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Diagnosis and Management of Postoperative Complications in Rectal Cancer Surgery - A Five-Year Retrospective Study in a Single Surgical Unit

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Rezumat

Diagnosticul și managementul complicațiilor postoperatorii în chirurgia cancerului rectal - un studiu retrospectiv pe o perioadă de cinci ani într-o singură clinică de chirurgie

Introducere: chirurgia pentru cancerul rectal ridică frecvent multiple provocări tactice şi tehnice din cauza unor factori precum extensia tumorii, spațiul anatomic limitat, proximitatea complexului sfincterian anal şi utilizarea radioterapiei neo-adjuvante. Aceşti factori pot creşte semnificativ complexitatea intervenției şi riscul apariției complicațiilor imediate şi tardive, atât intraoperator, cât şi postoperator. *Obiectivul studiului:* scopul acestui studiu a fost analiza retrospectivă a cauzelor, metodelor de diagnostic şi managementului complicațiilor la pacienții supuşi intervențiilor chirurgicale pentru cancerul rectal. De asemenea, s-a evaluat impactul acestor complicații asupra rezultatelor terapeutice ale pacienților.
Materiale şi metode: am realizat un studiu retrospectiv, descriptiv, non-experimental, într-un singur centru, pe o perioadă de cinci ani, în cadrul unei clinici chirurgicale. Cohorta a inclus 157 de pacienți cu cancer rectal, cu localizări tumorale variate, care au fost supuşi intervențiilor chirurgicale radicale sau paliative. S-au analizat datele demografice, factorii clinici şi imagistici,

precum şi incidentele, accidentele intraoperatorii, şi complicațiile postoperatorii, prin metode statistice.
Rezultate: complicațiile nu au fost evenimente izolate; mulți pacienți au prezentat multiple complicații asociate. Rata generală a complicațiilor a fost de 16,56%, dintre care 15,38% au fost incidente hemoragice, 7,69% au implicat leziuni ale plexurilor vasculare sau nervoase, iar 13 pacienți au prezentat dehiscență anastomotică. În plus, 26,9% dintre pacienți au avut complicații legate de stomă, iar 15,38% au dezvoltat stenoză anastomotică. Rata generală a mortalității a fost de 3,82%.
Concluzii: chirurgii implicați în tratamentul cancerului rectal trebuie să beneficieze de o pregătire amplă pentru a asigura un diagnostic precoce precis, o tehnică chirurgicală eficientă şi un management corect al complicațiilor postoperatorii. Acest demers este esențial pentru a preveni rezultatele negative, inclusiv scăderea calității vieții pacienților şi creşterea ratei mortalității.

Cuvinte cheie: cancer rectal, rezecție anterioară joasă, rezecție abdominoperineală, fistulă anastomotică, stenoză anastomotică

Abstract

Introduction: surgery for rectal cancer often presents multiple tactical and technical challenges due to factors such as the tumor's extent, limited anatomical space, proximity to the anal sphincter complex, and the use of neoadjuvant radiotherapy. These factors can significantly increase the complexity of surgery and the risk of both immediate and delayed complications, which can occur intraoperatively or postoperatively. *Objective:* the aim of this study was to retrospectively analyze the causes, diagnostic methods, and management of complications in patients who underwent surgery for rectal cancer. Additionally, the study sought to evaluate the impact of these complications on patients' therapeutic outcomes.
Materials and Methods: we conducted a single-center, non-experimental, descriptive retrospective study over a five-year period at a single surgical clinic. The cohort consisted of 157 patients with rectal cancer, with various tumor locations, who underwent either radical or palliative surgical interventions. We analyzed demographic data, clinical and imaging factors, and statistically assessed intraoperative incidents, accidents, and postoperative complications.
Results: complications were not isolated events; many patients experienced multiple associated complications. The overall complication rate was 16.56%, with 15.38% of complications being hemorrhagic incidents, 7.69% involving vascular or nervous plexus injuries, and 13 patients experiencing anastomotic dehiscence. Additionally, 26.9% of patients had complications related to the stoma, and 15.38% developed anastomotic stenosis. The overall mortality rate was 3.82%.
Conclusions: surgeons performing rectal cancer surgeries must undergo extensive training to ensure accurate early diagnosis, effective surgical technique, and the proper management of postoperative complications. This approach is crucial in preventing negative outcomes, including diminished quality of life for patients and higher mortality rates.

Key words: rectal cancer, low anterior resection, abdominoperineal resection, anastomotic leakage, anastomotic stenosis

Introduction

Rectal cancer refers to neoplasia that develops from the ano-cutaneous line to the recto-sigmoid junction. It ranks as the third leading cause of cancer-related mortality and the fourth most common cancer diagnosis globally, with an increasing incidence in developed countries (1). The disease predominantly affects males, with an incidence of 19.7 to 23.6 cases per 100,000 people, compared to 16.3 cases per 100,000 in females. While colorectal cancer is more common in individuals over 50, there is a rising incidence among those aged 20-49, with the average age at diagnosis being 63 for both sexes (2).

Surgical treatment for rectal cancer presents numerous tactical and technical challenges, including tumor extension, limited anatomical space, and the tumor's proximity to the anal sphincter complex. Neoadjuvant radiotherapy can further complicate the procedure, increasing the risk of both immediate and delayed intraoperative or postoperative complications (3). Despite these anatomical challenges, the surgeon must perform an oncologically safe resection with total mesorectal excision (TME), ensuring negative resection margins that are distant from the tumor. Additionally, efforts should be made to preserve the innervation and vascularization of pelvic organs, to optimize both oncologic and functional outcomes (4).

Due to its deep location, complex anatomical relationships, and relatively high rate of post-operative metastasis, the prognosis for rectal cancer patients is less favorable than for colon cancer, with a 5-year survival rate averaging 60% (5,6).

Some risk factors include male sex, advanced loco-regional tumors, blood transfusions, and obesity (7).

During surgery, a carefully planned anesthetic and surgical approach tailored to the patient is crucial. Postoperatively, vigilant monitoring and early intervention are key to addressing emerging complications (9).

When complications do occur, prompt diagnosis and effective management are critical to reducing postoperative morbidity and enhancing the quality of life for rectal cancer patients (10).

Aim

The objective of this study was to retrospectively analyze the causes, diagnostic methods, and management strategies for both immediate and delayed complications following major rectal cancer surgery.

Materials and Methods

We conducted a single-center, retrospective, non-experimental, descriptive study on 157 patients diagnosed with rectal cancer located in various areas (lower, middle, upper rectum, and rectosigmoid junction) who underwent either anterior resection with total or partial mesorectal excision (with or without protective ileostomy), abdominoperineal resection, or Hartmann's procedure. These patients were admitted to the Surgery Department II between 2018 and 2022.

The study included patients aged 20 to 99 years who were clinically, radiologically, and histopathologically diagnosed with rectal cancer, with the tumor located at the anal canal, lower rectum, mid or upper rectum, or rectosigmoid junction (excluding those with tumors located in the distal sigmoid colon). We also included patients who did not have histological confirmation at presentation (due to acute complications), but whose clinical symptoms and imaging were highly suggestive of neoplastic pathology. The main inclusion criterion, apart from the presence of a rectal tumor, was the requirement for surgical intervention. Only patients who underwent radical surgery, meaning those who had their tumor resected, were considered; cases in which resection was not achieved were excluded.

Data were retrospectively collected from clinical observation sheets, surgical protocols, and complete oncological files, both pre- and postoperatively. We analyzed demographic data as well as clinical, imaging, colonoscopic, and histopathological factors needed for

preoperative staging. Neoadjuvant treatment details, including the time interval between neoadjuvant therapy and surgery, were also considered (4). Intraoperative aspects, including surgical techniques and complications, were analyzed and correlated with the patients' final outcomes (5). Immediate or delayed complications, regardless of nature or location, were examined and their correlation with patient prognosis and oncological-surgical outcomes was assessed.

The following variables were collected: general patient data (age, sex), tumor location (lower, middle, upper rectum, rectosigmoid junction), tumor stage at the time of surgery, neoadjuvant therapy details, type of surgical intervention, type of anastomosis (hand-sewn or stapled), intraoperative incidents leading to postoperative complications, immediate and delayed postoperative complications, and the methods used to diagnose and resolve these complications.

The diagnosis of rectal cancer was confirmed through clinical evaluation, imaging (MRI), colonoscopy, and histopathology. Most patients received neoadjuvant oncological treatment, including preoperative chemotherapy and/or radiotherapy, except for those diagnosed due to an acute tumor complication that required emergency surgery.

The study was approved by the Ethics Committee of Craiova County Emergency Clinical Hospital (approval no. 46699/15.10.2024). The study did not interfere with patients' current medical care, no experimental substances were administered, and no biological samples were collected. All data were anonymized to ensure patient confidentiality.

Statistical Analysis

The data were entered into a database and analyzed using Microsoft Excel 2021 and MedCalc software (version 20.218).

Frequencies were presented as absolute case numbers and percentages. Chi-square tests were used to compare ordinal or nominal variables, and the Mann-Whitney U test was applied for continuous variables that were not normally distributed. The Fisher's exact test was used to compare clinical data of patients with and without complications. A p-value of less than 0.05 was considered statistically significant.

Results

Demographics and Patient Characteristics

The study cohort consisted of 157 patients diagnosed with rectal neoplasia, with a male-to-female ratio of 1.3:1, indicating a 30% higher incidence in males. Specifically, 89 patients were male (56.7%) and 68 were female (43.3%). Patient ages ranged from 29 to 95 years, with the mean age being 65 ± 3.2 years for males and 63 ± 4.15 years for females, a statistically significant difference ($p = 0.0000185$).

Cancer Staging and Surgical Procedures

At the time of surgical intervention, the distribution of cancer stages was as follows:

- Stage I: 19 patients (12%);
- Stage II: 32 patients (21%);
- Stage III: 57 patients (36%);
- Stage IV: 49 patients (31%).

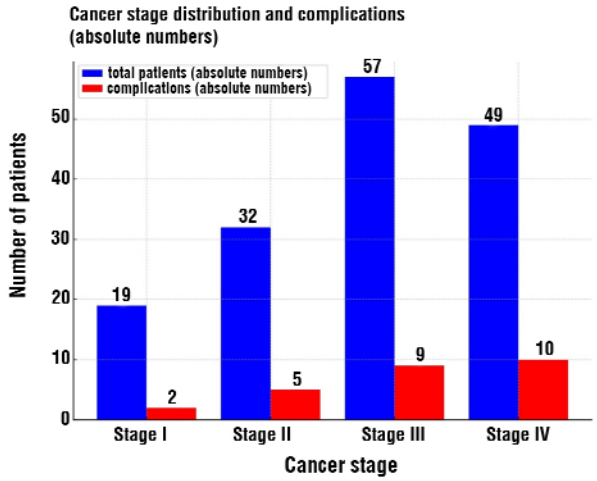
Among the 26 patients (16.56%) who experienced complications following rectal cancer surgery, the stage distribution was:

- Stage I: 2 cases (10%);
- Stage II: 5 cases (20%);
- Stage III: 9 cases (36%);
- Stage IV: 10 cases (49%).

Statistical analysis ($\chi^2 = 0.774$, $p = 0.856$) indicated no significant differences in stage distribution between patients with and without complications (see *Graph 1*).

Proportional Increase in Complications

- As the stage advances, the percentage of patients with complications rises sharply (Stage I: 10% → Stage IV: 49%).
- This suggests a direct correlation between disease progression and postoperative complications.



Graph 1. Patient distribution by stage of disease: total vs. complications

Relative Impact

- The relative proportion of complications is most significant in Stages III and IV, where the severity and systemic involvement likely increase risks of surgical challenges and postoperative morbidity.

Surgical and Clinical Implications

- Advanced stages require targeted perioperative management to mitigate complications.
- Emphasis on preoperative optimization and tailored postoperative care could reduce risks, particularly in Stages III and IV.

The surgical approaches included:

- Anterior resections with anastomotic protection: 38 cases (24.2%) - 25 with stapled anastomoses and 13 with hand-sewn anastomoses.
- Anterior resections without anastomotic protection: 27 cases (17.19%).
- Abdominoperineal resections: 52 cases (33.12%).
- Hartmann's resections: 40 cases (25.47%) (see *Graphs 2 and 3*).

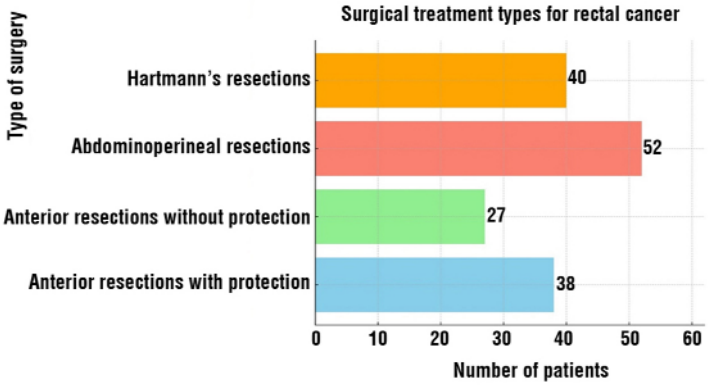
Complications

Intraoperative incidents and accidents were recorded in 15.38% of patients (4 cases), reflecting the technical and anatomical challenges posed by advanced disease or complex procedures: (see *Table 1*).

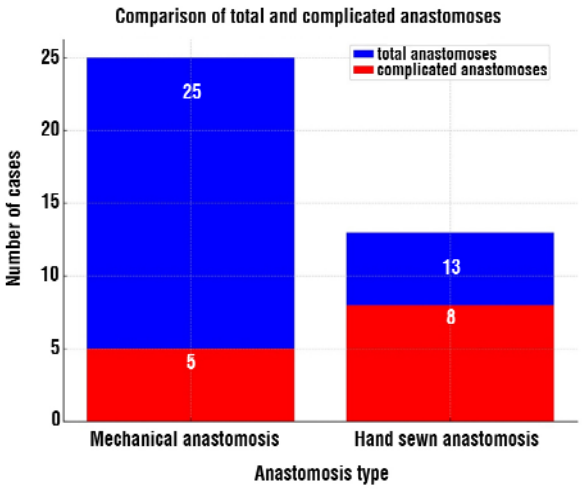
Intraoperative Accidents and Incidents which Led to Postoperative Complications

Intraoperative incidents and accidents were recorded in 15.38% of patients (4 cases), reflecting the technical and anatomical challenges posed by advanced disease or complex procedures:

- Hemorrhagic incidents: four cases required immediate intervention. Two patients sustained splenic injuries, which were managed through hemostatic



Graph 2. Type of resections performed for rectal cancer



Graph 3. Method of anastomosis vs. occurrence of complications

procedures and packing. One case involved injury to the right hypogastric vein, necessitating vascular repair, while another patient experienced diffuse hemorrhage, requiring transfusion and hemostatic control using advanced coagulation techniques.

- Hypogastric nerve injuries: recognized in 2 cases (7.69%), these injuries were managed conservatively.
- Rectal stump perforation: perforation occurred during mobilization in 2 cases (7.69%), leading to a conversion to an alternative surgical plan and extended operative time.
- Tumor rupture: documented in 5 cases (19.23%), tumor rupture during specimen handling was associated with advanced loco-regional invasion.

Table 1. Complications observed in the studied cohort.

Complication	Nr.	%
Intraoperative bleeding	4	15.38%
Hypogastric nerve injury	2	7.69%
Tumor rupture	5	19.23%
Rectal stump perforation	2	7.69%
Postoperative bleeding	5	19.23%
Stoma-related complications	7	26.92%
Urinary retention	2	7.69%
Erectile dysfunction	2	7.69%
Pulmonary embolism (PE)	2	7.69%
Sars-Cov2	2	7.69%
Clostridium difficile infection (C. difficile)	7	26.92%
Anastomotic stenosis	4	15.38%
Post-radiation pelvic fibrosis	2	7.69%

Early Postoperative Complications

The early postoperative period was marked by significant morbidity, particularly related to anastomotic integrity and stoma care:

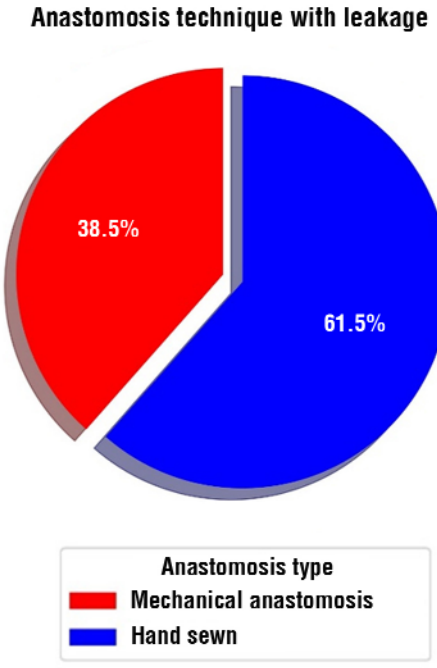
- Anastomotic leakage: this was the most common complication, occurring in 13 cases (50%). Of these, 8 progressed to diffuse peritonitis, requiring emergent reoperation and extensive lavage. The remaining 5 cases resulted in enterocutaneous fistulas, which were managed conservatively with nutritional support and wound care (see *Graph 4*).
- Postoperative hemorrhage: Occurred in 5 patients (19.23%). Three were managed conservatively with transfusion and coagulation support, while two required reoperation for hemostasis.
- Stoma-related complications: seven patients (26.9%) developed complications related to the stoma. This included 2 cases of stoma necrosis that necessitated revision surgery and 5 cases of peristomal abscesses, which required drainage.
- Pulmonary embolism: a potentially life-threatening complication observed in 2 cases (7.69%). Both patients were managed with immediate anticoagulation and intensive care support. One required prolonged ventilation.
- Urinary retention and erectile dysfunction: documented in 2 patients, these complications were attributed to intraoperative hypogastric nerve injury. Management included intermittent catheterization and counseling for sexual dysfunction.
- Postoperative intestinal obstruction: three cases (11.5%) of mechanical obstruction occurred. Two were managed conservatively, while one patient required reoperation for adhesion lysis.

- Nosocomial infections: nine patients (34.61%) developed infections, including 2 cases of SARS-CoV-2 pneumonia and 7 cases of Clostridium difficile colitis. Prompt isolation protocols and targeted antimicrobial therapy were implemented, leading to favorable outcomes in most cases.

Delayed Postoperative Complications

Delayed complications were primarily related to anastomotic healing and radiation-induced changes:

- Anastomotic stenosis: four cases (15.38%) developed progressive stenosis. Three patients were managed with endoscopic dilatation, while one patient required reoperation due to refractory symptoms.
- Post-radiation pelvic fibrosis: in 2 cases (7.69%), extensive fibrosis caused severe narrowing of the intestinal lumen and the anastomotic site. These cases required surgical reintervention, and outcomes were suboptimal due to the severity of the fibrosis.



Graph 4. Method of anastomosis in cases with anastomotic dehiscence

Mortality

The overall mortality rate was 3.82% (6 patients). The causes of death included complications such as refractory sepsis (2 patients), pulmonary embolism (1 patient), and multiorgan failure due to advanced disease (3 patients). There were no intraoperative deaths in the cohort; all fatalities occurred postoperatively as a result of complications.

Discussions

Preoperative Evaluation

Rectal cancer requires significant surgical interventions, with preoperative preparation being essential for reducing postoperative complications and improving outcomes (6,10). A literature review highlights the importance of thorough evaluations and preoperative optimization to mitigate risks and enhance prognosis (1).

Postoperative complications, which directly influence treatment success, can be minimized through prompt and appropriate management, resulting in faster recovery and better therapeutic outcomes (3). The complication rate in this study was notably lower (16.56%) compared to the typical 20% reported in the literature (1). However, the authors acknowledge potential underrepresentation of true incidence due to the small sample size (3).

The timing of surgery post-neoadjuvant treatments like chemotherapy and radiotherapy is critical for optimal outcomes (4,5). Addressing comorbidities such as cardiovascular disease, diabetes, and renal failure is also essential in minimizing serious complications (5).

Nutritional status significantly impacts postoperative risk, with malnourished patients facing higher risks of infections, anastomotic dehiscence, and delayed recovery (6). Preoperative measures, including bowel

preparation with cleansing solutions, are vital in infection risk reduction (6). Venous thromboembolism (VTE) prophylaxis is equally crucial, as major surgeries increase the likelihood of thrombus formation. Prophylactic anticoagulants and compression stockings effectively mitigate this risk (7).

In the study cohort, mechanical bowel preparation methods (Fortrans versus serial enemas combined with dietary restriction) showed no significant differences in postoperative complications. Uniform administration of preoperative antibiotic prophylaxis and thrombotic event prevention was maintained for both elective and emergency surgeries.

Evidence supports a coordinated, personalized approach for improved surgical planning and outcomes (8). The use of Enhanced Recovery After Surgery (ERAS) protocols has been effective in reducing complications and accelerating recovery (9). Optimal pain management and early mobilization are emphasized for preventing respiratory complications and improving gastrointestinal function (10).

Psychological Counseling

Preoperative psychological counseling plays a vital role in preparing rectal cancer patients for surgery. Unfortunately, not all patients in our study benefited from preoperative psychological counseling, particularly those requiring emergency surgery, which did not allow for psychotherapeutic intervention (11). However, counseling was initiated postoperatively with positive outcomes, as reflected in patient satisfaction surveys included in the clinical observation records.

Following surgery, all patients who required stoma formation, whether temporary or permanent, received stoma counseling. Both patients and their families were educated on proper stoma care and strategies to prevent long-term complications (12).

Surgical Tactics and Techniques

Rectal cancer poses significant surgical challenges due to its anatomical complexity and high complication risk. A well-planned surgical approach, following oncological principles and employing minimally invasive techniques, is crucial for improving outcomes (13). Key procedures include low anterior resection with total mesorectal excision (TME), abdominoperineal resection, and Hartmann's procedure (9). TME, the gold standard, reduces local recurrences by removing mesorectal tissue potentially harboring micrometastases (12,13). Achieving negative margins (R0) is critical for lowering recurrence risks and enhancing prognosis (13). Despite advances, complications like anastomotic dehiscence (5%-20%) remain a significant concern, often requiring reinterventions (13)(*Fig. 1*).

In our study, the surgical treatments included 38 (24.2%) anterior resections with anastomotic protection (25 stapled anastomoses and 13 hand-sewn anastomoses), 27 (17.19%) anterior resections without anastomotic protection, 52 (33.12%) abdominoperineal resections, and 40 (25.47%) Hartmann's resections.

Studies have shown that laparoscopic methods provide oncological control comparable to open surgery, with significant advantages in terms of complications and postoperative recovery (11). Two patients underwent laparoscopic low anterior resection with low colorectal anastomosis and total mesorectal excision; both experienced no complications.

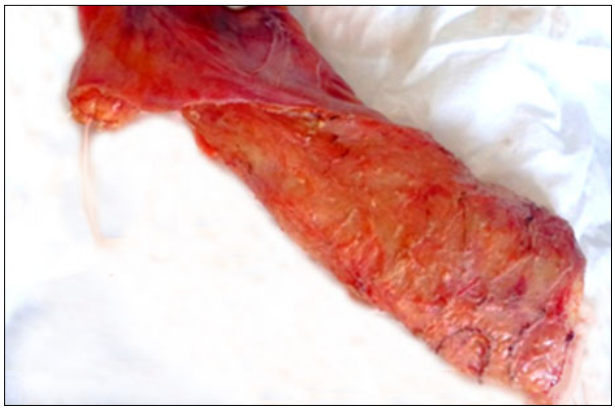


Figure 1. Resection specimen: rectum, mesorectal tissue, sigmoid colon, mesocolon and inferior mesenteric pedicle (marked with thread)

Impact of Intraoperative Accidents and Incidents on Immediate or Delayed Postoperative Complications

Intraoperative bleeding increases the risk of postoperative anemia, which can delay recovery and make patients more susceptible to infections (14). Furthermore, injuries to adjacent organs, such as the pelvic autonomic nerves, can result in sexual and urinary dysfunction, greatly impacting the patient's quality of life after surgery (11).

Intraoperative bleeding, often due to iatrogenic injuries to parenchymal organs (especially the spleen) or vascular injuries involving the inferior mesenteric artery or pelvic veins, is common in pelvic surgery and can lead to massive hemorrhage (15) (*Fig. 2*).

Injuries to the bladder or ureters are particularly serious, often requiring complex reconstructions and leading to significant postoperative complications, including fistulas or urinary infections (3,13).

In our study, intraoperative bleeding occurred in 15.38% of cases, with 7.69% involving splenic injuries resulting in significant bleeding during mobilization of the splenic flexure of the colon, which required splenectomy and increased transfusion requirements. In one case, injury to the right hypogastric vein caused hemodynamic instability and severe acute anemia, necessitating hemostatic packing and a reoperation 48 hours later, after stabilization of hemoglobin levels, to complete the hemostasis. Another case involved diffuse bleeding, which was controlled by pelvic packing.

Frequent bleeding was encountered in Miles' abdominoperineal resection, particularly from the prostatic capsule and periprostatic venous plexuses, requiring hemostatic packing and reoperation to remove the packs. This issue was entirely resolved by changing the surgical approach, using the Jackknife position during the perineal phase, which significantly facilitated hemostasis at this level (*Fig. 3*).

Intraoperative injuries to the hypogastric nerves were identified in two cases, both of which subsequently developed urinary retention and stage 2 renal failure (*Fig. 4*).

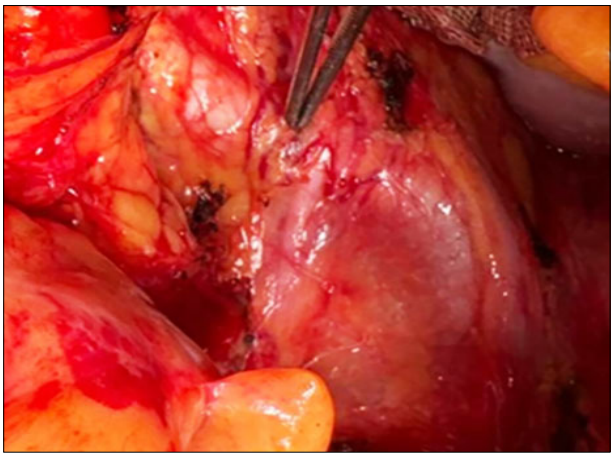


Figure 2. Intraoperative Aspect: correct dissection plane for avoiding uretheral or iliac vessels injury.

A precise surgical technique and minimizing excessive manipulation of the tumor are crucial to prevent accidents as tumor rupture or uretheral lesions (12,13,16).

In our cohort, tumor rupture occurred in

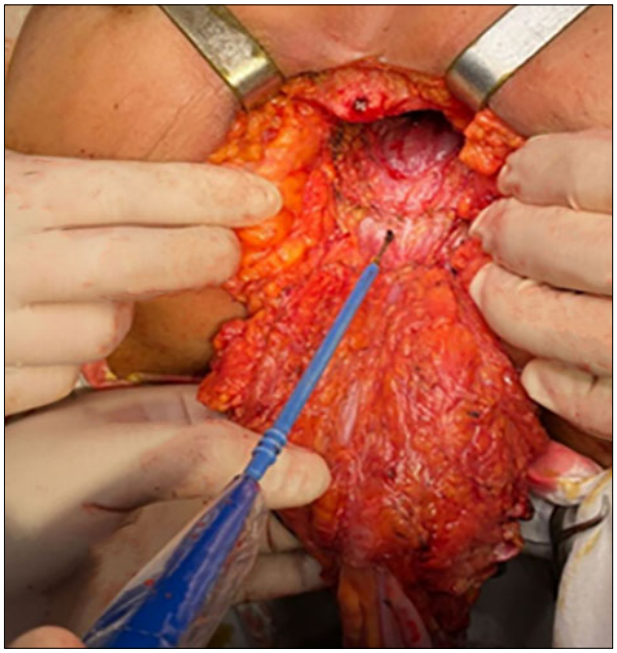


Figure 3. Intraoperative aspect: dissection of the anterior plane between the perineal rectum and the prostatic capsule (with significantly improved visual control in the Jackknife position) – better control of bleeding – prevention of heammorhagic complications.

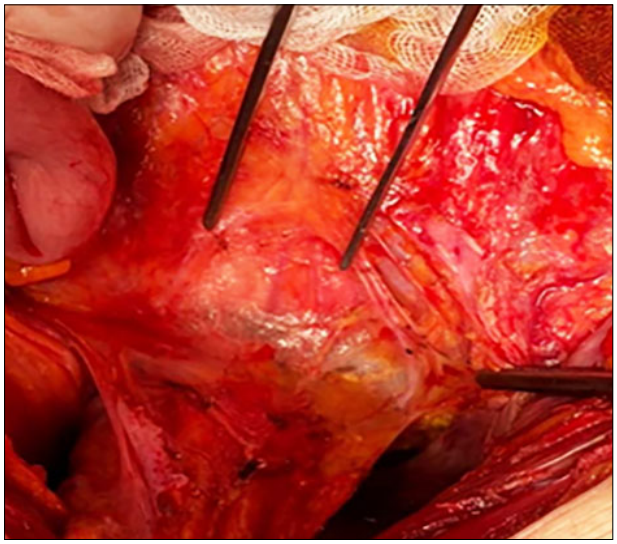


Figure 4. Intraoperative aspect: hypogastric nerves marked with a clamp. Correct dissectioin plane for avoiding iatrogenic lesions.

19.23% of cases, all involving patients with advanced rectal tumors that presented with covered perforations or microperforations. In one case, rectal stump perforation during mesorectal skeletonization resulted in a prolonged operative time, while in another case, it necessitated converting an anterior resection into a Hartmann's resection.

Early Postoperative Complications

Postoperative Bleeding

Postoperative bleeding is one of the most common and serious complications associated with rectal cancer surgeries. It can significantly affect patient outcomes by increasing the need for reoperations, contributing to higher morbidity, and negatively influencing long-term prognosis (2).

Postoperative bleeding in rectal cancer surgery typically occurs within the first few days after the procedure and can be influenced by various factors, including the type of surgery, the technique used, and the patient's overall health (3). Studies show that the incidence of postoperative bleeding ranges from 1% to 5%, with open surgical approaches more frequently associated with this complication compared to laparoscopic approaches (14).

The causes of postoperative bleeding may include coagulation defects, errors in hemostasis during surgery, injury to large vessels, or erosion at the anastomosis site (5,7). Open surgery tends to carry a higher risk of bleeding compared with laparoscopic or robotic techniques. Comorbidities such as hypertension, diabetes, and coagulopathies are significant risk factors that can contribute to postoperative bleeding (5).

In our study, postoperative bleeding occurred in 5 cases (7.85%). Of these, 3 were managed conservatively with dynamic monitoring, correction of coagulation defects, and blood transfusions. One of these cases later developed tight stenosis at the mechanical colorectal anastomosis, which was challenging to dilate using endoscopic methods. Two other cases required immediate reoperation to complete hemostasis.

Anastomotic Leakage

Anastomotic leakage is a severe complication in rectal cancer surgery, significantly impacting morbidity, mortality, and quality of life (17). It occurs due to insufficient healing at the anastomosis site, leading to peritonitis or enterocutaneous fistulas (18). Incidence varies from 5% to 20%, influenced by tumor location, surgical technique, and patient factors (13,19). Key risk factors include poor vascularization, proximity to the anal sphincter, neoadjuvant radiotherapy, and systemic issues like diabetes, malnutrition, and obesity (4,5,13,22).

Symptoms typically arise within 3-10 days post-surgery and include fever, pain, and abnormal drainage. Diagnosis is confirmed via CT imaging (17,20,21).

Preventive Measures and Management of Anastomotic Dehiscence

Preventive measures to reduce anastomotic dehiscence include using a protective stoma, optimizing patient conditions, and employing proper surgical techniques. A temporary protective stoma, such as a diverting ileostomy, allows

healing without fecal pressure and reduces symptomatic dehiscence risk (18,19).

In the study, ileostomies were used in 38 anterior resections for tumors under 5 cm from the anal verge, while 27 resections for tumors further away did not require them. Nutritional optimization, managing comorbidities, and smoking cessation support healing (1).

Proper techniques, including ensuring good vascularization and minimizing tissue tension, are critical to preventing dehiscence (12,22).

Management of Anastomotic Dehiscence

Treatment depends on the severity of the dehiscence:

- **Conservative management:** in cases with limited dehiscence and no peritonitis, conservative management is often effective. This includes broad-spectrum antibiotics, parenteral nutrition, and passive or aspirative drainage (20).
- **Surgical reintervention:** for severe cases with peritonitis or significant deterioration, surgical reintervention is necessary to lavage the peritoneal cavity and often convert the proximal part of the bowel into a stoma (21).

Type of Anastomosis and Dehiscence Risk

The impact of anastomosis type on dehiscence rates is debated, with leakage incidence ranging from 5% to 20% and no significant differences between hand-sewn and mechanical methods (22). Mechanical anastomoses may offer uniformity and speed but carry a higher bleeding risk, while hand-sewn techniques provide better tension adjustment and vascularization if performed skillfully (21, 22). In this study, 25 mechanical and 13 hand-sewn anastomoses showed no significant dehiscence difference ($p = 0.109$, Fisher's exact test). Of 13 dehiscence cases, 8 required re-operation due to peritonitis, often linked to unprotected hand-sewn anastomoses with inadequate vascularization. Five were treated conservatively, resolving without major complications.

Other Early Postoperative Complications

Complications of the Stoma Loop

Complications related to the stoma loop can significantly impact the quality of life for patients who have undergone rectal cancer surgery, especially in those requiring a diverting or protective stoma (23). Severe stoma-related complications, such as necrosis, prolapse, peristomal abscesses, and fistulas, may require additional surgical interventions, potentially affecting recovery and long-term prognosis (18,23).

Stoma Loop Necrosis

Stoma loop necrosis occurs when the vascularization of the exteriorized intestine is inadequate or when excessive tension is placed on the stoma loop, leading to impaired blood flow and typically manifests in the early postoperative period, and can range from superficial necrosis of the skin portion to deeper necrosis extending to the fascia (23,24).

In our study, we encountered colostomy necrosis in 2 cases, both of which involved Hartmann's procedure for advanced locoregional tumors. These cases required minimal resection of the necrotic portion of the stoma loop, and the complications were resolved without further issues.

Peristomal Abscesses and Fistulas

Peristomal abscesses and fistulas are infectious complications that occur when fecal leakage irritates and infects the tissues surrounding the stoma (23).

In our cohort, 5 cases of peristomal abscesses were identified. Four of these were minor and resolved quickly with appropriate management. However, one case involved more severe complications, including abdominal wall cellulitis, extensive peristomal musculocutaneous necrosis, and evisceration at the median wound site. This patient later died due to complications associated with severe SARS-CoV-2 infection.

Postoperative Intestinal Obstruction

Postoperative intestinal obstruction is a

significant complication in rectal cancer surgery, with an incidence ranging from 10% to 25%, depending on factors like surgical type, technique, and patient comorbidities (24). It can lead to reoperations, prolonged hospital stays, and diminished quality of life (24). Open surgeries have a higher obstruction risk than laparoscopic approaches due to increased adhesions and perivisceritis, while preoperative radiotherapy exacerbates the issue by compromising bowel vascularization, causing rigidity and stricture formation (25,26).

Key causes include peritoneal adhesions, the most common, resulting from tissue manipulation in open surgeries (25,26); anastomotic strictures, narrowing at the surgical site leading to blockage (27); internal hernias, where intestines slip into poorly closed defects (28); and paralytic ileus, a condition characterized by reduced intestinal motility due to anesthesia, opioids, or surgical trauma (25,28).

Diagnosis involves recognizing symptoms like abdominal distension and reduced bowel sounds, confirmed with imaging such as X-rays or CT scans (28). Paralytic ileus is often managed conservatively with fasting, intravenous hydration, nasogastric decompression, and prokinetic drugs to restore motility (28). For mechanical obstructions caused by adhesions, strictures, or hernias, surgical intervention may be necessary to release adhesions, widen strictures, or repair defects (25,27).

Reoperation increases morbidity, mortality, and healthcare costs, with risks of infection, delayed healing, and further intestinal injuries (13,14). Preventing obstruction and carefully managing complications are essential to improving outcomes and recovery for rectal cancer patients.

Postoperative Intestinal Obstruction in Our Study

In our cohort, high intestinal obstruction occurred in 3 patients. Two of these patients developed high intestinal obstruction within the first 5 postoperative days. Both required reoperation, which revealed plastic peritonitis, a complication resolved through viscerolysis (the surgical separation of adhesions). Both cases were also complicated by SARS-CoV-2 infection, which may have exacerbated the overall clinical situation.

One patient experienced high intestinal obstruction due to an improperly closed parieto-mesocolonic defect following a Hartmann's procedure. This resulted in an intestinal loop herniating and volvulating (twisting). The obstruction was resolved by devolvulation and proper closure of the defect, preventing further complications.

Postoperative Ileus

Postoperative ileus was encountered in 15 cases in our study. This condition was managed conservatively in all cases, with patients regaining bowel function within 4 to 5 days postoperatively. Conservative measures, including bowel rest, hydration, and gradual reintroduction of diet, were successful in resolving the condition without the need for surgical intervention.

Postoperative intestinal obstruction is a serious complication in rectal cancer surgery, especially after open surgery or radiotherapy. Effective management includes conservative treatments for ileus, timely surgical intervention for mechanical obstructions, and addressing risk factors like adhesions, strictures, and internal hernias.

Urinary Complications

Postoperative urinary complications significantly affect quality of life in rectal cancer patients, disrupting daily activities, sleep, and emotional well-being, and often contributing to anxiety and depression (29). Common issues include urinary incontinence and retention, with retention occurring in 10%-30% of cases, particularly after rectal resection or in patients who received neoadjuvant radiotherapy (29,30). Retention often results from pelvic autonomic nerve damage, such as injury to the hypogastric nerves or pelvic plexus, potentially causing long-term catheterization

and associated complications like erectile dysfunction (29). Patients requiring prolonged catheterization are at increased risk for urinary tract infections (UTIs), ranging from asymptomatic cases to symptomatic infections with fever, dysuria, and suprapubic pain (29). Thorough preoperative patient education, careful intraoperative techniques, and comprehensive postoperative support are essential to minimize these complications and improve patient outcomes.

Thromboembolic Complications

Patients with rectal cancer face an increased risk of thromboembolic complications due to the cancer itself and the extensive surgical procedures involved. The incidence of deep vein thrombosis (DVT) ranges from 2% to 10%, while pulmonary embolism (PE) is a significant cause of postoperative mortality, occurring in 1% to 5% of cases (31). Prevention strategies include low-molecular-weight heparin (LMWH), which reduces DVT and PE risks without significantly increasing bleeding (4,7). For patients with morbid obesity or thrombophilia, compression stockings and pneumatic devices were combined with preoperative LMWH. Despite prophylaxis, massive PE occurred in 7.69% of cases, successfully managed with anticoagulants.

Nosocomial Infectious Complications

Clostridium difficile infection (CDI) is a significant complication in rectal cancer surgery, prolonging recovery, hospital stays, and increasing mortality risks (32). Cancer patients are highly susceptible due to frequent antibiotic use, immunosuppression, and extended hospitalizations. Postoperative CDI symptoms include watery diarrhea, fever, abdominal cramps, and leukocytosis, with severe cases causing toxic megacolon, perforation, or septic shock (33). In the study, CDI occurred in 7 cases, confirmed by clinical signs, toxin tests, and CT scans. One patient required colectomy for toxic megacolon but succumbed postoperatively. Others were successfully treated with oral Metronidazole or Vancomycin, without affecting anastomosis or prognosis.

Late Postoperative Complications

Late complications following rectal cancer surgery encompass a range of issues that may emerge months or even years after the operation. These complications can greatly affect a patient's quality of life and are often linked to the anatomical and physiological changes resulting from rectal resection, as well as additional treatments such as radiotherapy (34,35).

Low Anterior Resection Syndrome

Low Anterior Resection Syndrome (LARS) is a frequent complication after rectal cancer surgery, affecting 60%-80% of patients and causing long-term bowel dysfunction, including increased stool frequency, urgency, fecal incontinence, and incomplete evacuation (36). Sexual and urinary dysfunctions are also common. In men, erectile dysfunction and retrograde ejaculation affect up to 60% of patients after total mesorectal excision (TME), caused by nerve and vascular damage during pelvic dissection (35). Women may experience lubrication disorders and dyspareunia, exacerbated by nerve damage and adhesions, especially when radiotherapy is involved (37). These complications significantly impact quality of life, causing emotional distress and relationship challenges (37).

Anastomotic strictures occur in 5%-20% of cases, influenced by factors such as anastomosis type (hand-sewn vs. mechanical), location (low vs. high), and preoperative radiotherapy (37). Low anastomoses are more prone to strictures due to increased scarring, tension, and reduced blood supply (38,39). Radiotherapy exacerbates the risk by impairing tissue healing and inducing fibrosis (39). Staplers may lead to more strictures than manual methods due to scar formation at staple sites, though outcomes depend on surgeon experience (22). Complications like anastomotic dehiscence and infections also contribute to abnormal healing, leading to excessive scar tissue and stricture formation (21,22).

Anastomotic stricture is a common late

complication of rectal cancer surgery, diagnosed through clinical examination and imaging. Digital rectal exams and endoscopy are key diagnostic tools, with the latter offering direct visualization and assessment of strictures. Radiologic contrast enemas provide confirmation and measure the extent of lumen narrowing (40).

Endoscopic dilation, using balloons or dilators, is the first-line treatment, with success rates of 70%-90% (40). For severe or resistant cases, temporary self-expanding stents may be used to maintain the lumen. If dilation fails, surgical reintervention, involving resection and anastomosis reconstruction, may be necessary, though repeat surgeries increase recurrence risk (37,40).

In the study, anastomotic stricture was the most common late postoperative complication, observed in 4 cases, all involving mechanically performed anastomoses. These strictures were identified clinically or via colonoscopy around 5 months post-surgery, delayed due to the need for urgent adjuvant therapy in advanced disease stages. Early reintegration (2 months post-surgery) showed no strictures (33).

Ileostomy reintegration was performed through the right iliac fossa with hand-sewn anastomoses for most cases. End-to-end or lateral-lateral approaches addressed loop diameter differences. For Hartmann's procedure patients, circular staplers were used if no recurrent disease was present, ensuring effective anastomosis reconstruction.

In the study, one case of postoperative bleeding was managed conservatively, with corticosteroids and endoscopic dilations resolving the anastomotic stricture, allowing ileostomy reintegration one year post-surgery. Two silent anastomotic dehiscence cases were treated with dilations, enabling safe reintegration. One undilatable stricture required ileostomy reintegration and permanent left colostomy creation. Pelvic fibrosis, linked to extrinsic strictures, was observed in patients receiving adjuvant radiotherapy, with an incidence of 10%-40% (40). Two patients with radiation-induced pelvic fibrosis and tight strictures unresponsive to medical treatment underwent ileostomy reintegration and permanent colostomies. Follow-ups revealed no new strictures after surgical exploration.

Conclusions

Although rectal cancer treatment is multidisciplinary, surgery remains the cornerstone of management. Major rectal cancer surgeries present numerous challenges due to the anatomy of the pelvis, tumor size, preoperative irradiation, and the tumor's proximity to the anal sphincter complex.

Accurate preoperative staging, appropriately indicated neoadjuvant treatment, and tailored surgical techniques for each individual case significantly reduce the risk of complications.

Early reintegration of the ileostomy reduces the likelihood of anastomotic strictures, while delayed reintegration is typically reserved for more advanced cases that require immediate postoperative adjuvant therapy.

Anastomotic leakage remains the most common and feared complication in rectal cancer surgery, accounting for approximately half of all postoperative complications. Surgeons performing rectal cancer surgeries must be highly skilled in the early detection and effective management of postoperative complications to avoid unfavorable outcomes, poor patient quality of life, and increased mortality.

A meticulous and careful surgical technique, minimizing tissue trauma, helps prevent intraoperative accidents, reduces operative time, and lowers the risk of postoperative ileus, thereby decreasing the overall risk of complications.

Lessons Learned and Preventive Strategies

Advanced surgical techniques emphasize precise dissection, intraoperative neuromonitoring, and improved hemostasis for better outcomes. Preventive measures focus on thromboembolic risk management using anticoagulants and anti-embolism devices. Comprehensive postoperative monitoring strengthens infection control and promotes

early mobilization. Multidisciplinary care ensures collaborative management of complications, enhancing overall patient recovery and outcomes.

Short Summary

Despite challenges such as a limited patient cohort and a single-clinic setting, the study yielded results aligning with specialized literature. Success was attributed to surgeries performed by experienced colorectal and oncologic surgeons in a university clinic. A key limitation was the small number of patients undergoing minimally invasive techniques, highlighting the need for further research. Future plans include increasing minimally invasive procedures, collaborating with other clinics at the Emergency County Hospital of Craiova, and expanding the study to encompass all county patients. This approach aims to provide a comprehensive analysis of rectal cancer treatment outcomes across the region.

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Conflicts of Interests

The authors declare no conflict of interest.

Ethical Statement

The study was conducted in compliance with the Declaration of Helsinki and received approval from the Ethical Committee of the Clinical Emergency County Hospital Craiova (approval number 46699/15.10.2024).

Data Availability

The data presented in this study is available upon request from the corresponding author.

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