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Conventional Laparoscopy Versus Laparoscopic Natural Orifice Specimen Extraction with Rectal Eversion for Rectal Cancer

Ashraf Samir Mohamed Ahmed Ashry*[1], Nawel El-Sayed Hussen Matar[2], Mohamed I. Abdelhamid[3], Hassan Rabiaa Galal Ashour[4], Mohamed Shehata Saleh[5], Ahmed Mesbah Abdelaziz[6]

Surgery Department, Faculty of Medicine, Zagazig University, Egypt

***Corresponding author:** Ashraf Samir Mohamed Ahmed Ashry, **Mobile:** (+20) 01066816137,

E-Mail : Ashrafashry89@gmail.com, [3]ORCID ID: 0000-0003-1296-5435, [5] ORCAD ID: 0009-0005-2771-3929

ABSTRACT

Background: Colorectal carcinoma (CRC) ranks as the third most prevalent cancer worldwide, with surgical resection remaining the primary treatment approach. Laparoscopic surgery has largely replaced conventional open surgery due to its safety and enhanced postoperative recovery. However, there are additional expenses, wound-related morbidity, and postoperative pain associated with conventional laparoscopic anterior resection, which involves a 4-8 cm abdominal incision. As an alternative that minimizes postoperative complications and does away with abdominal incisions, natural orifice specimen extraction surgery (NOSES) is a viable option.

Aim: This study aimed to compare Laparoscopic NOSES with rectal eversion to traditional laparoscopic anterior resection to assess its feasibility, safety, and effectiveness in treating rectal cancer.

Patients and methods: A prospective, randomized, controlled clinical trial was conducted at Zagazig University Hospitals from June 2021 to December 2024. A total of 24 patients with rectal carcinoma were divided into two groups: Group A (n=12) underwent conventional laparoscopic anterior resection, and group B (n=12) underwent laparoscopic rectal resection with rectal eversion and NOSES. Patients were assessed for operative duration, postoperative recovery, complications, and functional outcomes. **Results:** NOSES was associated with significantly longer operative duration (281.67 ± 24.8 min vs. 213.75 ± 18.84 min, $p<0.001$) but resulted in shorter hospital stays (5.17 ± 1.03 vs. 7.42 ± 1.56 days, $p<0.001$). NOSES had fewer postoperative complications (33.3% vs. 58.3%, $p<0.05$) and reduced urological complications (33.3% vs. 66.6%, $p<0.05$). Bowel recovery and pain management were superior in the NOSES group.

Conclusion: Laparoscopic NOSES with rectal eversion was a feasible and safe alternative to conventional laparoscopic resection, particularly for lower rectal cancer. It offered faster recovery, fewer complications, and improved postoperative outcomes while eliminating the need for abdominal incisions.

Keywords: Conventional laparoscopy, Laparoscopy, Natural orifice specimen extraction, Rectal eversion, Rectal cancer.

INTRODUCTION

Surgical resection is still the mainstay of treatment for colorectal carcinoma (CRC), the third most common cancer in the world [(1)]. Over the past two decades, laparoscopic surgery has increasingly supplanted conventional open surgery for CRC due to its enhanced safety, feasibility, and ability to facilitate a more rapid postoperative recovery [(2)]. However, traditional laparoscopic-assisted anterior resection for rectal cancer necessitates a 4–8 cm abdominal incision to accommodate stapler placement, specimen extraction, and anastomosis completion. These incisions contribute significantly to postoperative morbidity, including pain, infection, wound dehiscence, and incisional hernias, thereby escalating healthcare costs. Consequently, alternative specimen extraction techniques that circumvent abdominal incisions may offer significant advantages to patients [(3)]. A novel technique called natural orifice specimen extraction surgery (NOSES) has recently been developed, which can replace open or traditional laparoscopic surgery in certain patients by retrieving the surgical specimen through a small incision made in the patient's skin [(4)].

Following complete rectal mobilization and total mesorectal excision (TME), rectal eversion through the anal canal permits direct visualization of the distal resection margin. This technique obviates the necessity for complex endoscopic tools, streamlining the NOSES procedure [(5)]. Ultimately, laparoscopic NOSES with rectal eversion presents a promising alternative to standard and intersphincteric laparoscopic dissections, particularly for lower rectal cancer [(6)].

Therefore, this study aimed to evaluate the feasibility, safety, and efficacy of laparoscopic NOSES with rectal eversion compared to conventional laparoscopic anterior resection in rectal cancer patients.

PATIENTS AND METHOD

A prospective, randomized, controlled clinical trial assessing laparoscopic techniques for rectal cancer resection was created and executed from June 2021 to December 2024 in the Onco-surgical Unit of the General Surgery Department at Zagazig University Hospitals. A total of 24 patients diagnosed with rectal carcinoma and eligible for laparoscopic surgery were included. These patients were randomized into two groups: Group A, which consisted of 12 patients undergoing conventional laparoscopic anterior resection, and group B that comprised 12 patients who underwent laparoscopic rectal resection with rectal eversion and natural orifice specimen extraction (NOSE).

Inclusion criteria: Individuals with a T1–T3 rectal cancer diagnosis were considered for the study if their tumors were less than 3 cm in diameter and situated at

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least 7 cm from the anal margin. Patients between the ages of 18 and 70, classified as ASA score grades I to III, and those deemed fit for laparoscopic surgery were included, provided they had received neoadjuvant therapy.

Exclusion criteria: Patients with unresectable rectal cancer, distant metastases, or locally advanced tumors deemed inoperable. Those with anal stenosis, cases requiring emergency intervention due to obstruction or perforation, and patients with contraindications to laparoscopic surgery.

Patients were randomized using an odd-even numbering system: Odd-numbered entries were assigned to conventional laparoscopic resection (Group A), and even-numbered entries to the NOSE group (Group B).

All patients underwent a comprehensive preoperative assessment, including history-taking and documentation of demographic data, presenting complaints, past medical/surgical histories, and chronic conditions such as inflammatory bowel disease, diabetes, and cardiovascular diseases. General and local examinations, including vital signs, abdominal, and per rectal (PR) or per vaginal (PV) assessments, were performed to evaluate surgical and anesthetic fitness.

Laboratory tests included complete blood count, coagulation profile, kidney/liver function tests, viral markers, and tumor markers (CEA, CA19-9). Radiological evaluations involved pelvi-abdominal ultrasound, CT scans, and MRI when needed. Colonoscopy with biopsy confirmed histopathology, while metastatic workups included chest X-rays, CT chest, and PET-CT in relevant cases.

All patients received neoadjuvant chemoradiotherapy, which was administered as either a long-course regimen over four weeks followed by surgery within four to six weeks, or a short-course regimen over five days with surgery performed shortly thereafter. Preoperative preparation included the administration of prophylactic antibiotics, specifically 2 g of intravenous ceftriaxone 30 minutes before surgery following a negative skin test. Patients underwent mechanical bowel preparation two days before surgery, accompanied by oral metronidazole (500 mg three times daily). Measures to prevent venous thromboembolism were implemented based on individual risk stratification using the Rogero and Caprini scores.

In the operating room, all patients received general anesthesia. They were positioned in a modified lithotomy position, with the right arm tucked at the side to optimize the surgeon's and camera assistant's workspace. The laparoscopic phase of the procedure was standardized for both groups. A supraumbilical 10-mm disposable Visiport was used for optical entry into the peritoneal cavity, and additional ports were placed in the right lower quadrant (12 mm), right upper quadrant (5 mm), and left lower quadrant (5 mm) to facilitate the surgical procedure. To ensure adequate colonic length for tension-free anastomosis, the surgeon first mobilized the splenic flexure and then high-ligated the inferior mesenteric artery and vein. To preserve autonomic nerve function, total mesorectal excision (TME) was performed with meticulous attention to detail, with posterior dissection protecting the hypogastric nerves and lateral and anterior dissection separating the rectum from Denonvilliers' fascia. In group A, a Pfannenstiel incision of 8 to 10 cm was made for specimen extraction. The distal margin was transected using a contour stapler, and the proximal colon was stapled with a linear device. Anastomosis was completed using a circular stapler, and a pelvic drain was placed before closure. In contrast, group B underwent rectal eversion and NOSE. The rectum was exteriorized transanally, allowing a direct visual assessment of the distal margin. A side-to-end anastomosis was performed after securing the anvil through a side colotomy. The rectal stump was closed with interrupted sutures or a linear stapler, depending on the available distal segment length. A bubble test was conducted to confirm anastomotic integrity, and a pelvic drain was positioned.

Postoperative management focused on early mobilization, with patients encouraged to ambulate on the first postoperative day based on their physical condition. Pain control was tailored to individual needs, and oral fluid intake was permitted once patients regained full consciousness. Breathing exercises were introduced to promote pulmonary function, and solid food intake was initiated by day four, particularly after the passage of stools. Discharge criteria for both groups included the confirmation of an intact coloanal anastomosis through digital rectal examination, which was performed to exclude fistula formation.

Postoperative functional outcomes were assessed using validated scoring systems. Urinary function was evaluated with the International Prostate Symptom Score (IPSS), measuring frequency, nocturia, weak stream, hesitancy, intermittency, incomplete emptying, and urgency. Sexual function assessment varied by gender: Males completed the International Index of Erectile Function (IIEF-5), while females used the Female Sexual Function Index (FSFI), which measured desire, arousal, lubrication, satisfaction, and dyspareunia. An FSFI score below 26.55 indicated female sexual dysfunction. The Low Anterior Resection Syndrome (LARS) score was used to evaluate anorectal function. This score included incontinence due to flatus and liquid stools, as well as stool frequency, clustering, and urgency. Patients were categorized as having no LARS score (0-20 points), minor LARS score (21-29 points) and major LARS score (30-42 points). These assessments were crucial for understanding the functional outcomes following conventional and NOSE laparoscopic rectal cancer resection.

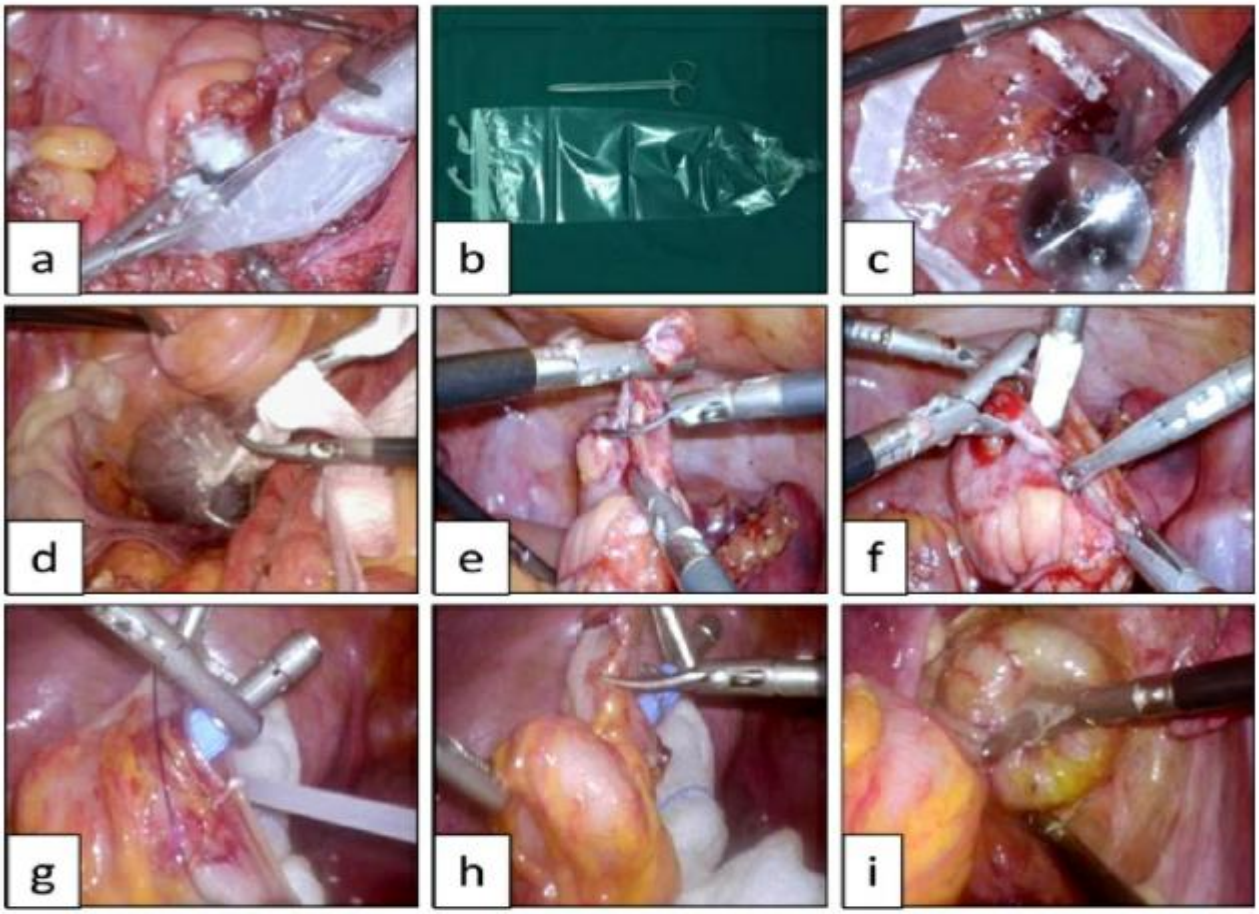

Figure (1): (a) A plastic sleeve is inserted through the main trocar for specimen protection. (b) A sleeve that the surgeon makes themselves is placed inside the specimen protection sleeve. (c) The stapler anvil is placed into the abdominal cavity. (d) The specimen is placed inside the sleeve for specimen protection. (e) The sealed edge of the colonic stump is incised. (f) The anvil is positioned within the intestinal stump. (g) The colonic stump is secured to the central rod using a snare. (h) Excessive tissue from the intestinal wall is removed. (i) An end-to-end colorectal anastomosis is created.

Ethical approval: The Ethics Committee of Zagazig Faculty of Medicine has given its approval to this investigation. All participants gave their acceptance to participate in the study in a written form after a thorough briefing on study objectives and procedures. Throughout its implementation, the study complied with the Helsinki Declaration. Patient confidentiality was strictly maintained.

Statistical analysis:

Gathering data involved patient history, clinical examinations, laboratory tests, and outcome measures. Following data entry and coding in Excel, it was processed using SPSS version 20.0. Quantitative data were expressed as mean ± SD, while qualitative data were given as frequencies and percentages. Statistical tests included the Chi-square or Fisher's exact test for qualitative variables, the independent t-test for quantitative groups, and the sign test for paired data. A $p \leq 0.05$ was deemed significant, and a $p \leq 0.001$ was deemed highly significant.

RESULTS

Regarding sex, 66.7% of group I were males and 58.3% of group II were males. The mean age of group I was 58.5 ± 7.45 years and the mean age of group II was 57.5 ± 6.23 years. The mean body mass index (BMI) for group I was 29.42 ± 1.78 Kg/m^2 and for group II it was 27.25 ± 3.77 Kg/m^2 (Table 1).

Table (1): Demographics of all cases

Variable		**Group I (Conventional Laparoscopy) (*n*=12)**		**Group II (NOSE) (*n*=12)**		**t**	**P**
Age: (years)	*Mean ± Sd* *Range*	58.5±7.45 47-72		57.5±6.23 48-68		0.36	0.73 NS
BMI: (Kg/m^2)	*Mean ± Sd* *Range*	29.42±1.78 27-33		27.25±3.77 22-33		1.8	0.09 NS
Variable		**No**	**%**	**No**	**%**	**χ^2**	**P**
Sex:	*Female* *Male*	4 8	33.3 66.7	5 7	41.7 58.3	0.18	0.67 NS

About 58.3% in both groups had comorbidity. Most frequent comorbidity was HTN in group I & DM in group II. Only 2 cases in group I and 3 cases in group II had history of previous surgery. FH of CRC was +ve in 33.3% in group I & 25% in group II. ASA II was the most frequent class in both groups (41.7%) (Table 2). Regarding symptoms in group I, 66.7% had bleeding, 58.3% had pain & 66.7% had change in bowel habits. While in group II, 75% had bleeding, 50% had pain & 66.7% had change in bowel habits. When comparing ASA and symptoms across the groups, no statistically significant changes were found (Figure 2).

Table (2): History among the studied groups

Variable		**Group I (Conventional Laparoscopy) (*n*=12)**		**Group II (NOSE) (*n*=12)**		**χ^2**	**P**
		No	**%**	**No**	**%**		
Comorbidity:	*No* *DM* *HTN* *Both* *HTN + Cardiac*	5 2 3 1 1	41.7 16.7 25 8.3 8.3	5 3 1 2 1	41.7 25 8.3 16.7 8.3	1.53	0.82 NS
Previous surgery:	*No* *Appendectomy* *Cholecystectomy*	10 1 1	83.3 8.3 8.3	9 1 2	75 8.3 16.4	1.05	0.79 NS
FH of CRC:	*No* *Yes*	8 4	66.7 33.3	9 3	75 25	0.20	0.65 NS

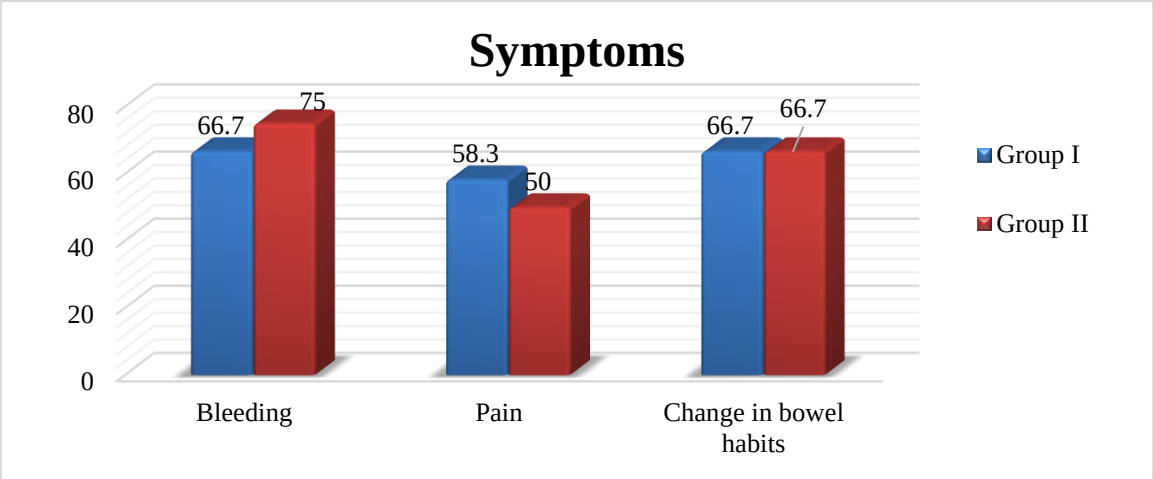

Figure (2): Symptoms among the studied groups.

Group II's **mean mass distance from the anal verge** was 10.75 ± 1.14 cm, while group I's was 9.67 ± 1.37 cm. The most common type of neoadjuvant treatment was a short course of treatment, which was reported in 83.3% of cases in group I and 83.6% in group II. When comparing the groups, neither mass distance nor neoadjuvant therapy showed any statistically significant changes.

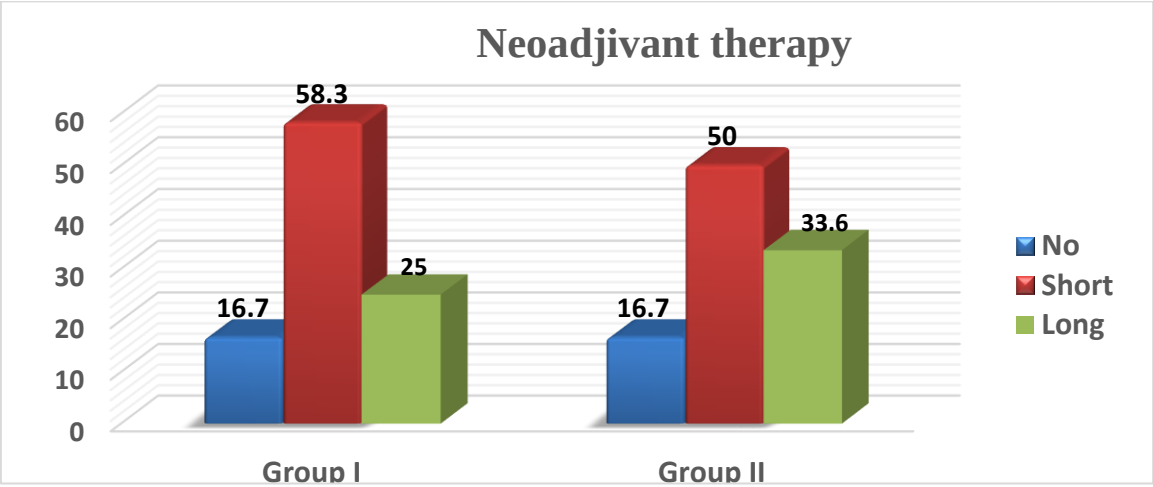

Figure (3): Neoadjivant therapy among the studied groups.

Group II had a significantly longer operation time (213.75 ± 18.84 versus 281.67 ± 24.8 min), but neither group I nor group II had a significantly lower blood loss (245.67 ± 79.30 ml versus 213.67 ± 62.30 ml) or frequency of blood transfusion (25% versus 16.6%). When comparing the groups' stoma (Table 3).

Table (3): Operative data of all cases

Variable		**Group I (Conventional Laparoscopy) (*n*=12)**		**Group II (NOSE) (*n*=12)**		**t**	**P**
Operation duration: (min)	*Mean ± Sd* *Range*	213.75±18.84 190-250		281.67±24.8 240-320		**7.55**	**<0.001****
Blood loss: (ml)	*Mean ± Sd* *Range*	245.67±79.30 300-500		213.67±62.30 300-480		**2.11**	**0.55 NS**
Variable		**No**	**%**	**No**	**%**	**χ^2**	**P**
Blood transfusion:	*No* *Yes*	9 3	75 25	10 2	83.3 16.6	**.21**	**0.72 NS**
Stoma:	*No* *Yes*	11 1	91.6 8.3	10 2	83.3 16.7	3	0.08 NS

Table (4) showed that no cases had +ve proximal or distal margin among both groups. Specimen was Mercury 1 complete in 66.7% & 91.7% of group I & II respectively. Mean number of +ve LN was 2.4 ± 2.4 for group I and 3.8 ± 3.5 for group II with a range from 6-24.

Table (4): Specimen data of all cases

Variable		**Group I (Conventional Laparoscopy) (*n*=12)**		**Group II (NOSE) (*n*=12)**		**χ^2**	**P**
		No	**%**	**No**	**%**		
Proximal margin:	*-ve*	12	100	12	100	--	---
Distal margin:	*-ve*	12	100	12	100	--	---
Specimen (mesorectum):	*Mercury 1 complete* *Mercury 2 nearly complete*	8 4	66.6 33.3	11 1	91.7 8.3	2.27	0.13 NS
LN **+ve LN** **Total**	 *Mean ± Sd* *Range* *Mean ± Sd* *Range*	 2.4 ± 2.4 1-6 10.7 ± 4.5 6-17		 3.8 ± 3.5 2-8 12.9 ± 5.6 9-22		 t 0.68	 0.51 NS

Group II had a significantly lower usage of multimodal pain treatment and nonsteroidal anti-inflammatory medications (NSAIDs), while group I had a significantly higher use of opioids and a much shorter hospital stay (4.17 ± 1.03 versus 6.42 ± 1.56 day) (Table 5).

Table (5): Post-operative data of all cases

Variable		**Group I (Conventional Laparoscopy) (*n*=12)**		**Group II (NOSE) (*n*=12)**		**t**	**P**
Hospital stay: (day)	*Mean ± Sd* *Range*	7.42±1.56 5-9		5.17±1.03 4-7		**4.16**	**<0.001 ****
Variable		**No**	**%**	**No**	**%**	χ^2	**P**
Bowel movement:	*Day 1* *Day 2* *Day 3* *Day 4*	0 4 5 3	0 33.3 41.7 25	5 6 1 0	41.7 50 8.3 0	**11.07**	**0.01***
Management of pain:	*NSAID* *Both(NSAID& Narcotic)* *Multimodal*	12 6 3	100 50 25	12 2 0	100 16.6 0	**20.67**	**<0.001 ****

Group I had 2 cases of anastomotic leak and 3 cases of urological problems, while group II had 8 cases of anastomotic leak and 4 cases of urological complications, for a total of 166.7 and 33.3 percent respectively. The frequency of urological complications was significantly different between group I and group II, as indicated in the table comparing the two groups (58.3% versus 33.3%).

Table (6): Complications among all cases

Variable		**Group I (Conventional Laparoscopy) (*n*=12)**		**Group II (NOSE) (*n*=12)**		χ^2	**P**
		No	**%**	**No**	**%**		
Post-operative complications:	*No* *Yes*	5 7	41.7 58.3	9 3	66.6 33.3	**6**	**0.01***
	(Chest infection) *(SSI)* ---------- • *Port site* • *Pfannenstiel wound*	2 5 ----- 1 4	16.7 55.5 ------ 8.3 33.3	2 1 ---- 1 0	16.7 8.3 ------ 8.3 0		
Anastomotic leak:	*No* *Yes*	10 2	83.3 16.7	9 3	75 25	0.25	0.62 NS
Urological complications:	*No* *Yes*	4 8	33.3 66.6	8 4	66.6 33.3	5	0.01* S
	UTI *Urine retention* *Impotence*	2 5 1	16.7 41.7 8.3	1 2 1	8.3 16.7 8.3		

DISCUSSION

In order to remove specimens and perform anastomosis, traditional laparoscopic colorectal surgery calls for a mini-laparotomy and many trocar incisions. Even if the number of trocar incisions is reduced with single-port surgery, a mini-laparotomy is still required. **Zattoni *et al.*** [7] found that larger trocars independently increased pain, complications, and cosmetic concerns. Thus, eliminating the mini-laparotomy may offer greater benefits than merely reducing trocar incisions.

Laparoscopic low anterior resection (LAR) is an effective rectal cancer treatment with favorable oncological outcomes, less pain, and shorter hospital stays. However, the required mini-laparotomy contributes to pain, infections, and hernias [8]. To address these issues, surgeons developed natural orifice specimen extraction (NOSE), which enables specimen removal and anastomosis without an abdominal incision, minimizing surgical trauma and improving recovery [9].

A key advantage of NOSE is direct visualization of the distal resection margin via rectal eversion, ensuring precise oncological control without advanced equipment [10]. This study evaluated the feasibility, safety, and efficacy of laparoscopic LAR with NOSE and rectal eversion compared to conventional LAR. The study included 24 rectal carcinoma patients, randomly assigned to conventional laparoscopic LAR (12 patients) or LAR with NOSE and rectal eversion (12 patients).

Patients ranged from 47 to 72 years, with a mean age of 58.5 ± 7.45 years. Males predominated in both groups, which is aligning with Egyptian colorectal cancer statistics by **Ibrahim *et al.*** [11]**,** who reported higher incidence in men (66.7% and 58.3% in the respective groups). Rectal bleeding was the most common symptom, affecting 66.7% in group I and 75% in group II, followed by changes in bowel habits (66.7% in both groups). **Law *et al.*** [12] found that rectal bleeding (63%) was the leading reason for consultation in rectal cancer patients, though differences in screening protocols may explain variations in presentation.

The American Society of Colon and Rectal Surgeons (ASCRS) recommends neoadjuvant therapy to reduce local recurrence [13]. In our study, 83.3% of group I and 83.6% of group II received preoperative treatment, consistent with **Duran *et al.*** [14]**,** who reported an 81.9% neoadjuvant therapy rate. Laparoscopic surgery is known to reduce intraoperative blood loss and transfusion need [15]. Mean blood loss was 245.67 ± 79.30 mL in group I and 213.67 ± 62.30 mL in group II, comparable to two randomized trials reporting ~200 ± 40.30 mL [16-17]. **Efetov *et al.*** [18] found significantly lower blood loss (54.2 mL) with NOSE, likely due to advanced energy devices (Harmonic® scalpel, Ligasure™), which enhance dissection and coagulation.

Laparoscopic surgery often had longer operative times than open procedures, influenced by surgical team experience. Mean operative time was 213.75 ± 18.84 minutes in group I and 281.67 ± 24.8 minutes in group II. **Liang *et al.*** [17] reported a mean of 244 minutes, while **Nagtegaal *et al.*** [16] documented 213.5 minutes for laparoscopic anterior resection. **Barrie *et al.*** [19] reported operative times between 180–260 minutes for upper and mid-rectal cancers. Despite the longer operative time in group II (281.67 ± 24.8 minutes), **Sun *et al.*** [20] reported a significantly shorter duration (166.9 ± 55.2 minutes) in 102 rectal cancer patients undergoing LAR with NOSE. This difference may reflect higher surgical proficiency, experience, and the NOSE learning curve.

Mean tumor distance from the anal verge was 9.67 ± 1.37 cm in group I and 10.75 ± 1.14 cm in group II, which is consistent with **Qingqiang *et al.*** [21]**,** who reported 8.32 ± 1.04 cm for low rectal cancers. Rectal eversion with direct distal margin resection offers an alternative to standard intersphincteric dissection. **Perez and São Julião** [22] emphasized its value in distal rectal cancer treatment.

Achieving radical resection requires clear circumferential, distal, and proximal margins. All cases in our study had negative margins, which is aligning with **Efetov *et al.*** [18]**,** who reported a 100% radical resection rate in NOSE cases. However, the COLOR II trial found a 10% incidence of positive circumferential resection margins (CRM) in both laparoscopic and open surgery groups, with CRM ≤2 mm linked to a 16% increased local recurrence risk [16]. **Bonjer** [23] noted that laparoscopic LAR may increase coning, reducing distal specimen diameter and contradicting TME principles.

The AJCC Cancer Staging Manual (7th edition) recommends retrieving 10–14 lymph nodes in colorectal cancer resection without neoadjuvant therapy [24]. In our study, lymph node yield ranged from 6–17 in group I and 9–22 in group II, which is similar to **Mechera *et al.*** [25] who reported 7–12 nodes in laparoscopic cases. Neoadjuvant therapy reduces identifiable lymph nodes due to fibrosis, lymphocyte depletion, and adipocyte replacement. **Sun *et al.*** [20] reported a yield of 10–15, with lower counts in patients receiving chemoradiotherapy.

A shorter hospital stay and lower readmission rates reduce overall healthcare costs in laparoscopic surgery, as concluded by **Edge *et al.*** [24]. In our study, postoperative hospital stay was significantly shorter in group II (4–7 days) than in group I (5–9 days). Typically, hospital stays after laparoscopic rectal cancer resection range from 6 to 10 days, but the shorter stays in our study may be due to the enhanced recovery program at our center [26].

Early bowel function recovery is another advantage of laparoscopic surgery. In group II, 41.7% regained bowel function by postoperative day one, compared to 0% in group I, with no cases of

postoperative ileus in either group. These findings align with the COLOR II trial, which reported a median recovery time of two days in laparoscopic cases. **Nagtegaal *et al.* [16]** found similar results, while **Awad *et al.* [27]** reported a longer recovery period (3.8 days). **Efetov *et al.* [18]** also reported normal bowel function by day two in NOSE patients.

Conventional laparoscopic anterior resection often requires a Pfannenstiel incision, increasing postoperative pain and infection risk. In our study, only 16.6% of group II needed narcotic analgesics versus 50% in group I. **Adamina *et al.* [28]** reported that NOSE patients ambulated earlier and required less analgesia.

Postoperative complications included a 16.6% incidence of chest infections in both groups, which is aligning with **Monson *et al.* [13]** (5%) and **Cataneo *et al.* [29]** (3.9%). Wound infections were significantly higher in group I (41.7%) than in group II (8.3%), likely due to the larger Pfannenstiel incision in conventional surgery. **Park *et al.* [26]** found similar results in a study of 163 NOSE cases, reporting a wound infection rate of 0.7% in NOSE versus 5.8% in conventional surgery.

The spread of tumor cells and other contaminants, such as bacteria, is a major worry with NOSE. Nevertheless, colorectal surgery with an intra-corporeal intestinal opening for anastomosis did not raise the risk of infection according to **Park *et al.* [26]**. **Awad and Griffin [27]** also reported no higher risk of tumor seeding in transanal extraction compared to transabdominal, provided an extraction bag was used. In our study, no abdominal cavity infections were recorded, though extended follow-up is needed for long-term oncological outcomes.

Pelvic autonomic nerve injury is a known complication of rectal resection, often causing postoperative urological dysfunction. In our study, intraoperative nerve injury occurred in two cases (8.3%), with no other organ injuries reported. High-definition laparoscopic cameras enhance visualization, reducing blind spots common in open surgery and aiding nerve preservation. **Adamina *et al.* [28]** emphasized laparoscopic magnification as a key advantage in precision dissection.

Urological complications were significantly higher in group I (66.6%) than in group II (33.3%). Urinary retention was the most frequent issue, likely due to postoperative pain from larger incisions rather than direct nerve injury. Erectile dysfunction was documented in one case from each group, indicating largely successful nerve preservation. These results align with **Cataneo *et al.* [29],** who reported urinary complications in 15.2% of NOSE cases and 23.8% in conventional laparoscopic cases, with no significant difference between techniques.

Anastomotic leakage remains a major concern in rectal cancer surgery. Leakage occurred in two cases (16.6%) in group I and three cases (25%) in group II. These rates differ from **Park *et al.* [26]** who found no significant difference in leak rates between NOSE and conventional laparoscopic surgery, though the latter had a slightly higher rate (8% vs. 6.5%).

CONCLUSION

Our study confirms that laparoscopic low anterior resection (LAR) with natural orifice specimen extraction (NOSE) and rectal eversion is a safe and effective alternative to conventional laparoscopic LAR for selected rectal cancer cases. NOSE offers significant benefits, including reduced postoperative pain, lower wound infection rates, shorter hospital stays, and faster bowel recovery, while maintaining comparable oncological outcomes. By eliminating the need for a Pfannenstiel incision, NOSE reduces wound-related morbidity and ensures precise distal margin resection. However, concerns about anastomotic leakage and urological complications highlighted the need for further surgical refinements and evaluation in larger, multicentric studies with long-term follow-up.

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