Journal of Coloproctology

www.jcol.org.br

Original Article

Laparoscopic colorectal cancer resection with natural orifice specimen extraction: a prospective study

Islam H. Metwally[a,*], *Sherif Z. Kotb*[a], *Mohamed A.F. Hegazy*[a], *Waleed Elnahas*[a], *José F. Noguera*[b]

[a] *Oncology Center Mansoura University (OCMU), Surgical Oncology Unit, Mansoura, Dakahlia, Egypt*
[b] *Complejo Hospital Universitario A Coruña (CHUAC), Servicio de Cirugía General y Digestiva, La Coruña, Galicia, Spain*

ARTICLE INFO

Article history:
Received 2 July 2018
Accepted 5 September 2018
Available online 25 September 2018

Keywords:
Colorectal cancer
Laparoscopy
NOTES
Transanal
Transvaginal
NOSE

ABSTRACT

Introduction: Laparoscopic colorectal resection is more and more being employed in the daily oncology practice. Natural orifice techniques to obviate the need for a specimen extraction incision are evolving.
Materials and methods: We studied transanal and transvaginal specimen extraction after laparoscopic colorectal resections prospectively in 16 patients.
Results: The technique was successfully implemented in 75% of the cases. The site of the tumour and the patient age were the significant predictors of the technique success.
Conclusion: The technique is reproducible and can be more widely adopted.

© 2018 Sociedade Brasileira de Coloproctologia. Published by Elsevier Editora Ltda. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

Ressecção laparoscópica do câncer colorretal com extração de espécime em orifício natural: um estudo prospectivo

Palavras-chave:
Câncer colorretal
Laparoscopia
NOTES
Transanal
Transvaginal
NOSE

RESUMO

Introdução: A ressecção colorretal laparoscópica está sendo cada vez mais empregada na prática diária de oncologia. Observa-se uma evolução nas técnicas que usam orifícios naturais de modo a evitar a necessidade de uma incisão para extração de espécimes.
Materiais e métodos: O estudo avaliou prospectivamente a extração transanal e transvaginal de espécimes após ressecções colorretais laparoscópicas em 16 pacientes.
Resultados: A técnica foi implementada com sucesso em 75% dos casos. A localização do tumor e a idade do paciente foram preditores significativos de sucesso da técnica.

* *Corresponding author.*
E-mail: drislamhany@mans.edu.eg (I.H. Metwally).
https://doi.org/10.1016/j.jcol.2018.09.002
2237-9363/© 2018 Sociedade Brasileira de Coloproctologia. Published by Elsevier Editora Ltda. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

Conclusão: A técnica é reprodutível e pode ser mais amplamente adotada.

© 2018 Sociedade Brasileira de Coloproctologia. Publicado por Elsevier Editora Ltda. Este é um artigo Open Access sob uma licença CC BY-NC-ND (http://creativecommons.org/licenses/by-nc-nd/4.0/).

Introduction

Colorectal cancer is the third commonest cancer in the world and the second cause of cancer death.[1]

Studies comparing open to laparoscopic surgery showed many advantages for the laparoscopy, including less neuroendocrine and inflammatory stress responses as proved by lower level of circulating cytokines, together with a better preserved immune response.[2] Also, damaging the peritoneum initiates an inappropriate fibrosis/fibrinolysis activity ending in the formation of abdomino-pelvic adhesions.[3]

Laparoscopic colorectal resection is usually followed by an anastomosis either extracorporeal or intracorporeal. Classically, in either case a minilaparotomy is needed, at least for the specimen extraction. The abdominal incision is done either transversely (as an extension of any port site or Pfannenstiel) or longitudinally (in or outside the midline). This incision is associated with complications, most commonly hernia in top of longitudinal incisions.[4]

As a part of the shift toward Natural Orifice Transluminal Endoscopic Surgery (NOTES), several routes for specimen extraction appeared. These include the vagina, anus, orogastric, and some consider the umbilicus as a natural orifice route. However, in colorectal surgery the vagina and anus remain the widely accepted options.[5]

Vaginal Natural Orifice Specimen Extraction (NOSE) in colorectal surgery was first reported in a case of colonic sarcoma in 1991, after its previous use in the extraction of uterine myomas, appendices and ovarian cysts.[6] Although it has several advantages being the vagina extensible (it accommodates a baby), easy and direct, the risk of contamination and dyspareunia reported by some authors remained a limitation. The other problem of Transvaginal Specimen Extraction (TVSE) is that it is an option only in females and so cannot address the specimen extraction issue in male patients.[7] Two options are available for TVSE either removal of the whole specimen after complete separation by staplers, in right hemicolectomy or total colectomy[4,8] or delivery of the specimen after cutting the distal end only so that the anvil of the circular stapler is introduced through the vagina in left hemicolectomy, sigmoidectomy and proctectomy. The problem in the second technique is that with traction the artery of Riolan and the marginal artery of Drummond are vulnerable.[9]

On the other hand, the transanal NOSE was first described later in 1993.[10] It is advantageous to TVSE in being non-sex related procedure (global technique). However, bulky mesentry/mesorectum, sizable tumours, and narrow anus may make it difficult and hazardous for anal sphincter function. Many techniques were described, including direct colon exteriorization with specimen in situ with/without a wound protector, exteriorization with rigid transanal endoscopic surgery platform (TEM/TEO) and extraction after intracorporeal resection of the specimen with an endoscopic bag.[11,12]

Wolthuis et al. in his systematic review of the NOSE techniques divided the extraction site for better assessment into 4 categories: transanal (in case of total proctectomy), transrectal (in case of sigmoidectomy or anterior resection where the specimen pass through partially intact rectum), transcolonic (in case of resection of other parts of the colon necessitating passage of the specimen through intact colon, rectum and anal canal), or transvaginal (in case the specimen is extracted through a posterior colpotomy).[13]

The advantages of NOSE, or what is called by some scholars 'total laparoscopic surgery' is actually augmentation of the known minimally invasive advantages, including less pain with lower need of postoperative analgesia, lower incisional hernia rate and better cosmesis.[14,15]

In this study, the authors discuss their experience with the NOSE technique, aiming to identify the predictors of success of the technique and highlighting the difficulties and gains of this approach.

Patients and methods

Patients

During the three-year period from November 2014 till November 2017, sixteen patients (11 from Egypt and 5 from Spain) with colorectal cancer were enrolled in a prospective pilot study to assess the feasibility, difficulties and short-term outcomes of employing NOSE technique after laparoscopic resection of malignant colorectal tumours.

The inclusion criteria were medically fit patients of any age with pathologically proven colon or rectal cancer without distant spread as proved by CT scan of chest, abdomen and pelvis. Patients were excluded if (a) high risk with American Society of Anesthesiologist (ASA) score four or five; (b) had chest or cardiac problems that prohibit CO_2 insufflation; (c) locally advanced, obstructed or perforated tumours.

Patients were operated by senior colorectal surgeons/surgical oncologists; all patients were consented and the study obtained ethical committee approval.

Operative technique

Conventional multiport laparoscopic surgery was done (number of ports ranged from 3 to 5) in a stepwise fashion; abdominal exploration, dissection medial to lateral, control of the vascular pedicle, opening the paracolic gutter, then natural orifice specimen extraction either.

Transanal/Transrectal: in this case the distal margin was cut by staplers or directly with diathermy, then two methods

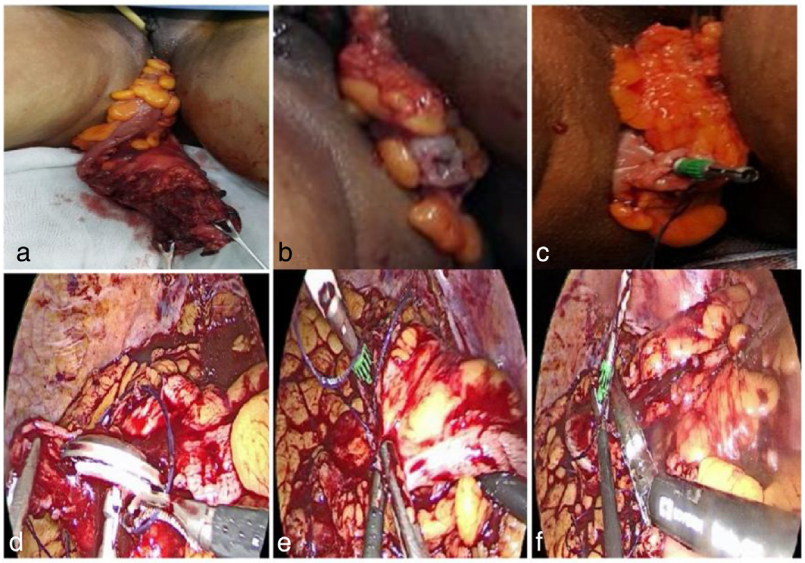

Fig. 1 – (a) Exteriorization of the rectum with the tumour through the anal canal. (b) Resection of the colon extracorporeally. (c) Inserted anvil with a purse string suture around it. (d and e) Insertion of an anvil introduced transanally through a proximal colotomy. (f) Cutting below the anvil with a linear laparoscopic stapler.

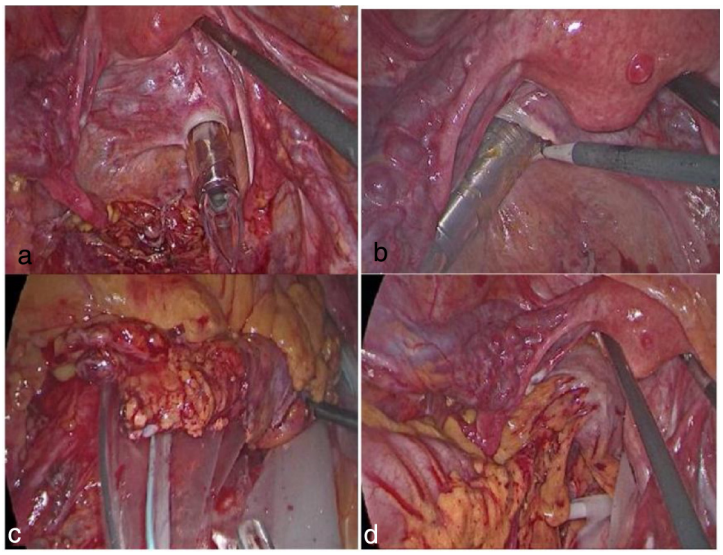

Fig. 2 – (a) Insertion of a long size 12 mm trocar in the posterior vaginal fornix. (b) Widening of the posterior colpotomy by monopolar diathermy on a hook. (c) Putting the specimen in an endobag. (d) Transvaginal extraction of the specimen with the colon in continuity.

were used either; (a) exteriorization of the specimen (Fig. 1a) and extracorporeal resection of the tumour (Fig. 1b), then insertion of the anvil (Fig. 1c) with closure of the stump and stapled anastomosis (1 case) or hand-sewn anastomosis (9 cases) or closure in preparation for a Hartmann's stoma (1 case), or (b) if short mesentery or long rectal stump the anvil was introduced transanally proximal to the site of proposed resection (Fig. 1d and e), then the proximal margin was controlled with linear stapler intracorporeally (1 case) (Fig. 1f), then the colon was extracted and finally the distal stump was closed. Thereafter, the anastomosis was done by a circular stapler with a size 29–33 mm.

Transvaginal: A colpotomy was done in the posterior fornix (Fig. 2a and b), then in this case if right-sided tumours (1 case) the colon was completely resected intracorporeally then exteriorized with an endoscopic bag, but if left sided the distal margin was cut and the colon exteriorized as in transanal NOSE (Fig. 2c and d) with the anvil inserted extracorporeally (2 cases). Thereafter, the vagina was closed by 3 simple/continuous sutures transvaginally.

Table 1 – The operative details of the patients enrolled in the study.

Operative details	Patients
Conversion rate	3 cases were supplemented by Pfannenstiel incision while 1 was complemented by a midline incision.
Specimen extraction	Transanal/transrectal route in 13 cases and transvaginal in 3 cases.
Anastomosis	10 hand-sewn, 3 double stapling, 1 triple stapling, 1 single stapling and with 1 no anastomosis. In 14 cases the anastomosis was end to end, while in 1 patient after a right hemicolectomy a side-to-side anastomosis was done.
Operative time	The mean operative time was 297 min (SD = 94 min).
Blood loss	The median blood loss was 300 mL (with range 700 mL).
Intraoperative blood transfusion	5 cases received transfusion (1–2 packs).
Ostomy	In 7 cases no stoma, while in 6 patients an ileostomy, in 2 cases transverse colostomy and in 1 Hartmann's colostomy.

Table 2 – Complications encountered during the follow up of the patients in the study, its grading on the Clavien-Dindo scale and the treatment applied.

Complication	Clavien-Dindo	Treatment
2 Pulmonary embolism	IVa	Both survived on conservative measures
4 Anastomotic stenosis	IIIb	3 ended by permanent stoma and 1 treated by resection anastomosis
1 Partial disruption of coloanal anastomosis	IIIb	Transanal debridement and refashioning
1 Major bleeding	IIIb	Exploration
1 Intestinal obstruction	IIIb	Exploration and resection anastomosis of jejunal volvulus
1 Minor leak and perirectal abscess	IIIa	Transanal drainage and antibiotics
1 Urine retention	I	Urine catheter
4 Wound infections	I	Antibiotics

Statistical analysis

The data were analyzed and statistical values were obtained using SPSS version 22 (Chicago, IL). Continuous variables are presented as mean and standard deviation when symmetrical or median and range when asymmetrical. Categorical variables are presented as proportions. Bivariate analysis was done using Student's *t*-test, Mann-Whitney and Chi-Square test. p-value < 0.05 was considered significant.

Results

Ten females and six males were included in this study. The mean age of the patients enrolled was 52.1 years old (SD = 12.6) and the mean Body Mass Index (BMI) was 28.2 (SD = 4.6). Half of the cases were located in the low-rectum, 5 cases in the sigmoid, two in the mid-rectum, while one in the ascending colon. The median distance of the tumour from the anal verge was 5 cm (ranging from 2 to 25 cm) and the median lesion size was 3.7 cm (ranging from no detected lesion post neoadjuvant therapy to 7 cm).

The postoperative pathology was conventional adenocarcinoma in 11 patients, mucinous adenocarcinoma in 4 patients and one with serrated adenoma with high-grade dysplasia. About third of the cases were Stage II (37.5%) and another third were Stage III (31.3%). The median number of lymph nodes retrieved was 11 (ranging from 1 to 26 nodes), nodes infiltrated ranged from 0 to 12. Eight patients with rectal cancer cases received concurrent chemotherapy with long course radiotherapy, one sigmoid cancer received neoadjuvant chemotherapy, while the other 7 cases did not receive any neoadjuvant therapy. The response to neoadjuvant therapy was no or minimal in 3 cases, moderate in other 3, good in 1 and complete response with no residual tumour in one patient. Two patients showed infiltrated margins, one distal and one circumferential.

In the vast majority of cases the transanal/transrectal route was the proposed site of specimen extraction, while in 3 cases the transvaginal route was used. The NOSE procedure failed in 4 patients. The causes of failure was the inability to extract the specimen transrectally in one patient, while in another one the distal rectal stump was ragged and not feasible for laparoscopic closure, in the other two the distal margin appeared ischemic after exteriorization and extraction necessitating redo resection anastomosis. In the 4 cases, an abdominal incision was done (Table 1). Postoperative complications occurred in 10 cases (62.5% of patients) including four wound infections (Table 2).

Median hospital stay was 8.5 days (ranging from 5 to 45). Oral intake was started with median 2.5 days (ranged from 1 to 7). Anastomotic leak occurred in one case.

Primary outcome was the success rate of the procedure. The success rate of NOSE was significantly correlated with the site of the tumour, where tumours in the rectum were readily feasible for extraction whatever the size, in comparison with sigmoid tumours ($p = 0.008$). In addition the technique was significantly successful in young age patients ($p = 0.013$) with 95% confidence intervals (−30.46, −4.36) (Table 3).

Secondary outcomes were operative time, wound infection rate, time to start oral intake, hospital stay and postoperative complications. The patients who underwent NOSE were

Table 3 – Predictors of NOSE technique success.

Parameter	Natural orifice extraction (NOSE)		*p*-value
	Succeeded (12 cases)	Failed (4 cases)	
Age	Mean 48.09 (SD = 10.88)	Mean 65.5 (SD = 8.35)	0.013
BMI	Mean 28.05 (SD = 5.07)	Mean 27.3 (SD = 4.84)	0.838
Site	8 low rectum, 2 mid-rectum, 1 sigmoid and 1 ascending	4 sigmoid	0.008
Size	Mean 3.77 (SD = 1.62)	Mean 3.62 (SD = 2.72)	0.904
Distance from anal verge	Median 5 (range 2–25)	Median 15 (range 15–25)	0.27

Table 4 – (A) A comparison between the patients who succeeded in one arm and those who failed the NOSE technique in the other arm. (B) A comparison between the patients who succeeded in one arm (excluding the ISR group) and those who failed the NOSE technique in the other arm.

A

Parameter	Natural orifice extraction (NOSE)		*p*-value
	Succeeded (12 cases)	Failed (4 cases)	
Operative time	Mean 277 (SD = 93)	Mean 285 (SD = 110)	0.509
Hospital stay	Median 8.5 (range 6–45)	Median 7.5 (range 5–12)	1
Oral intake	Median 3.5 (range 1–7)	Median 1 (range 1–5)	0.559
Blood loss	Median 300 (range 150–750)	Median 375 (range 50–650)	0.810
LN retrieved	Median 10 (range 1–26)	Median 11 (range 4–14)	0.792
Wound infection	2 cases	2 cases	0.248
Other complications	7 cases	1 case	0.182

B

Parameter	Natural orifice extraction (NOSE)		*p*-value
	Succeeded (5 cases)	Failed (4 cases)	
Operative time	Mean 269 (SD = 145)	Mean 285 (SD = 111)	0.86
Hospital stay	Mean 6.8 (SD = 1.3)	Mean 8 (SD = 3.6)	0.56
Oral intake	Median 2 (range 1–5)	Median 1 (range 1–5)	0.6
Blood loss	Median 300 (range 150–300)	Median 375 (range 50–650)	0.97
LN retrieved	Mean 18.6 (SD = 9.3)	Mean 10 (SD = 4.2)	0.135
Wound infection	Not encountered	2 cases	0.073
Other complications	2 cases	1 case	0.635

compared in these parameters to those who failed the procedure, but none showed a statistically significant difference (Table 4a).

Excluding the patients with very low rectal cancer who required intersphincteric resection (ISR), the NOSE group showed shorter hospital stay (patients were discharged with mean 1.2 days earlier), shorter operative time (mean 16 min less), less blood loss and negligible wound infection. Number of LN retrieved was even greater in those with succeeded natural orifice extraction. However, the small number of patients probably led to statistical insignificant results (Table 4b).

Discussion

NOSE was proved equivalent in long-term oncological outcomes in patients with rectal cancer compared with conventional laparoscopy-assisted surgery. Moreover, in Park et al. study, the use of transanal and transvaginal routes for specimen extraction had no adverse effects on anorectal and sexual functions, respectively, during midterm follow-up.[16]

To date, limited data are available to inform which cases are appropriate for NOSE after laparoscopic colorectal resections. Karagul et al. recruited 72 consecutive cases that were intended for NOSE after colorectal resection. In his study, he always chose the transanal route as the primary option, while the transvaginal route was tried in female patients as a second option after failure of extraction transanally. In case of failure of both routes, the specimen was considered unsuitable for NOSE and was removed through an abdominal wall incision. He concluded that nearly 2/3 of the laparoscopic colorectal resections were suitable for NOSE. The success rate was higher with rectal resections, female patients and small tumours.[17] The success rate of the technique in our patients was 75%. Here, it should be clarified that the failure is defined as either failure of extraction which occurred only in one case or development of a technical problem related to the NOSE that necessitated making an incision for redo-anastomosis or closure of the distal stump.

In the literature, tumor size was limited to a maximum of 6.5 cm as an inclusion criterion for studies on the transanal NOSE approach.[18] However, other authors do not consider the specimen size alone to be a restricting criterion for the use of the transanal route for specimen removal. Also, the three dimensional configuration of the mass play a role in the success of the NOSE procedure, where some masses have a pattern that permits removal more easily in spite of their large sizes.[17] On the other hand, some authors reported removal

of 8 cm tumours[19] and others removed 9 cm ascending colon mass transvaginally without any problem.[20] In this study, the tumour size was not a significant determinant of the success rate of the NOSE technique and we could extract a 7 cm tumour transvaginally.

Another important consideration is the tumour site. For example, small tumours located in the caecum or ascending colon may fail to be extracted. The more distal the tumor location, the more successful it can be extracted. Moreover, it was suggested that the consistency of the tumor is important in the specimen removal, where authors reported not having a challenge in removing transrectally a sigmoid colon with a 12 cm size villous adenoma.[17] This correlates with our finding that the tumour site was a determinant factor for the success of the NOSE technique, with rectal tumours being readily extracted whatever their size. However, this may not apply in a similar manner to the transvaginal route, which in this series never failed to extract the specimen.

Ischemic anastomosis represented the most important withdrawal of the NOSE technique in our study; it was detected intraoperatively in 2 cases for whom a TVSE was planned. To avoid ischemic anastomosis: first, the tension on the mesocolon should be avoided during the specimen extraction; second, pulling should be applied to the colon rather than the mesocolon; third, mobilization of the splenic flexure is essential.[9] Other authors did not recommend TVSE for patients with narrow vagina, pelvic surgery or endometriosis.[21]

The failure of the NOSE in this study was also significantly related to the age of the patient. This can be explained by the better vascularity in the proximal end after exteriorization of the specimen in the young aged group in comparison to possible atherosclerosis of marginal vessels in old age patients, reflected as higher incidence of ischemia necessitating abdominal incision and redo-anastomosis in the later group of patients. However, this finding was not mentioned in any other study to our knowledge.

Bacterial contamination of the pelvis related to transanal/transvaginal specimen extraction was studied by few authors; some showed an increased bacterial count in swabs taken from pelvis in 20%–100% of patients, although the implication of this count was not established. However, some authors recommended vaginal/anal rinsing with povidone-iodine, using wound protector, and giving prophylactic perioperative multiple doses of antibiotics to address this problem.[22] Other studies showed no significant difference in the infection rate between NOSE and conventional extraction.[23] In concordance, in this study there was no vaginal infections after transvaginal extraction, also the rate of wound infection were not increased in those who succeeded the NOSE procedure.

In this study, the failure to prove superiority of the NOSE technique in those patients who succeeded the procedure over the conventional extraction in those who failed the procedure can be explained by the fact that 7 of the patients who underwent successful extraction were very low tumours treated with ISR, a colorectal surgery with renowned high complication rate. In addition, the small number of cases with aborted procedure (4 cases) made the statistical analysis difficult. However, excluding patients with ISR, the operative time, blood loss, hospital stay and wound infection were lower in those with succeeded the NOSE procedure (Table 4).

The authors declare that small number of patients, inclusion of more than one NOSE technique and operation by different surgeons are limitations to this work. However, being a prospective study is the main strength of the work.

Conclusion

NOSE technique is suitable for most of the patients undergoing laparoscopic recto-sigmoid resections with limited complications related to the technique. In females, the transvaginal route can further extend the indications of the NOSE procedure to the whole colon. The lower site of the tumour and the young age of the patient are the main factors increasing the probability of the NOSE technique success. Minimal scar is the dominant advantages of this technique. However, we could not prove superiority as regard wound infection, operative blood loss and hospitalization over conventional laparoscopy.

Future randomized trials comparing conventional to NOSE colorectal procedures, and others comparing the transvaginal to the transanal extraction routes in female patients are required to further delineate the rule of the NOSE technique.

Conflicts of interest

The authors declare no conflicts of interest.

JFN reports personal fees from Medtronic, other from Johnson & Johnson, outside the submitted work.

REFERENCES

1. World Health Organization. GLOBOCAN 2012: estimated cancer incidence, mortality and prevalence worldwide in 2012. Lyon, France: International Agency for Research on Cancer; 2014.
2. Grande M, Tucci G, Adorisio O, Barini A, Rulli F, Neri A, et al. Systemic acute-phase response after laparoscopic and open cholecystectomy. Surg Endosc. 2002;16:313–6.
3. Milingos S, Kallipolitis G, Loutradis D, Liapi A, Mavrommatis K, Drakakis P, et al. Adhesions: laparoscopic surgery versus laparotomy. Ann NY Acad Sci. 2000;900:272–85.
4. Palanivelu C, Rangarajan M, Jategaonkar PA, Anand NV. An innovative technique for colorectal specimen retrieval: a new era of "natural orifice specimen extraction" (NOSE). Dis Colon Rectum. 2008;51:1120–4.
5. Cai J-C, Hong X-Y. Laparoscopic-assisted natural orifice specimen extraction radical descending colectomy using a cai tube. World J Surg. 2016;40:2803–7.
6. Cooperman AM, Katz V, Zimmon D, Botero G. Laparoscopic colon resection: a case report. J Laparoendosc Surg. 1991;1:221–4.
7. Diana M, Perretta S, Wall J, Costantino F, Leroy J, Demartines N, et al. Transvaginal specimen extraction in colorectal surgery: current state of the art. Colorectal Dis. 2011;13:e104–11.
8. Awad ZT, Griffin R. Laparoscopic right hemicolectomy: a comparison of natural orifice versus transabdominal specimen extraction. Surg Endosc. 2014;28:2871–6.

9. Tarantino I, Linke GR, Lange J, Siercks I, Warschkow R, Zerz A. Transvaginal rigid-hybrid natural orifice transluminal endoscopic surgery technique for anterior resection treatment of diverticulitis: a feasibility study. Surg Endosc. 2011;25:3034–42.
10. Franklin ME, Ramos R, Rosenthal D, Schuessler W. Laparoscopic colonic procedures. World J Surg. 1993;17:51–6.
11. Hisada M, Katsumata K, Ishizaki T, Enomoto M, Matsudo T, Kasuya K, et al. Complete laparoscopic resection of the rectum using natural orifice specimen extraction. World J Gastroenterol. 2014;20:16707–13.
12. Metwally IH. Natural orifice specimen extraction (NOSE); an incisionless approach for colorectal cancer: technical report. World J Lap Surg. 2018:11.
13. Wolthuis AM, de Buck van Overstraeten A, D'Hoore A. Laparoscopic natural orifice specimen extraction-colectomy: a systematic review. World J Gastroenterol. 2014;20: 12981–92.
14. Xingmao Z, Haitao Z, Jianwei L, Huirong H, Junjie H, Zhixiang Z. Totally laparoscopic resection with natural orifice specimen extraction (NOSE) has more advantages comparing with laparoscopic-assisted resection for selected patients with sigmoid colon or rectal cancer. Int J Colorectal Dis. 2014;29:1119–24.
15. Wolthuis A, Fieuws S, Van Den Bosch A, de Buck van Overstraeten A, D'Hoore A. Randomized clinical trial of laparoscopic colectomy with or without natural-orifice specimen extraction. Br J Surg. 2015;102:630–7.
16. Park JS, Kang H, Park SY, Kim HJ, Lee IT, Choi G-S. Long-term outcomes after natural orifice specimen extraction versus conventional laparoscopy-assisted surgery for rectal cancer: a matched case-control study. Ann Surg Treat Res. 2018;94:26–35.
17. Karagul S, Kayaalp C, Sumer F, Ertugrul I, Kirmizi S, Tardu A, et al. Success rate of natural orifice specimen extraction after laparoscopic colorectal resections. Tech Coloproctol. 2017;21:295–300.
18. Huang CC, Chen YC, Huang CJ, Hsieh JS. Totally laparoscopic colectomy with intracorporeal side-to-end colorectal anastomosis and transrectal specimen extraction for sigmoid and rectal cancers. Ann Surg Oncol. 2016;23:1164–8.
19. Wilson J, Dogiparthi K, Hebblethwaite N, Clarke M. Laparoscopic right hemicolectomy with posterior colpotomy for transvaginal specimen retrieval. Colorectal Dis. 2007;9:662.
20. Yagci MA, Kayaalp C, Novruzov NH. Intracorporeal mesenteric division of the colon can make the specimen more suitable for natural orifice extraction. J Laparoendosc Adv Surg Tech A. 2014;24:484–6.
21. Ma B, Huang XZ, Gao P, Zhao JH, Song YX, Sun JX, et al. Laparoscopic resection with natural orifice specimen extraction versus conventional laparoscopy for colorectal disease: a meta-analysis. Int J Colorectal Dis. 2015;30:1479–88.
22. Ngu J, Wong ASY. Transanal natural orifice specimen extraction in colorectal surgery: bacteriological and oncological concerns. ANZ J Surg. 2016;86:299–302.
23. Costantino FA, Diana M, Wall J, Leroy J, Mutter D, Marescaux J. Prospective evaluation of peritoneal fluid contamination following transabdominal vs. transanal specimen extraction in laparoscopic left-sided colorectal resections. Surg Endosc. 2012;26:1495–500.