



Who is suitable for natural orifice specimen extraction (NOSE) following laparoscopic colorectal surgery: a narrative review

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Background and Objective: Minimally invasive methods in colon and rectum surgery have been widely applied in the last decades. After laparoscopic resections, a new incision in the anterior abdominal wall is required to remove the specimen from the abdomen. This incision reduces the benefits of minimally invasive surgery. Natural orifice specimen extraction (NOSE) enabled the removal of resection materials without additional incisions. The specimen is removed from the abdomen using the transanal or transvaginal route. This procedure has advantages in terms of patient comfort and postoperative morbidity. However, there is no clarity in the literature about which patients and specimens are suitable for removal in this way. The purpose of this review is to evaluate which patients might be more suitable for NOSE.

Methods: Literature search was carried out using PubMed database and Google Scholar to identify relevant articles on NOSE following laparoscopic colorectal surgery.

Key Content and Findings: This article contains a review in selection of patients candidate for natural orifices specimen extraction after laparoscopic colorectal surgery.

Conclusions: It is necessary to make an evaluation that includes various characteristics of the patient and the specimen for NOSE after colorectal surgery. Large tumors and bulky specimens are more difficult to remove. The success rate is low in right colon resections and high in rectal resections. Female patients and patients with low body mass index are more advantageous.

Keywords: Colon; minimal invasive surgery; natural orifice; rectum; transanal; transvaginal

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Introduction

In the last 30 years, with the contribution of technological developments, surgeons have focused on minimally invasive methods. One of the most important developments in this field has been the use of laparoscopic techniques in intra-abdominal surgeries. Oncological results were as successful as open surgeries in laparoscopic resections of colorectal

cancers (1).

The use of laparoscopic methods, especially in procedures where the risk of surgical site infection is high, such as colon and rectal surgeries, has enabled surgeons to make great progress in reducing postoperative morbidities. At the same time, the advantages of small surgical incisions are clearly seen, with benefits such as patient comfort, early

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Table 1 Search strategy

| Items | Specification |
|--------------------------------------|--|
| Date of search | 1 April 2022 |
| Databases and other sources searched | PubMed/Medline, Google Scholar |
| Search terms used | “Natural orifice specimen extraction”, “colorectal*”, “laparoscop*”, transanal specimen extraction” and “transvaginal specimen extraction” |
| Timeframe | January 1993 to April 2022 |
| Inclusion and exclusion criteria | English literature relevant to NOSE after laparoscopic colorectal surgery |
| Selection process | The search was made by the first author. The found articles were reviewed, the suitability of the articles and their contribution to narrative review were evaluated by both authors |

NOSE, natural orifice specimen extraction.

mobilization, and early return to daily life (2-4). Surgical procedures were performed through smaller incisions, such as trying to minimize laparoscopic instruments and applying single port surgeries.

Although colon and rectal cancer surgeries can be completed laparoscopically, an incision must be made in the anterior abdominal wall to remove the specimen from the abdomen. This means an increase in incision-related morbidity (5-7). The experience gained with the use of single port shows us how important the incision made by specimen removal can be a cause of morbidity in minimally invasive surgery (8). It was determined that the size of the incision made with the single port method, regardless of the number of ports, was a factor that increased morbidity. The incision made on the abdominal wall for specimen extraction somewhat reduces the advantages of laparoscopic surgery (9,10). At this point, removing the specimen from the natural orifice emerged as an important development (11-16). There was no difference between conventional methods in terms of local recurrence, disease free survival and overall survival in terms of oncology (17). A threshold has been passed in minimally invasive colorectal surgery with the beginning of the removal of colon and rectal specimens by transanal and transvaginal routes. However, it is not possible to apply this method in every patient. The lack of standardization of NOSE candidates creates difficulties in patient selection. The use of healthy organs, such as the removal of a specimen from a distal intestine that will not be resected, or the use of colpotomy, which is not included in the surgical procedure in the conventional method, raises concerns. Passing the specimen through a narrow structure increases the complexity of the surgery. In addition, NOSE requires experience in the intracorporeal

anastomosis technique. Data showing the advantages of natural orifice specimen extraction (NOSE) over the conventional laparoscopic method, such as reduced postoperative morbidity, less pain, rapid recovery, and good cosmetic results, have begun to emerge (11,12). However, our knowledge on the selection of patients suitable for the NOSE is not sufficient (18). In this article, we aimed to evaluate who might be suitable for specimen extraction via natural orifice in laparoscopic colorectal surgery. This article shares up-to-date information on who can undergo NOSE following laparoscopic colorectal surgery. We present the following article in accordance with the Narrative Review reporting checklist (available at <https://ales.amegroups.com/article/view/10.21037/ales-22-17/rc>).

Methods

Literature search was carried out using PubMed database and Google Scholar to retrieve relevant articles published before April 30, 2022. Searched terms were “natural orifice specimen extraction”, “colorectal*”, “laparoscop*”, transanal specimen extraction” and “transvaginal specimen extraction”. Only English articles were included. The articles were identified and then the abstracts of the selected articles were read. References were also evaluated to reach related studies. Case reports included. Ethics committee approval was not required for the study (*Table 1*).

Size of specimen

There are two natural orifices, vagina and anus, from which the resected specimen can be removed after colon or rectal surgery. The anatomical boundaries of both orifices allow

them to relax up to a certain width. On the one hand, while removing the specimen, on the other hand, care should be taken not to damage the tissues and functions of the natural orifice. The size of the specimen is therefore important. Few studies are available to determine which sizes of specimens are suitable for NOSE. There is a tendency to exclude patients, mostly with tumors larger than a certain diameter (13,19-24). Accordingly, although studies on NOSE have increased in the literature, there has not been enough information about the size of tumors and specimens to which NOSE can be applied.

An important study on this issue was done by our team (18). In this study, we found that tumor size is one of the important factors in the success of NOSE. An international consensus was reported in 2019 on NOSE in colorectal cancers. Since its publication, the consensus has greatly influenced patient selection in subsequent studies. Accordingly, the maximum circumferential diameter of specimen was <3 cm most appropriate for the transanal NOSE, and <5 cm most appropriate for the transvaginal nose (25). Of course, these criteria cover an important group of patients. Although the diameter of specimen is above the criteria in the consensus, it is possible to easily remove some specimens from the natural orifice. Tumor sizes in our study were 3.5 ± 3.1 cm at transanal extraction and 5.4 ± 1.4 cm transvaginally. Kayaalp stated that tumors up to 8 cm in size can be successfully removed with transvaginal NOSE. This systematic review of patients who underwent laparoscopic right colon resection showed that this part of the colon, which is difficult to remove by the transanal route, can be removed via the vagina even when large tumors are present (26). We observed that in addition to tumor size, consistency of the tumor is one of the factors affecting specimen extraction. A soft tumor can be removed more easily than a solid tumor with a little stretching. The procedure can be facilitated by its flexible nature in a soft tumor. We were able to easily transanally remove a 12-cm-sized villous adenoma specimen from the sigmoid colon, even though failures could be seen in some patients with small tumors. The factor in achieving this was that the villous adenoma had a soft consistency despite its large diameter (18). For this reason, the maximum diameter of specimen should not be considered alone while making the final decision.

With transvaginal specimen extraction in large size tumors, female patients have another chance for NOSE. This method for specimen extraction according to tumor size should be evaluated separately in women. In the

randomized study conducted by Zhou *et al.*, 18% failure was observed in the NOSE group, where they only chose the transrectal route. Within the NOSE group, there were 22 patients whose specimens could not be extracted from the natural orifice. The reason for failure in these was large tumor in 13, mesentery thickness in 3 (27). It was not specified how many of the failed NOSE patients were women. Zhu *et al.* shared a valuable randomized study in this area (28). They randomized their patients into three groups: laparoscopic NOSE, laparoscopic non-NOSE, and open surgery. Fourteen of 122 patients randomized for NOSE failed to extract specimens transrectally. Although there was no difference between the groups in terms of tumor size, they unfortunately did not specify in which patients NOSE failed. In studies, unsuccessful cases should be given in detail, as well as successful extractions. In the study we mentioned above, we achieved 80% success with the transvaginal route in 15 female patients in whom transanal extraction was not successful.

The contents of the specimen usually consist of tumor, normal intestinal tissues and mesentery. In addition, colorectal resections are also performed for benign reasons. Although it is not a large tumor, the bulky nature of the specimen prevents its removal from the natural orifice. Division of the mesentery is a method used for the removal of large specimens. By applying the mesenteric division method in a right hemicolectomy specimen with a width of 12 cm, Yagci *et al.* reduced the largest width to 9 cm and were able to extract the specimen transvaginally (29). Bu *et al.* separated the omentum in colon tumors and thus the nose failed in only two patients with large tumors (23). Bulky specimens can be removed by dividing the omentum and mesentery by reducing them to reasonable sizes. The length of the specimen is not a limiting parameter as much as its width. The fact that NOSE can be applied as successfully as the conventional method in laparoscopic total colectomy shows that the length of the specimen is not as effective as the width (30).

Specimen size is important in extracting the specimen from the natural orifice. In the relationship between the size of the specimen and the success of extraction, whether the specimen is bulky or not, the consistency of the tumor, the 3-dimensional shape of the tumor and the extraction route are also influential factors.

Location of specimen

The location of the specimen is one of the factors affecting

the success rate of NOSE in laparoscopic colorectal resections. In transanal specimen extraction, the anal canal is the narrowest transition zone of this pathway. The sigmoid colon constitutes the smallest diameter segment of the colon lumen. In addition, the curved structure of the sigmoid colon creates difficulties for transluminal processes and for passing a specimen distally through it. The right colon is larger in volume than the other parts of the colon. The fact that the specimen to be extracted is located in the proximal segments of the colon increases the possibility of failure of transanal specimen removal.

In laparoscopic rectum resections, removal of the specimen via anus is more attempted and can be performed successfully (27,28,31). In our experience, the NOSE procedure appears to be more successful in rectal tumors (18). Generally, surgeons have a tendency to transanal extraction in left colon resections as well as in the rectum (32,33). One of the reasons for trying to remove the specimen by transanal route in rectum and left colon resections is that no new organ damage has been done by removing the specimen from an opening to be opened for anastomosis, and in addition, the anvil can be sent inside without enlarging abdominal wall incisions. As in rectal resections, it has been shown that the use of the rectum for specimen extraction is safe and feasible in left colon resections (34-36). If there is no bulky mesentery and a large tumor in patients who will undergo left colon resection, the transanal route can be successfully performed by an experienced team, as in rectal tumors.

Due to the narrowness of the descending colon and sigmoid colon and the omega-shaped structure of the sigmoid colon, it is difficult to take out the specimens of the right colon transluminally. In right colon resections, the specimen is taken out of the abdomen by passing this long and curved path transanally. Therefore, specimens located in the right colon through the anus are challenging for NOSE. In female patients, an easy and safe procedure can be applied for specimen extraction using the transvaginal route (37-41). Therefore, in right colon tumors, if the patients are female, the transvaginal route comes to the fore (32,42).

In general, the success rate for NOSE is low in right colon specimens. In our study, we had difficulties in transanal specimen extraction even in small tumors located in the cecum or ascending colon. While our success rate in anterior and low anterior resections was 96.7%, our success rate in right colon resections was only 52.9% (18). Kong *et al.* demonstrated that laparoscopic right hemicolectomy

with transcolonic natural specimen extraction is safe in selected patients. However, bulky tumors were excluded in this study. In addition, only patients with body mass index (BMI) $<28 \text{ kg/m}^2$ were included in the study. With these criteria, transanal NOSE was successfully applied after right hemicolectomy (22).

The location of the specimen is one of the features that affect the success of extraction from the natural orifice. NOSE can be applied in all bowel segments in colon and rectum surgery. The localization of the specimen alone is not a sufficient criterion for performing the procedure. The transanal route can be used for all colon and rectal specimens. Transanal NOSE is more likely to be successful in rectal resections and left colon resections, respectively. This ratio decreases as the resection area moves proximally. Transcolonic extraction can be considered for the removal of right hemicolectomy material in frail male patients with small tumors, female patients who do not allow transvaginal removal, and patients operated on non-tumor indications. The vagina is a useful way of extracting specimens for all large bowel segments in female patients. Especially in right colon resections, the success rate in female patients increases with the use of vagina.

Gender

Anatomically, the differences between men and women also affect the success rates of specimen extraction from natural orifices. The female pelvis is larger in structure than the male pelvis. Male pelvis has a narrower and deeper structure than female pelvis. Huang *et al.* created a nomogram to predict the feasibility of transanal specimen extraction in laparoscopic rectal resections, based on pelvic diameters and pelvic depth measurements. According to this study, wide and shallow pelvis increases the likelihood of successful transanal NOSE (43). In the study, anatomical evaluations were performed with CT. In order to develop truly predictive models, structural evaluation of patients will assist in intraoperative decision making. Planning the specimen extraction procedure based on gender is actually part of this structural evaluation.

Transvaginal extraction can be applied as an option when transanal specimen extraction cannot be achieved in women. It has been observed that the vaginal route can be used for right hemicolectomy specimens. Even a history of surgery, old age and obesity are not contraindications for transvaginal extraction (26). While Gundogan *et al.* achieved a success rate of only 3.8% in men in right colon

resections, they successfully performed NOSE in 61.5% of women (44). For authors, indications for vaginal extraction were tumor smaller than 9 cm, absence of vaginal atresia and virginity. In this way, they successfully removed tumor specimens measuring between 4.5 and 9 cm. Transvaginal route can be used easily in specimens that are not suitable for transanal extraction. In addition, this study suggests that female patients may be more suitable candidates for NOSE in specimens with large tumors and bulky mesentery. In our study, the failure rate in men was 3.3 times higher than in women. We initially tried the transanal route in women as well, and specimen extraction was attempted by the transvaginal route in unsuccessful patients. In this way, the success of NOSE was higher in women in our study (18).

It can be stated that the female pelvis has a more suitable structure anatomically for NOSE. In addition, the use of the vaginal route in right colon tumors and large tumors is also an advantage for female patients. Patient preference, virginity, pelvic anomalies, anal stenosis and anal dysfunction are effective factors in using the anal or transvaginal route for specimen extraction. In male patients, there is no chance of NOSE in large tumors. Gender should also be considered in preoperative NOSE planning in minimally invasive colorectal surgery candidates.

BMI

Laparoscopic surgery can be performed in colon and rectum surgeries with as successful results as open surgeries (45-47). Especially in rectal resections, laparoscopic and robotic surgeries have brought convenience in mobilization and transection of the rectum. High BMI makes laparoscopic surgeries difficult as well as open surgeries (48,49). In patients with a high BMI, it has been observed that minimally invasive surgery of the colon and rectum can be performed successfully, although the available data are scarce (50-53). On the other hand, as the experience of surgeons increases, minimally invasive surgery is preferred more than the open method in gastrointestinal procedures, especially in the obese group. NOSE is a preferred method in patients who are suitable for minimally invasive surgery. Wound complications are more complex in obese patients. The use of natural orifices will reduce the morbidity associated with abdominal wall incision in these patients. However, studies on NOSE in obese patients are not sufficient.

Studies on NOSE in laparoscopic colorectal surgery mostly exclude patients with a BMI above 30. It is

considered more appropriate for a BMI to be below 30 kg/m² for transanal NOSE and below 35 kg/m² for transvaginal NOSE (25). Whereas, specimen removal from natural orifices was also performed successfully in patients with BMI above 30 kg/m² (26,29,54). Wolthuis *et al.* considered a BMI above 35 kg/m² as an exclusion criterion when evaluating patients undergoing transanal NOSE. In this study, 5.5% of the patients had a BMI above 30 kg/m² and NOSE could be applied (55). No difficulties due to high BMI were mentioned in the details of the study. Kayaalp *et al.* demonstrated that obesity is not a contraindication for transvaginal specimen extractions (26). In our opinion, it is also important to reach this result in patients who have undergone right colon resection, because right colon specimens are larger in volume.

The main problem in minimally invasive colorectal surgery is not high BMI but increased visceral adipose tissue. In addition, the body type of the patient is also important. Although BMI is used frequently and easily in the measurement of obesity, the distribution of fat in the body cannot be determined exactly with the BMI. Visceral obesity does not always correlate with BMI (56). On the other hand, the same level of BMI in different ethnic groups should not be taken as a measure of obesity. Although android body type patients are of equal weight with gynoid body type patients, minimally invasive procedures are more challenging. Therefore, other physical characteristics of patients should also be considered.

Obese patients are excluded in the initial experience of specimen extraction, as in every new phase of minimally invasive surgery. More NOSE studies are needed in colorectal surgery patients with high BMI. We predict that as surgical experience increases, the criteria for patients with high BMI will change to some extent. Easier NOSE methods can be found for specimens with bulky mesentery with different surgical maneuvers and manipulations.

Risk of infection

A new abdominal wall incision for specimen removal in laparoscopic surgery also increases the risk of wound infection. However, the opening of highly contaminated natural cavities such as the anus or vagina into the peritoneal cavity due to NOSE has also created suspicions about causing surgical site infection through this method. Bacterial contamination can be seen in a very significant portion of patients treated with NOSE (25,57,58). However, an increase in infectious complications is not

observed with both vaginal and transanal approaches (18,57-59). Liu *et al.* studied the conventional laparoscopic method and the NOSE method in radical colorectal cancer surgery. Bacterial contamination was found to be 30% in the NOSE method, while it was 25.33% in conventional laparoscopic surgery. However, no significant difference was observed between the two groups. In addition, there was no difference between the two groups in terms of postoperative infectious complications (60). In diverticular disease, natural orifices have also been successfully used for specimen extraction (61-64). Although there is a possibility of contamination to the peritoneal cavity, considering its advantages, the use of natural orifices in terms of infection can be safely used as a minimally invasive method. It can be said that NOSE in laparoscopic colorectal procedures is not inferior to conventional methods in terms of surgical site infection (60,65-67). There is an increase in the early inflammatory response with transanal specimen extraction, but this did not have a serious effect on morbidity (13). In order to reduce the risk of contamination until adequate clinical results are obtained, the use of prophylactic antibiotics, mechanical bowel preparation, intraoperative irrigation and lavage may be beneficial in NOSE (25).

Other factors

The NOSE procedure is not recommended in colorectal surgery in the presence of bowel obstruction, perforation and in patients with locally advanced tumors (25). There is no data indicating that features such as age and previous surgery are a barrier to the procedure. It should be noted that the patients do not have an anal stenosis, vaginal stenosis, virginity or any other anatomical obstacle. It is necessary to obtain approval from the patient for the procedure to be performed.

Conclusions

There is a lack of studies in the literature on which patients are more suitable for NOSE. Research has mostly focused on the feasibility and benefits of the procedure. However, before performing NOSE procedures, each patient should be evaluated individually. The characteristics of both the specimen and the patient should be considered when making a decision. Small tumors are more easily removed. The success rate is higher in rectal resections and this rate decreases progressively to the proximal colon. Non-obese patients are considered to be more suitable. The probability

of success is higher in female patients.

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