



Classification of natural orifice specimen extraction surgery (NOSES) for colorectal procedures: a review

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Abstract: Surgery is the primary treatment method for colorectal malignancies, and laparoscopic surgery, the most common method of minimally invasive surgery, has become synonymous with minimally invasive surgery. However, laparoscopic-assisted colorectal cancer surgery frequently requires a 5–10 cm incision in the abdominal wall to remove the specimen, which weakening the minimally invasive effect. In recent years, natural orifice specimen extraction surgery (NOSES), as a new techniques in the field of minimally invasive surgery, has gradually attracted widespread attention of the surgical community and has been widely discussed internationally. NOSES combines the incision-free ideology of natural orifice transluminal endoscopic surgery (NOTES) with the surgical techniques of laparoscopic surgery. It has made significant innovation in the way of tumor specimen extraction, reducing the postoperative pain of patients greatly and improving the postoperative satisfaction of patients without affecting the oncology prognosis, which making it rapidly accepted by surgeons. It has finally achieved the result of ‘no auxiliary abdominal incision’ and has extended its indications to the entire colorectum. Currently, NOSES for colorectal neoplasms has been divided into ten modalities with a total of 21 approaches, depending on their location, size and patient’s gender. There were five modalities for each of the rectal and colonic tumours. This article is the first time that the definition of NOSES, the classification method and the nomenclature of colorectal tumour NOSES are described in detail in the form of an international article, which will hopefully contribute to the promotion of NOSES in the international arena.

Keywords: Colorectal neoplasms; natural orifice specimen extraction surgery (NOSES); minimally invasive surgery; progress; classification; laparoscopic surgery

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With the continuous advancements in medical technology, doctors’ understanding of the disease deepens, and people’s demand for tumour treatment increases, which prompts changes in the medical model of surgical oncology: from the traditional tumour removal and symptom relief to a bio-social-psychological medical model (1). Several new concepts and techniques have been developed. The minimally invasive technique is now the mainstream concept

in surgical oncology and even in surgery. It positively affects both the patient’s return to society post-operatively and the maintenance of the patient’s psychological well-being. Minimally invasive in a broad sense is a philosophy that applies to all invasive surgical procedures. Its core idea is to reduce tissue damage and preserve the autonomic function of the organism as much as possible. Other aspects, such as gentle intraoperative handling and protection of

adjacent tissues and organs, should also be included in the scope of the minimally invasive concept. In a narrower sense, Its clinical application is aimed at obtaining the best possible surgical outcome with minimal trauma or invasion. Laparoscopic surgery is the most well-known minimally invasive surgery because it transforms large incisions of a previous open surgery into smaller incisions of 5–10 cm only. However, laparoscopic surgery is only one form of minimally invasive surgery. Strictly speaking, the laparoscopic technique is only a minimally invasive embodiment of surgical access and addresses surgical access problems.

At present, when surgeons perform most laparoscopic assisted colorectal cancer operations, they still cut the abdominal wall to remove the specimens, making the minimally invasive results much less effective. The natural orifice transluminal endoscopic surgery (NOTES) uses a flexible endoscope to access the body cavity through the natural lumen and to perform various endoscopic procedures (2). It is a breakthrough in minimally invasive surgery, avoiding the need for an abdominal incision and overturning the traditional concept of minimally invasive surgery to the ultimate ‘incision-free’ concept. However, the technique is extremely difficult, requires a long training period and a high level of anatomical understanding is unfriendly to young surgeons and has limited indications. Hence, natural orifice specimen extraction surgery (NOSES) combines the ‘no-incision’ concept of NOTES with technical skills of laparoscopy to achieve the goal of no-assisted abdominal incision based on the existing laparoscopic techniques. NOSES aims to achieve the goal of no auxiliary abdominal incision based on existing laparoscopic techniques and to expand the range of indications compared to NOTES (3). The latest finding showed that NOSES has the advantages of faster postoperative recovery, less postoperative pain and better cosmetic results than conventional laparoscopic surgery, with no increased risk of postoperative complications (4). In China, there have been more than 200 hospitals and more than 8,000 cases of colorectal cancer NOSES surgery data uploaded to the China NOSES database (CNDB), which indicates that colorectal cancer NOSES has received extensive attention from Chinese surgeons and has a growing trend of prosperity (5). The International Alliance of NOSES was established in 2018. The book, *Natural Orifice Specimen Extraction Surgery*, had been translated into English, Russian, French, Japanese, Korean and many other languages.

At present, NOSES for colorectal cancer has been divided into ten modalities depending on the tumour location and size, with a total of 21 methods. This review, for the first time, expounded the naming rules of NOSES completely and systematically, and slightly modifies the names of these 21 methods to make these names more accurate. In this way, it would be more efficient and easier for surgeons in international communication, publish articles, or retrieve research progress.

NOSES naming and definition

NOSES is defined as follows: surgical procedures, including specimen resection or reconstruction, are performed intracorporeally by laparoscopic, robotic device or flexible endoscopy, followed by specimen extraction through a natural orifice (anus, vagina or mouth) (3,6). The main difference between this procedure and conventional laparoscopic surgery is that the specimen is removed through the natural cavity, avoiding the need for an auxiliary abdominal wall incision, and leaving only a few tiny poke marks in the abdominal wall post-procedure.

In addition to NOSES, NOTES and taTME (transanal total mesorectal excision), which have gradually emerged in recent years, are also representatives of minimally invasive technologies. NOTES is a surgery that uses the natural opening and lumen of the human body to penetrate the endoscope into the body cavity to perform endoscopic surgery. Natural orifices include stomach, colon, vagina and other natural orifices. The wall of the digestive tract is penetrated to establish a channel, and the endoscope is sent into the abdominal cavity to complete endoscopic exploration, biopsy, lesion removal and other operations (2). All surgeries are performed through the natural cavity. In recent years, a series of concepts associated with NOTES have been gradually proposed, such as pre-NOTES, pure-NOTES and hybrid-NOTES, by combining different instruments and equipment and various surgical methods (7-9). The common aim of these three technologies is to maximise the minimally invasive effects and minimize the postoperative abdominal wall dysfunction through the way that there is no auxiliary incision on the abdominal wall. taTME is a transanal lumpectomy performed using the total mesorectal excision (TME) or transanal minimally invasive surgery platform, using a ‘top-down’ approach and following the TME principles (10). Its main characteristics are a retrograde transanal approach and the absence of incisions and scars on the abdominal wall.

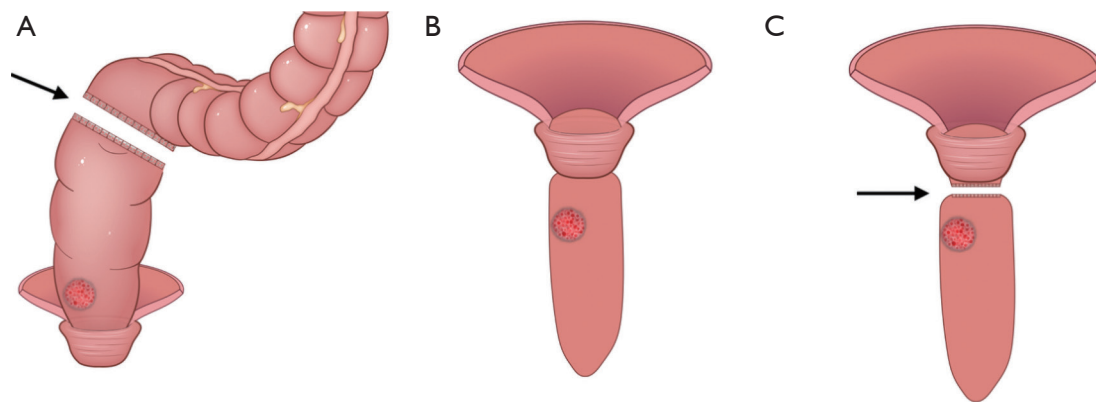


Figure 1 Main surgical procedures of specimen extraction in the eversion-resection technique. (A) Proximal bowel division is performed using a linear stapler (the black arrow marks the resection line); (B) the rectal specimen is everted out of the body transanally; (C) the distal rectal resection is performed extra-abdominally (the black arrow marks the resection line).

The definitions of NOSES, NOTES and taTME show that NOSES has the broadest scope, encompassing both NOTES and taTME and that it emphasises the combination of the ‘no-incision’ concept with conventional equipment to perform conventional intra-abdominal surgery using a transabdominal approach and to fully use the natural cavity. NOSES is a minimally invasive procedure that uses the natural cavity to remove the specimen. Conversely, NOTES is a great challenge to the traditional open surgery, because it changes the way to take an operation for organs in the body, and can perform various diagnosis or treatment related operations. As the route of specimen removal in NOTES is also via the natural lumen, NOTES should be considered part of NOSES from this point of view. NOSES and NOTES are two broad surgical concepts applied to a wide range of tissues and organs, whereas taTME is a narrow surgical concept limited to the rectum. The surgery is performed through an anal approach using a ‘reverse’ surgery from the anus to the abdominal cavity to free and remove the entire rectal mesentery and remove the specimen through the anus, and thereby, taTME is part of NOTES.

Classification of colorectal neoplasms using NOSES

NOSES can be classified in two ways: one method is based on the natural lumen from which the specimen is removed and can be grouped under three categories (transrectal-anal, transvaginal and transoral NOSES), and colorectal cancer NOSES hardly involving transoral specimens

and are mainly classified into two classes (transrectal-anal and transvaginal specimens). Transanal specimens are mainly used for patients with small specimens that can be easily removed, whereas transvaginal specimens are mainly used for female patients with larger specimens that are difficult to remove through the anus. The other method is based on the method of specimen removal, which can be divided into three classes [transanal specimen eversion and extracorporeal resection technique (eversion-resection) (*Figure 1*), transluminal specimen extraction and extracorporeal resection technique (resection-extraction) (*Figure 2*), and intra-abdominal specimen resection and transluminal extraction technique (extraction-resection) (*Figure 3*)]. Different surgical approaches have various operational characteristics and techniques; however, the decisive factor influencing the choice of surgical approach is the tumour location. For colorectal tumours, eversion-resection is mainly used for patients with low rectal tumours, while extraction-resection is more appropriate for mid-rectal tumours and resection-extraction most widely used for the high rectum, sigmoid colon, left hemicolectomy, right hemicolectomy and total colon.

Surgical approach to NOSES for colorectal tumours

When the colorectal tumour NOSES system was first established, the authors divided the colorectal tumour NOSES into ten categories based on the different ways of specimen removal and routes of specimen collection. These included five types of rectal surgeries for high,

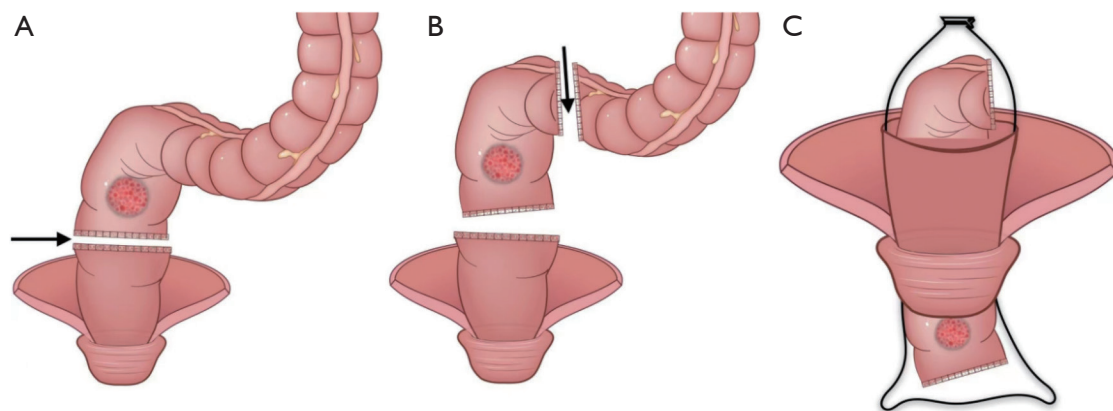


Figure 2 Main surgical procedures of specimen extraction in the resection-extraction technique. (A) Distal bowel division is performed using a linear stapler (the black arrow marks the resection line); (B) the proximal bowel division is performed using a linear stapler (the black arrow marks the resection line); (C) the specimen is placed inside a protective bag and extracted transanally.

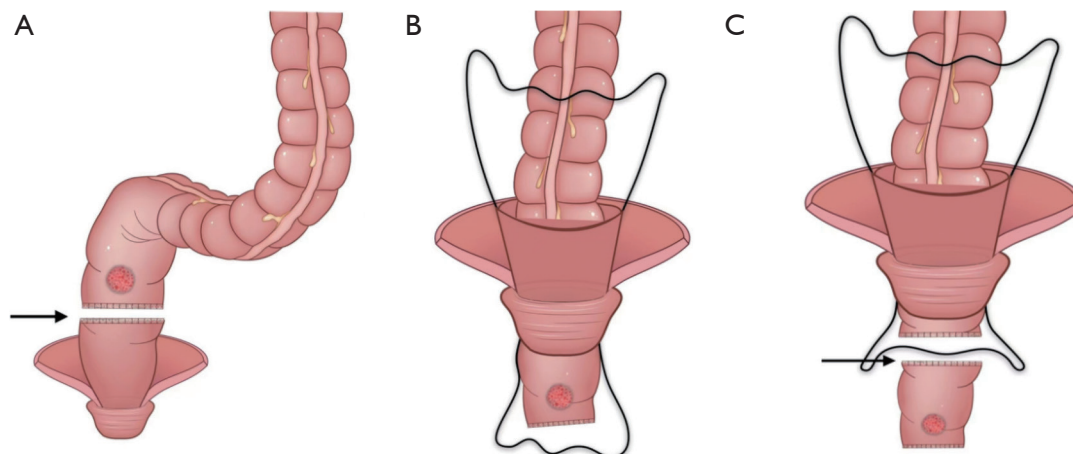


Figure 3 Main surgical procedures of specimen extraction in the extraction-resection technique. (A) Distal bowel division is performed using a linear stapler (the black arrow marks the resection line); (B) the distal rectal stump is opened, and the distal side of the specimen is extracted transanally through the protective bag; (C) the proximal rectal resection is performed extra-abdominally (the black arrow marks the resection line).

medium and low rectal tumours, and five types of colon surgery for the left hemicolectomy, right hemicolectomy and total colon. With the advancements in international research and discussion on NOSES for colorectal tumours, the NOSES system for colorectal tumours has now been developed into ten approaches with a total of 20 methods. Among them, NOSES I for low rectal tumours is further divided into six methods: NOSES IA and NOSES IB are transanal specimen eversion and extracorporeal resection techniques, NOSES IC is the park technique, NOSES ID is intersphincteric resection (ISR) technique, NOSES IE

is the bacon technique and NOSES IF is invented by Prof. Petr V. Tsarkov (11). Furthermore, for transverse colon and right hemicolectomy tumours, the authors also creatively take specimens through the vagina or rectum. Although these types of NOSES are less commonly performed in clinical practice and are still subject to some question and controversy, as a new surgical procedure and surgical concept, it must be continuously improved and perfected amidst the constant questioning and controversy and eventually recognised and supported by the majority of medical practitioners and patients.

Nomenclature of colorectal tumour NOSES

In the *Natural Orifice Specimen Extraction Surgery-Gastrointestinal Tumour (Second Edition)*, the authors identify NOSES procedures based on the removal route and tumour location. Overall, the name is derived from a combination of the location of the tumour and the orifice of removal of the specimen. For example, laparoscopic upper rectal cancer resection with transanal specimen extraction (NOSES IV), the ‘upper rectal cancer’ represents the location of the tumour, and ‘transanal specimen extraction’ for the orifice of removal of the specimen. According to the differences in some details of specific operations, letters are added after the names of NOSES for tumors at the same location to distinguish them. For example, NOSES I is divided into six methods A to F. For the specific operation methods of each NOSES operation, the reader can refer to the book ‘*Natural Orifice Specimen Extraction Surgery-Gastrointestinal Tumour (Second Edition)*’.

With the increasing number of NOSES procedures, the authors have revised the nomenclature of NOSES procedures, making them more distinctive and accurate. For example, in colonic tumours, the previous routine surgical operation did not involve the rectum, whereas NOSES required a rectal incision; therefore, the original ‘transrectal specimen retrieval’ was changed to ‘transrectal incisional specimen retrieval’. According to the methods of resection of low rectal cancer specimens, NOSES I can be divided into two methods: laparoscopic lower rectal cancer eversion and resection with transanal specimen extraction and laparoscopic lower rectal cancer resection with transanal specimen extraction. It is the first time that the new NOSES system has been reported internationally.

Conclusions

The NOSES procedure has opened up new ideas and directions for surgery. It is based on conventional laparoscopic surgery, the difficulty is totally performed under laparoscopic and the way in which the specimen is extracted is the innovation. All of these make NOSES highly maneuvered, widely indicated and easily generalized. Through the convergence of international thinking of fellow surgeons, the NOSES system for colorectal tumours remains mature and well established. It is now widely used in gastric tumours, gynaecological tumours and urological tumours. Therefore, sufficient time should be provided to prove a new procedure and to be accepted in the industry,

a process that all new matters have to go through (12). Indeed, the NOSES system has started to be accepted and recognised by more and more colleagues internationally, and we also hope that NOSES will benefit more patients and become a boon to patients (13-18).

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Footnote

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References

1. Tometich DB, Hyland KA, Soliman H, et al. Living with Metastatic Cancer: A Roadmap for Future Research. *Cancers (Basel)* 2020;12:3684.
2. Atallah S, Martin-Perez B, Keller D, et al. Natural-orifice

- transluminal endoscopic surgery. *Br J Surg* 2015;102:e73-92.
3. Wang X. Natural orifice specimen extraction surgery. Singapore: Springer, 2021.
 4. Guan X, Hu X, Jiang Z, et al. Short-term and oncological outcomes of natural orifice specimen extraction surgery (NOSES) for colorectal cancer in China: a national database study of 5055 patients. *Science Bulletin* 2022;67:1331-4.
 5. Guan X, Wang GY, Zhou ZQ, et al. Retrospective study of 718 colorectal neoplasms treated by natural orifice specimen extraction surgery in 79 hospitals. *Chinese Journal of Colorectal Diseases (Electronic Edition)* 2017;6:469-77.
 6. Guan X, Liu Z, Longo A, et al. International consensus on natural orifice specimen extraction surgery (NOSES) for colorectal cancer. *Gastroenterol Rep (Oxf)* 2019;7:24-31.
 7. Nau P, Ellison EC, Muscarella P Jr, et al. A review of 130 humans enrolled in transgastric NOTES protocols at a single institution. *Surg Endosc* 2011;25:1004-11.
 8. Bernhardt J, Köhler P, Rieber F, et al. Pure NOTES sigmoid resection in an animal survival model. *Endoscopy* 2012;44:265-9.
 9. Pugliese R, Forgione A, Sansonna F, et al. Hybrid NOTES transvaginal cholecystectomy: operative and long-term results after 18 cases. *Langenbecks Arch Surg* 2010;395:241-5.
 10. Maykel JA. Laparoscopic Transanal Total Mesorectal Excision (taTME) for Rectal Cancer. *J Gastrointest Surg* 2015;19:1880-8.
 11. Efetov SK, Tulina IA, Kim VD, et al. Natural orifice specimen extraction (NOSE) surgery with rectal eversion and total extra-abdominal resection. *Tech Coloproctol* 2019;23:899-902.
 12. Nunoo-Mensah JW, Rizk M. Correspondence on international consensus on natural-orifice specimen-extraction surgery (NOSES) for colorectal cancer. *Gastroenterol Rep (Oxf)* 2020;8:487-9.
 13. Chen MZ, Cartmill J, Gilmore A. Natural orifice specimen extraction for colorectal surgery: Early adoption in a Western population. *Colorectal Dis* 2021;23:937-43.
 14. Wolthuis AM, Fieuws S, Van Den Bosch A, et al. Randomized clinical trial of laparoscopic colectomy with or without natural-orifice specimen extraction. *Br J Surg* 2015;102:630-7.
 15. Thakkar S, Pancholi A, Carleton N. Natural orifice specimen extraction for colorectal cancer removal: the best of both worlds. *Gastrointest Endosc* 2021;94:651-2.
 16. Ma B, Huang XZ, Gao P, 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.
 17. Liu Z, Efetov S, Guan X, et al. A Multicenter Study Evaluating Natural Orifice Specimen Extraction Surgery for Rectal Cancer. *J Surg Res* 2019;243:236-41.
 18. Zhang M, Lu Z, Hu X, et al. Comparison of the short-term outcomes between intracorporeal isoperistaltic and antiperistaltic totally stapled side-to-side anastomosis for right colectomy: A retrospective study on 214 consecutive patients. *Surg Open Sci* 2022;9:7-12.

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