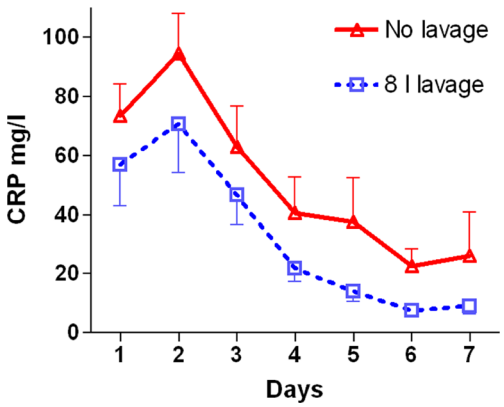

Fig. 1 Mean and standard error of CRP concentrations following full thickness resection of deep endometriosis of the rectum in case of extensive lavage with 8 or 0.5 L. Overall significance, P=0.01 (repeated measurement ANOVA)

still were markedly elevated on day 6 with a mean of 22 mg/L. WBC counts did not show any difference, being from day 1 to day 7, 13,330±3510, 11,650±3720, 10,140±3280, 8430±2240, 7690±2300, 6370±830 and 8010±1810/mL in the lavage group and 10,450±3220, 9690±3280, 8170±2630, 7200±1600, 7640±1830, 6920±2530 and 7650±990/mL in the control group.

In the control group, 1/10 women had a late bowel perforation in comparison with 0/10 in the lavage group. Follow-up was uneventful in all.

Discussion

The treatment of deep endometriosis surgery penetrating the bowel wall varies from excision with a single suture of a muscularis lesion or a two-layer suture following a full thickness resection to a discoid excision with a circular or a linear stapler and to a bowel resection and anastomosis. The debate is still open, between those who consider that an open bowel should be avoided in any case and those who accept an open bowel with a suture if necessary. This trial was designed to evaluate whether more extensive lavage should be introduced to decrease the bacterial contamination when the bowel had been opened. The results that CRP concentrations are lower after extensive lavage suggest, at least, that more extensive lavage decreases the postoperative inflammatory reaction.

The risks and benefits of extensive peritoneal lavage should be balanced. Extensive lavage was reported not to have negative effects even up to 30 L. Also, the concern that macrophages and other immune-competent cells are removed is probably rather theoretical. Also in this series and in those patients undergoing extensive lavage for late bowel perforations, we never identified negative side effects or complications. A benefit of lavage is the decrease of the bacterial contamination in the peritoneal cavity. Lavage decreases mortality in animal models of peritonitis [22]. In observational studies, repeated lavage by laparotomy for four-quadrant peritonitis [2] decreased mortality and morbidity. Lavage reduced morbidity in peritonitis [7]. Recent evidence suggests that lavage could be used as a first line in treatment of diverticulitis, if not to cure the disease, at least to prevent a colostomy during subsequent surgery. Also for complications after bowel surgery, lavage is suggested [8–16]. RCTs to confirm the beneficial effect of lavage in diverticulitis have been initiated in the Netherlands [23] and in Scandinavia. In gynaecology, lavage has become a standard practice for PID [24] and for pelvic abscesses [25]. Although today, the evidence of a better outcome is scanty, it seems logic that lavage is performed with the concept that if it does not help, it does no harm.

It remains unclear how extensive peritoneal lavage should be done. It is unclear whether the upper abdomen should be included and whether lavage should be continued until the fluid is clear. The lower postoperative CRP concentrations after extensive lavage demonstrate, at least, that the postoperative inflammatory reaction is decreased in women who had a full thickness resection with an open bowel. It seems logic to postulate that the effect of extensive lavage will even be more pronounced when the abdominal bacterial load is more severe as in peritonitis. In the absence of negative side effects, we therefore suggest that more extensive peritoneal lavage should be considered to decrease the postoperative inflammatory reaction.

It is unclear whether the observed decrease in postoperative CRP concentrations is important in the absence of other demonstrated clinical benefits. A decreased postoperative inflammatory reaction, however, is associated with less adhesion formation in a laparoscopic mouse model [26] and in women [27]. Since lavage decreases adhesions following an infection in animal models [17], we suggest that a more rigorous and extensive lavage could also be beneficial in women.

The data on mesothelial damage [28], acute inflammation and enhanced adhesion formation by factors in peritoneal fluid shed new light on lavage [19, 22]. In addition to the removal of bacterial load, lavage is bound to affect the abdominal temperature. If the rinsing fluid is heated, care should be taken not to heat too much, since adhesion formation increases exponentially with temperature [29]. Since 80 % of the beneficial effect of lower temperatures upon adhesion formation is obtained at 31 °C, it is suggested to use a fluid around 31 °C. High volumes of fluid at a lower temperature indeed might affect the core body temperature. Considering that saline can be harmful to mesothelial cells, causing retraction and bulging [19, 30, 31], a richer solution, as Ringer's lactate, might be preferable. This also explains that adhesions increase after lavage with saline supplemented with 1 % povidone-iodine, 0.5 % povidone-iodine or 0.05 % chlorhexidine gluconate [32] probably through mesothelial cell trauma. The addition of antiseptics, antibiotics and substances affecting osmolality and pH anyway remains controversial [7]

In conclusion, more extensive lavage is suggested to be beneficial to remove bacterial load in diverticulitis, perforated appendicitis and severe PID or pelvic abscesses. Extensive lavage moreover decreases inflammation and CRP concentrations after surgery, which is important for reducing postoperative adhesion formation. Indirect evidence suggests that extensive lavage should be performed with a fluid around 30–31 °C, that a richer fluid as Ringer's might be preferable, and that antiseptics should be avoided.

Acknowledgments The authors wish to thank Marleen Craessaerts and Diane Wolput, Leuven, Belgium, for instrumental help.

Compliance with ethical standards All procedures performed were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Conflict of interests Drs. De Cicco, Schonman and Ussia have no conflicts of interest to disclose. PR Koninckx declares to be a shareholder of endoSAT NV.

Informed consent Informed consent was obtained from all individual participants included in the study.

Contributions of the authors Dr De Cicco, Dr Schonman, Dr Ussia and Prof Koninckx designed the trial. Surgery was performed by Koninckx with the help of Dr De Cicco or Dr Schonman. Dr Ussia helped in reviewing the literature.

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