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P O L I S H G Y N E C O L O G Y

GINEKOLOGIA POLSKA

ORGAN POLSKIEGO TOWARZYSTWA GINEKOLOGICZNEGO
THE OFFICIAL JOURNAL OF THE POLISH GYNECOLOGICAL SOCIETY

ISSN: 0017-0011

e-ISSN: 2543-6767

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Authors: Ewa Milnerowicz-Nabzdyk, Krzysztof Nowak, Weronika Ogonowska, Maja Mrugała, Tomasz Sachanbinski

DOI: 10.5603/GP.a2022.0122

Article type: Research paper

Submitted: 2022-07-24

Accepted: 2022-07-28

Published online: 2022-10-12

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Articles in "Ginekologia Polska" are listed in PubMed.

Modified segmental bowel resection technique in deep infiltrated endometriosis. Is it a suitable method to reduce the risk of bowel leakage after an extensive complex surgery?

Ewa Milnerowicz-Nabzdyk¹, Krzysztof Nowak¹, Weronika Ogonowska², Maja Mrugala¹,
Tomasz Sachanbinski³

¹*Department of Oncological Gynecology, Centre of Oncology in Opole, Poland*

²*Faculty of Medicine, University of Opole, Poland*

³*Department of Oncological Surgery, Centre of Oncology in Opole, Poland*

Corresponding author:

Krzysztof Nowak

Department of Oncological Gynecology, Centre of Oncology in Opole, Poland

e-mail: knowakmd@gmail.com

ABSTRACT

Objectives: To evaluate the novel modified laparoscopic technique of the bowel resection for deep infiltrated endometriosis (DIE) of the bowel versus the classical technique of bowel segmental resection in terms of anastomosis leakage.

Material and methods: Patients (n = 138) treated with segmental bowel resections due to DIE were included; 30 patients had the classic, while 108 patients had the modified laparoscopic bowel segmental resection with indocyanine green vascular visualization and fibrin sealant use.

Results: The modified technique was used more often in complex operations (65.7% vs 46.6%). More anastomotic leakages occurred in patients undergoing the classic technique than the modified technique (10% vs 2.8%; p = 0.117). No leakage in modified versus 12% in classic technique was observed in simple segmental bowel resections (p = 0.05); 2.5% of cases with leakage in modified versus 7.1% in classic technique were observed in bowel resections with hysterectomy. In complex cases operated with the modified technique, the frequency of anastomotic leakage was 4.2%, which were even less than leakage in simple cases in classic technique group (10%). Although the low location of the lesions increases the

risk of leakage, the modified technique was associated with a small percentage of leakages (25% vs 6.3%). The laparotomy conversion rate was similar in both groups (3.4% for classic and 2.7% for modified).

Conclusions: In DIE, the modified technique of segmental bowel resection showed superiority over the classic technique in terms of the risk of anastomotic leakage. This risk was lower regardless of the complexity of the surgery and lesion location.

Key words: deep infiltrated endometriosis; laparoscopy; modified technique; anastomotic leakage

INTRODUCTION

Endometriosis is a chronic inflammatory disease characterized by the presence of endometrial tissue outside of a normal location, *e.g.*, in the ovaries, peritoneum, bowels, bladder, and even lungs. It is commonly diagnosed in women of reproductive age, but the time of diagnosis can vary because symptoms and signs can be mistaken for other diseases [1]. A patient with endometriosis can present many symptoms, including dysmenorrhea, pain during ovulation, dyspareunia, abnormal bleeding, chronic pelvic pain, dyschezia, constipation, and infertility [2]. Bowel endometriosis is the presence of endometriotic tissue infiltrating the intestinal wall into different depths, but mostly to the muscular layer. Endometriotic nodules can cause significant stenosis of the intestinal lumen and obstruction [3]. They can be present anywhere along the lower gastrointestinal tract, but the main location is the distal colon-rectum and sigmoid.

Bowel endometriotic nodules can be treated using different surgical techniques such as shaving, discoid excision, and segmental resection. The shaving method is used when the lesions are superficial and of a small diameter, mostly limited to serosa. Discoid excision is used for a full-thickness resection of small nodules of the intestinal wall. Many authors recommend it for lesions up to 3 cm in diameter and lower location such as the rectum and distal part of the sigmoid colon, and an anterior part of the bowel wall. However, it is not recommended for multifocal bowel lesions. Segmental resection is the removal of the bowel segment with subsequent anastomosis. It has been the most common technique for treating intestinal endometriosis. It is performed for larger, obstructive nodules and multiple endometriotic nodules (multifocal disease) [4], with no limitation on the involvement in the bowel wall. One of the most dangerous complications after this surgery is anastomosis leakage, a major cause of postoperative mortality and morbidity. The prevalence of anastomosis leakage varies from 1% to 19% depending on an anatomical site, as well as other

preoperative, intraoperative, and postoperative factors [5]. Several surgical techniques and prevention methods have been developed in the last few decades to reduce the risk of anastomosis leakage.

Objectives

The goal of our study was to evaluate the laparoscopic technique of bowel resection for deep infiltrated bowel endometriosis. We compared our modified technique with the classic bowel segmental resection technique, taking into account the occurrence of leakage from anastomosis.

MATERIAL AND METHODS

In total, 138 patients who had segmental bowel resection were included in the study. Each patient was operated on due to deep infiltrated bowel endometriosis between June 2018 and November 2021. The qualification for surgery was done based on the complex examination of the patients. Patient's history, physical examination, bimanual gynecological examination, per rectum examination, pelvic expert magnetic resonance imaging for endometriosis, and expert gynecological ultrasound were analyzed. The patients were included in the study according to the specified inclusion and exclusion criteria. The primary inclusion criterion was a diagnosis of deep infiltrated endometriosis qualified to segmental bowel resection based on the measurement of changes, localization or the number of foci. Patients who had confirmed COVID-19 infection, endometriotic nodules qualified for shaving procedures, and absolute contraindications to surgery were excluded.

Patients

The patients were divided into two groups:
Group A (n = 30) had the classic laparoscopic bowel resection without indocyanine green (ICG) control. This group was further divided into group A1 (n = 16) treated with only bowel resection and group A2 (n = 14) undergoing bowel resection with hysterectomy.

Group B (n = 108) had the modified laparoscopic bowel segmental resection with ICG vascular visualization and fibrin sealant use. This group was also divided into group B1 (n = 37) treated with bowel resection only, group B2 (n = 39) treated with bowel resection and hysterectomy, B3 (n = 6) treated with bowel resection with urinary tract surgery, B4 (n = 20) treated with bowel resection with a hysterectomy and urinary tract surgery, and B5 (n = 6)

undergoing multiple bowel resections with hysterectomy. All resections in this group were done close to the wall of the bowel with preserving the vascularity and nerves.

Surgical techniques

Classic laparoscopic technique

The classic laparoscopic technique of segmental bowel resection for bowel endometriosis was described in 1990 by Redwine and Sharpe [6].

Below we present the classical technique in detail done by our team:

1. The procedure starts with lysis of adhesions and bilateral dissection of the ureters, opening of pararectal spaces, mobilization of the ureters, uterosacral ligament and hypogastric nerve.
2. A bowel endometriotic nodule is detached from surrounding structures (vagina, uterosacral ligament, ovaries, vagina, etc.).
3. Resection of the intestine is done by clipping and cutting the vessel(s) that corresponded to the vascularity of the bowel segment planned to remove.
4. Resection is performed with a part of adequate mesentery that belongs to the segment of the bowel. The bowel is sectioned with a healthy intestinal margin of 1–2 cm using a linear laparoscopic stapling device, but according to an avascularized segment of the bowel.
5. Later, an end-to-end anastomosis with a circular stapler or side-to-side anastomosis with the use of linear stapler is done if needed.
6. The anvil is inserted by minilaparotomy, Fishing technique, or by vagina (vaginal NOTES technique) when removal of the uterus is performed. The bowel segment is extracted through a suprapubic minilaparotomy.
7. When two organs are operated at the same time, the flap technique for the suture separation is performed.

Modified laparoscopic technique

The modified laparoscopic technique is changed in some respects compared to the classic technique. The differences are as follows:

1. Bowel resection is performed tailored at the border of the bowel wall with endometriotic nodule and with a few millimeters of healthy margin.
2. Vascularity is checked by injecting ICG into the vein just before bowel resection (first dose of ICG) and just after anastomosis (second dose of ICG).
3. The bowel planned to be resected is extracted using a surgisleeve technique or Fishing technique, which is a preferred method that can reduce the need for mobilization of the

intestine compared to the vaginal NOTES technique. It also gives an opportunity to check once again all bowel segments planned to be resected if there are any undetected endometriotic nodules located close to the first one by palpation, which is not rare.

4. The anastomosis is later secured by sealing materials such as fibrin sponge or fibrin glue and separated from other organs (bladder or vagina) by an omental flap.

Statistical analysis

The number and percentage of anastomotic leakage were presented and compared between the groups of patients operated with the presented techniques. To determine the statistical significance of differences between groups, the chi-squared or Fisher's exact test was used. Statistical analyses were performed using R version 3.4.4 (R Foundation for Statistical Computing, Vienna, Austria).

RESULTS

Overall, anastomotic leakage occurred in 10% of patients operated with the classic technique (group A) and 2.8% of patients operated with the modified technique (group B), which is 4 times less. Considering patients who had isolated resection of an affected segment of the intestine, using the classic technique (group A1) led to the development of anastomotic leakage in 12.5% of patients, while no such complications were observed in 37 patients operated with the modified technique (group B1). The difference was statistically significant ($p = 0.05$). Considering patients who had bowel resections and the uterus removed with the classical technique, the leakage rate was 7.1% (group A2), while for the modified technique, it was only 2.5% (group B2). Taking into account all complex cases operated with the modified technique in which, in addition to an intestine resection, a reproductive organ, bladder, or additional segments of the bowel were removed, or the uterus was re-transplanted, the leakage rate was 4.2%. Detailed data are presented in Table 1.

In both groups A and B, the same total number of leakages (3 in each) were observed, but group B was three times bigger. Most patients who underwent modified technique resection had much more complex operations (65.7% in group B vs 46.6% in group A). Only in group B, there were surgeries on the 3 or 4 organs (24% of cases). The conversion rate to laparotomy was similar in both groups (3.4% in group A vs 2.7% in group B). Significantly more surgeries were performed by a surgeon in group A than in group B (83% vs 16.7%; $p < 0.001$). In the rest of the cases, 83.3% were performed by a team of gynecological oncologists

and gynecologists. Protective stomas were used only in group B due to the most comprehensive treatments employed in this group, which were not performed in group A. Table 2 describes the characteristics of the groups by the complexity of the procedures.

Analysis of various factors that influence the incidence of leakage considered cooccurring intraoperative complications. More complications were associated with anastomotic leakages in group B (2 of 3 cases). Leakages were not related to intraoperative complications in group A and even more of them were seen in the group with only bowel segmental resection (2/3) than in a group with bowel resection and hysterectomy. All leakages in group A were related to the quality of the anastomosis. Leakages without previous intraoperative complications occurred in 33% of the cases in group B (1/3). However, considering the entire number of patients in group A, the percentage of leakage without prior complications was 10% (3/30), while in group B, it was only 0.9% (1/108) of all patients. Exclusion of intraoperative complications was associated with a very significant reduction in the risk of leakage. Similar numbers of low anastomosis were performed in both groups A and B. The final and total number of leakages in group B was 4 times smaller than in group A. The characteristics of the groups by the location of the anastomosis and complications are presented in Table 3.

The intraoperative complications in group B were the unnoticed microperforation above the anastomosis associated with the method of introducing an anvil into the intestine - the fishing technique. We had to use the colonoscope to regain the anvil that escaped us to the proximal part of the bowel. The second complication was the leakage of urine from the sutured and stented ureter after thermal damage. Both bowel leakages occurred after the operation due to the complications mentioned. In each of these cases, the double leakage test performed intraoperatively with blue, and water and gas did not reveal a lack of continuity of the intestine.

DISCUSSION

The main goal of laparoscopic or laparotomic surgeries in patients with deep infiltrating endometriosis is to remove all endometrial lesions. We compared two laparoscopic approaches to evaluate their safety. Our study showed differences between the classic and modified techniques in favor of the modified technique. The modified technique of bowel resection based on the use of ICG, the tailored technique, and the sealant materials considerably reduced the risk of anastomotic leakage from 10% to 2.8% ($p = 0.117$). The complexity of surgery increased the risk of anastomotic leakage; however, based on our

observations, the use of the modified technique in such cases reduced this risk from 7.2% to 4.2% ($p = 0.462$). The low location of the lesions tends to increase the risk of leakage, but the use of the modified technique of bowel resection reduced this risk from 25% to 6.3%.

Surgery for deep infiltrating endometriosis requires a multidisciplinary approach and skilled teams to perform it [7]; however, our study showed that the experienced team of gynecological oncologists performs equally well as multidisciplinary teams. As shown in our study, the number of bowel leakages in more complex surgeries performed only by the team of gynecological oncologists was even lower than by the team with the surgeon involved. However, the comparison was not adjusted for the complexity of the surgery that was the reason for using the modified technique due to its superiority in such cases.

The number of conversions to laparotomy in the literature ranges from 3.2% to 7.8% [3, 4]. The conversion rate in group A was 3.4% and 2.7% in group B. In total in groups A and B (138 patients), conversions were carried out in four cases (2.8%), demonstrating the experience of the team and the possession of appropriate qualifications for laparoscopic procedures. It should be noted that all cases of endometriosis admitted to our hospital were qualified for laparoscopy independently of the number of previous abdominal surgical procedures. This group was heterogeneous and included cases with a history of 10 abdominal surgeries in the past, as well as those without any surgery at all, although they were in the minority. In our study, previous abdominal surgeries were not considered the exclusion criterion for laparoscopy.

The rate of anastomotic leakage in severe cases is around 1–6% [8], 1–19%[9], 1.8–19% [10]. In our group B treated with the modified technique, in more complex surgeries with two or more resected organs, the risk of anastomotic leakage was 2.8% for the entire group. Excluding patients with coexisting intraoperative complications, the leakage rate was 0.9%. The difference is in favor of our modified technique. We are convinced that one of the important advantages of this method is the use of ICG, as determined by Chan et al. as well [11]. In a systematic evaluation of 5,498 patients from 20 studies, including two randomized controlled trials conducted to assess the use of ICG fluorescence imaging in patients undergoing colon surgery, it was shown that ICG can considerably reduce the likelihood of an anastomotic leak. The number of studies reporting benefits of ICG in patients with endometriosis is lower, but the results are consistent [12, 13]. The use of ICG plays a crucial role as a tailored surgery in deep infiltrated bowel endometriosis compared with the classic technique used in traditional colon surgery. The tailored surgery in deep infiltrated bowel

endometriosis is strongly recommended by most specialists experienced in surgery conducted in endometriosis [14, 15].

Some centers recommend and perform protective stoma for all low rectum resections [16, 17], while others recommend them for patients who have other intraoperative risk factors for leakage [18]. In our group, protective stoma was performed only in a few very complex cases and one case of a very low resection that led to the rate of 2.9% in the entire segmental bowel resection group (138 patients). We observed only one leakage in the low rectum resection group treated with the modified technique (1/16; 5.4%) and one in the classical technique (1/4; 25%). For a more adequate conclusion in this category, we would need a larger group of low resections. However, in our observation, the low resection of the rectum is an important risk factor for leakage. Even in this group, it is worth using the modified technique and deciding on a case-by-case basis whether to do or not to do the protective stoma. From our point of view, the crucial issues are to be prudent about hemostasis, about the vascularity of the saved bowel and the tension of the tissue, which many other authors have also pointed out [19–21]. As we observed, the extent of excised tissues (*e.g.*, levator ani and other muscles, as well as other layers of low pelvic muscles) increases the risk of the leakage, and it should be a decision-making factor for the need for protective stoma [22]. In summary, what makes our modified technique more unique and very suitable is not only tailored surgery and detection of vascularity with the ICG but also a coherent use of fibrin sealant, which was used before by other surgeons [23, 24], but not in combination with all other agents, decreasing, in our opinion, the risk of leakage.

Our study is not without limitations. The study group is relatively small, with an uneven distribution of cases among the techniques studied. We observed a low number of complications/leakages and a low number of patients who were operated with the classical technique due to ethical reasons. After obtaining preliminary results, we could not qualify more patients for that less effective method.

CONCLUSIONS

In deep infiltrated endometriosis, the modified technique of segmental bowel resection showed superiority over the classic technique of segmental bowel resection in terms of the risk of anastomotic leakage. This risk was lower regardless of the complexity of the surgery and the location of lesions. Our study showed that the modified technique is safer than the classic technique; however, further research is needed on larger populations of patients, including patients at high risk of complications.

Conflict of interest

All authors declare no conflict of interest.

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Table 1. Occurrence of anastomotic leakages per group

	A1	A2	B1	B2	B3	B4	B5
Number of cases	16	14	37	39	6	20	6
Number of leakages	2	1	0	1	1	1	0
Percentage of leakages	12.5%	7.1%	0%	2.5%	16.6%	5%	0%
Total A1–A2; B1–B5	10%		2.8%				
Total B2–B5			4.2%				

Table 2. Characteristics of the groups by complexity of the procedure

	Group A	Group B	P value
Number of cases	30	108	
Number of leakages	3 (10%)	3 (2.8%)	0.117
Complex cases (at least 2 organs)	14 (46.6%)	71 (65.7%)	0.057
Complex cases (at least 3 organs)	0 (0%)	26 (24.1%)	0.001
Conversion to laparotomy	1 (3.4%)	3 (2.8%)	0.999
Procedures done with surgeon	25 (83.3%)	18 (16.7%)	< 0.001
Protective stomas	0 (0%)	4 (3.7%) B4 i B5	0.577

Table 3. Characteristics of the groups by localization of the anastomosis and complications

	Group A	Group B	p value
Number of cases	30	108	–
Number of leakages	3 (10%)	3 (2.8%)	0.117
Low localization of anastomosis < 60 mm	4 (13.3%)	16 (14.8%)	0.999
• Leakage in this group	1/4 (25%)	1/16 (6.3%)	–
Intraoperative complications prior to leakage	0	2/3 (66.6%)	–
Leakage without any prior complications	3/3 (100%)	1/3 (33.3%)	–
Leakage without prior complications in	3 (10%)	1 (0.9%)	0.032

all groups			
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