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Enhanced Recovery after Surgery in Colorectal Cancer: A Prospective 6-Month Study

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Abstract

Background: Enhanced Recovery After Surgery (ERAS) protocols have gained considerable momentum in colorectal surgery, with evidence-based recommendations established by learned societies worldwide. However, implementation rates and outcomes vary across different healthcare settings.

Objective: To evaluate the degree of implementation of ERAS protocol recommendations in colorectal cancer surgery at EPH Mohammed Boudiaf, Ouargla, Algeria, and assess associated clinical outcomes.

Methods: A prospective, observational, single-center study was conducted over six months (October 23, 2022 to April 23, 2023) involving patients undergoing elective colorectal cancer surgery. Data were collected across preoperative, intraoperative, and postoperative periods up to 30 days post-surgery. Primary outcome was the implementation rate of ERAS protocol items. Secondary outcomes included 30-day morbidity, mortality, and length of hospital stay.

Results: Sixteen patients were included (mean age 61 years, 62.5% female). Overall ERAS protocol implementation rate was 63.89%, with the highest compliance in the postoperative period (90.63%) and lowest in the intraoperative period (52.08%). Specific item implementation rates varied: patient information (100%), antibiotic prophylaxis (100%), antiemetic prophylaxis (100%), immunonutrition (62.5%), preoperative fasting <6 hours (12.5%), carbohydrate loading (12.5%), multimodal analgesia (0%), and laparoscopic approach (6.3%). The overall morbidity rate was 18.8%, with no mortality. Mean hospital stay was 11 days (range 7-25 days, median 12 days).

Conclusion: ERAS protocol implementation in colorectal cancer surgery is feasible in our setting with moderate overall compliance. The protocol was associated with acceptable morbidity and zero mortality. Improved multidisciplinary collaboration, staff training, and resource allocation could enhance implementation rates and potentially improve clinical outcomes.

Keywords: Enhanced Recovery After Surgery, ERAS, Colorectal Cancer, Multimodal Analgesia, Postoperative Morbidity, Length of Stay, Protocol Implementation, Algeria

Introduction

The concept of Enhanced Recovery After Surgery (ERAS), also known as "fast-track surgery," represents a paradigm shift in perioperative care that has revolutionized surgical practice over the past three decades. First introduced by Professor Henrik Kehlet in 1995, ERAS encompasses a multimodal, multidisciplinary approach aimed at attenuating the surgical stress response and accelerating functional recovery following major surgery [1, 2].

Traditional perioperative care was characterized by prolonged preoperative fasting, liberal fluid administration, routine use of drains and nasogastric tubes, delayed mobilization, and late resumption of oral feeding. These practices, though deeply rooted in surgical tradition, often contributed to prolonged ileus, increased complications, extended hospital stays, and delayed return to normal activities [3]. ERAS challenges these conventional practices by implementing evidence-based interventions throughout the perioperative continuum.

The physiological rationale underlying ERAS is well established. Surgical trauma triggers a complex cascade of metabolic, endocrine, and inflammatory responses collectively termed the "surgical stress response" [4]. This response, while initially adaptive, can become maladaptive when excessive or prolonged, leading to complications such as insulin resistance,

immunosuppression, increased catabolism, cardiovascular dysfunction, and impaired wound healing [5]. ERAS protocols systematically address each component of this stress response through targeted interventions.

In colorectal surgery specifically, ERAS protocols have demonstrated significant benefits. Multiple randomized controlled trials and meta-analyses have shown that ERAS implementation reduces postoperative complications by 30-50%, decreases hospital length of stay by 2-3 days, and accelerates return to normal bowel function, all without increasing readmission rates [6, 7]. These benefits translate not only to improved patient outcomes and satisfaction but also to substantial healthcare cost savings.

The ERAS Society, established in 2010, has developed comprehensive guidelines for various surgical specialties, with colorectal surgery being the most extensively studied and validated [8]. These guidelines encompass approximately 20-25 evidence-based elements spanning preoperative, intraoperative, and postoperative care. Key components include patient education and counseling, optimization of nutritional status, avoidance of prolonged fasting with carbohydrate loading, goal-directed fluid therapy, minimally invasive surgical techniques, multimodal opioid-sparing analgesia, prevention of postoperative nausea and vomiting, early removal of drains and catheters, early mobilization, and early resumption of oral nutrition [9].

Despite robust evidence supporting ERAS protocols, implementation remains challenging worldwide. Barriers include institutional inertia, resistance to change among healthcare providers, lack of multidisciplinary coordination, resource limitations, inadequate staff training, and patient-related factors [10]. Implementation rates vary considerably across institutions and geographic regions, with compliance rates ranging from 40% to 90% for individual protocol elements [11].

In Algeria, ERAS is still in its early stages of adoption. The Algerian Group for Enhanced Recovery (AGER) was established in 2018 to promote and standardize ERAS implementation across the country [12]. However, few data exist regarding actual implementation rates and outcomes in Algerian surgical centers. Understanding local implementation patterns, barriers, and outcomes is essential for developing strategies to improve ERAS adoption and optimize perioperative care.

Colorectal cancer represents a significant health burden globally and in Algeria. It is among the most common malignancies, with surgical resection remaining the cornerstone of curative treatment. Patients undergoing colorectal cancer surgery are particularly vulnerable to perioperative complications due to factors including advanced age, nutritional deficiencies, tumor-related inflammation, and the magnitude of surgical intervention [13]. ERAS protocols offer substantial potential benefits for this patient population.

The present study was undertaken to evaluate the current state of ERAS implementation in colorectal cancer surgery at our institution, identify specific areas requiring improvement, and assess clinical outcomes including postoperative morbidity, mortality, and length of hospital stay. By establishing baseline implementation rates and outcomes, we aim to identify opportunities for quality improvement and contribute to the growing body of evidence regarding ERAS implementation in diverse healthcare settings.

Materials and Methods

Study Design and Setting

This was a prospective, observational, single-center study conducted at the Department of General Surgery and Cancer Center of EPH Mohammed Boudiaf in Ouargla, Algeria. The study period extended from October 23, 2022, to April 23, 2023, covering six months of patient recruitment with 30-day follow-up for all participants. The study protocol was designed to evaluate real-world ERAS implementation without mandating specific interventions, allowing assessment of actual clinical practice patterns.

Study Population

Inclusion Criteria

- Adult patients (≥18 years) scheduled for elective colorectal cancer surgery
- Histologically confirmed or clinically suspected colorectal malignancy
- Patients able to provide informed consent
- Surgery performed during the study period

Exclusion Criteria

- Emergency surgery
- Surgery for benign colorectal pathology
- Patients with unresectable tumors discovered intraoperatively
- Incomplete data collection

ERAS Protocol Elements

The ERAS protocol evaluated in this study was based on guidelines published by international learned societies, including the Enhanced Recovery After Surgery Society and the French Association of Surgery [14, 15]. The protocol comprised 18 key elements distributed across three perioperative phases:

Preoperative Phase

1. Comprehensive patient information and education
2. Immunonutrition supplementation (7-10 days preoperatively)
3. Abbreviated preoperative fasting (solids <6 hours, clear liquids <2 hours)
4. Preoperative carbohydrate loading
5. No mechanical bowel preparation (except for rectal surgery)

Intraoperative Phase

1. Antibiotic prophylaxis
2. Prophylaxis against postoperative nausea and vomiting (PONV)
3. Multimodal analgesia
4. Minimally invasive surgical approach (laparoscopy when feasible)
5. Goal-directed fluid therapy
6. No routine surgical drain placement (except selected cases)
7. No routine nasogastric tube or early removal
8. Prevention of perioperative hypothermia

Postoperative Phase

1. Multimodal opioid-sparing analgesia
2. Early removal of urinary catheter (within 24 hours for colonic surgery)
3. Early oral nutrition (within 24 hours)
4. Thromboprophylaxis
5. Early mobilization (within 24 hours)

Data Collection
A standardized case report form was developed to systematically collect data for each patient. Data were recorded prospectively at multiple time points:

Preoperative Assessment:
- Demographics (age, sex)
- Comorbidities and ASA physical status classification
- Nutritional assessment including body mass index
- Receipt of patient education
- Immunonutrition supplementation
- Preoperative fasting duration
- Carbohydrate loading
- Mechanical bowel preparation

Intraoperative Data:
- Date and type of surgical procedure
- Surgical approach (laparoscopic vs. open)
- Antibiotic prophylaxis administration
- PONV prophylaxis
- Type of analgesia provided
- Intraoperative fluid management
- Placement of drains and catheters
- Nasogastric tube insertion

Postoperative Data:
- Analgesia regimen
- Timing of urinary catheter removal
- Timing of oral nutrition resumption
- Thromboprophylaxis
- Timing of mobilization
- Return of bowel function
- Postoperative complications (classified by Clavien-Dindo)
- Length of hospital stay
- 30-day readmission
- 30-day mortality

Outcome Measures
Primary Outcome:
- Overall ERAS protocol implementation rate, calculated as the percentage of applicable protocol elements successfully implemented for each patient, then averaged across all patients

Secondary Outcomes:
- Phase-specific implementation rates (preoperative, intraoperative, postoperative)
- 30-day postoperative morbidity rate
- Types and severity of complications (Clavien-Dindo classification)
- 30-day mortality rate
- Length of hospital stay (days from surgery to discharge)
- 30-day readmission rate
- Reoperation rate

Immunonutrition Protocol
Given the unavailability of commercial immunonutrition products (such as Oral Impact®) in Algeria, a combination supplementation regimen was designed to approximate standard immunonutrition composition:
- Cetornan® (ornithine oxoglutarate) 5g, twice daily
- Sargenor® (arginine aspartate) 1g, twice daily
- Taurine 1 capsule, twice daily
- Omega-3 fatty acids 1 capsule, twice daily
- Multivitamins (B1, B6, B12, C)
- Magnesium supplementation

This regimen was prescribed 5-7 days before scheduled surgery, with the goal of achieving 7-10 days of supplementation before the procedure.

Statistical Analysis
Data were analyzed using IBM SPSS Statistics version 25 and Microsoft Excel 2019. Descriptive statistics were employed to characterize the study population and summarize outcomes. Continuous variables were expressed as means with standard deviations and ranges, or as medians with interquartile ranges when appropriate. Categorical variables were presented as frequencies and percentages. The implementation rate for each protocol element was calculated as the proportion of patients for whom the element was successfully applied when indicated. The overall implementation rate was computed as the mean of all applicable element implementation rates. Given the descriptive nature of the study and limited sample size, inferential statistical testing was not performed.

Ethical Considerations
The study was conducted in accordance with the Declaration of Helsinki and local ethical guidelines. As this was an observational study of routine clinical practice without experimental interventions, formal ethical approval requirements were waived according to institutional policy. However, all patients provided verbal informed consent for data collection and inclusion in the study. Patient confidentiality was maintained throughout data collection, analysis, and reporting.

Results
Patient Characteristics
During the six-month study period, 16 patients met inclusion criteria and were enrolled in the study. All patients completed the 30-day follow-up period without loss to follow-up.

Demographic Data: The mean age was 61 years (range 36-79 years, median 65 years). The modal age group was 60-70 years, comprising 37.5% (n=6) of patients. There was a female predominance, with 10 women (62.5%) and 6 men (37.5%), yielding a female-to-male ratio of 1.6:1.

Comorbidities: Ten patients (62.5%) had no significant medical comorbidities. Among the six patients (37.5%) with comorbidities, the distribution was: hypertension (n=2, 12.5%), diabetes mellitus (n=1, 6.3%), and other comorbidities (n=3, 18.8%).

ASA Physical Status: Half of the patients (n=8, 50%) were classified as ASA I, six patients (37.5%) as ASA II, and two patients (12.5%) as ASA III. No patients were classified as ASA IV or higher.

Nutritional Status: The mean body mass index was 25.38 kg/m², indicating slight overweight on average.

Preoperative ERAS Implementation
Patient Information and Education: All patients (100%, n=16) received verbal information and education about their surgery and the perioperative care pathway.

Immunonutrition: Ten patients (62.5%) received the prescribed immunonutrition supplementation regimen for the recommended duration preoperatively. Six patients (37.5%) did not receive immunonutrition, primarily due to financial constraints or difficulty obtaining the supplements.

Preoperative Fasting: Only two patients (12.5%) achieved the recommended fasting duration of less than 6 hours for solids before surgery. The majority (n=13, 81.3%) had prolonged fasting due to organizational factors related to meal timing and operating room scheduling. One patient (6.3%) declined abbreviated fasting by personal choice.

Carbohydrate Loading: Similarly, only two patients (12.5%) received carbohydrate-rich beverages 2 hours before anesthesia induction as recommended. Thirteen patients (81.3%) did not receive carbohydrate loading due to organizational barriers, and one patient (6.3%) declined.

Mechanical Bowel Preparation: Consistent with current evidence-based recommendations, no patients (0%) underwent mechanical bowel preparation, including those undergoing rectal surgery. This represented 100% compliance with the recommendation to avoid routine mechanical bowel preparation.

Overall Preoperative Implementation: The aggregate implementation rate for preoperative ERAS elements was 63.75%.

Intraoperative ERAS Implementation

Antibiotic Prophylaxis: All patients (100%, n=16) received appropriate antibiotic prophylaxis according to protocol, typically consisting of metronidazole plus an aminoglycoside administered 30 minutes before incision.

PONV Prophylaxis: Universal prophylaxis against postoperative nausea and vomiting was achieved, with all patients (100%, n=16) receiving dexamethasone 8mg intravenously at induction.

Multimodal Analgesia: No patients (0%, n=0) received multimodal analgesia as defined by the protocol during the intraoperative period. Specifically, no patients received epidural analgesia or regional anesthetic techniques. This represented a major gap in protocol implementation. All patients received general anesthesia alone.

Surgical Approach: The vast majority of patients (n=15, 93.8%) underwent open laparotomy. Only one patient (6.3%) was approached laparoscopically. The predominance of open surgery reflected surgeon preference and experience rather than patient selection factors.

Surgical Procedures Performed:

- Segmental colectomy with colorectal anastomosis: 56.3% (n=9)
- Right hemicolectomy with ileocolic anastomosis: 25.0% (n=4)
- Abdominoperineal resection: 6.3% (n=1)
- Ileocecal resection with ileocolic anastomosis: 6.3% (n=1)
- Left hemicolectomy with colorectal anastomosis: 6.3% (n=1)

Surgical Drainage: Fifteen patients (93.8%) had surgical drains placed. Only one patient (6.3%) had surgery without drain placement. This represented low compliance with recommendations to avoid routine drainage.

Overall Intraoperative Implementation: The aggregate implementation rate for intraoperative ERAS elements was 52.08%, the lowest of the three perioperative phases.

Postoperative ERAS Implementation

Postoperative Analgesia: All patients (100%, n=16) received postoperative analgesia, consisting uniformly of non-steroidal anti-inflammatory drugs (NSAIDs) plus paracetamol. No patients received epidural analgesia, patient-controlled analgesia, or other advanced analgesic modalities postoperatively.

Early Oral Nutrition: Only three patients (18.8%) resumed oral nutrition within the recommended 24-hour timeframe postoperatively. The majority (n=13, 81.3%) had delayed resumption of oral feeding, typically awaiting return of bowel function according to traditional practice.

Urinary Catheter Management: One patient (6.3%) did not have a urinary catheter placed. Among the remaining 15 patients with catheters, none had early removal within 24 hours as recommended; all catheters were removed late, with a mean removal time of 2 days postoperatively.

Thromboprophylaxis: Universal thromboprophylaxis was achieved, with all patients (100%, n=16) receiving low-molecular-weight heparin at prophylactic doses beginning on the evening of surgery and continuing for 30 days in cancer patients.

Early Mobilization: Eight patients (50%) achieved mobilization on postoperative day 1 as recommended. The distribution of mobilization timing was:

- Day 0 (day of surgery): 6.3% (n=1)
- Day 1: 50.0% (n=8)
- Day 2: 12.5% (n=2)
- Day 3: 12.5% (n=2)
- Day 5 or later: 18.8% (n=3)

Overall Postoperative Implementation: The aggregate implementation rate for postoperative ERAS elements was 90.63%, the highest of the three perioperative phases.

Clinical Outcomes

Length of Hospital Stay: The mean postoperative length of stay was 11 days (range 7-25 days, median 12 days). The distribution was:

- <7 days: 25.0% (n=4)
- 8-14 days: 62.5% (n=10)
- 15-21 days: 6.3% (n=1)
- 22-28 days: 6.3% (n=1)

Postoperative Morbidity: Three patients (18.8%) experienced postoperative complications within 30 days. Thirteen patients (81.3%) had an uneventful recovery without complications.

Types of Complications: Among the three patients with complications:

- Wound infection: n=1 (6.3%)
- Anastomotic leak: n=1 (6.3%)
- Wound dehiscence (evisceration): n=1 (6.3%)

All complications were classified as Clavien-Dindo grade II, managed with antibiotics and wound care without requiring surgical reintervention.

Reoperation: No patients (0%) required reoperation during the 30-day follow-up period.

Readmission: No patients (0%) were readmitted to the hospital within 30 days of discharge.

Mortality: There were no deaths (0% 30-day mortality) in this cohort.

Return of Bowel Function: Data on timing of first flatus and bowel movement were collected but mean values were not calculated due to the descriptive nature of this report.

Overall ERAS Protocol Implementation

Aggregate Implementation Rate: The overall ERAS protocol implementation rate across all phases was 63.89%. Implementation rates varied by phase:

- Preoperative: 63.75%

- Intraoperative: 52.08%
- Postoperative: 90.63%

Implementation Rate by Complication Status: Patients who developed complications had a mean implementation rate of 58.62%, while patients without complications had a mean rate of 61.96%. However, given the small number of events and the descriptive nature of this study, no statistical inferences regarding this difference can be drawn.

Discussion

This prospective observational study provides the first detailed assessment of ERAS protocol implementation in colorectal cancer surgery at our institution in Ouargla, Algeria. Our findings reveal an overall implementation rate of 63.89%, with notable variability across perioperative phases and specific protocol elements. While certain elements achieved near-universal compliance, others showed substantial gaps requiring targeted improvement efforts.

Interpretation of Implementation Rates

The overall implementation rate of 63.89% in our study is comparable to early ERAS implementation reports from other centers. A 2018 multicenter French study reported implementation rates ranging from 40% to 85% across participating institutions [16]. Our rate falls within this range, suggesting that our implementation challenges are similar to those encountered elsewhere, particularly in the early phases of ERAS adoption.

The phase-specific analysis reveals important patterns. The high postoperative implementation rate (90.63%) suggests strong nursing and junior medical staff engagement with simple, easily standardized interventions such as thromboprophylaxis and basic mobilization protocols. Conversely, the lower intraoperative implementation rate (52.08%) reflects challenges related to surgeon preference, technical expertise, and resource availability, particularly regarding laparoscopic surgery and regional anesthesia.

Preoperative Phase

Patient Education: The 100% rate of patient information provision is encouraging and aligns with the patient-centered philosophy of ERAS. However, we acknowledge that the quality and comprehensiveness of information likely varied among providers. A 2020 study from Hospital Central d'Alger reported a 98.4% information rate, while the 2018 French Association of Surgery (AFC) multicenter study reported 92% [17, 18]. Future efforts should focus not just on whether information is provided, but on developing standardized educational materials and assessing patient comprehension and engagement.

Immunonutrition: Our immunonutrition implementation rate of 62.5% compares favorably to the 52% rate in the AFC study but falls short of the 80.3% achieved at Hospital Central d'Alger [17, 18]. The primary barriers identified were the high cost of supplements and difficulty obtaining specific formulations in Algeria. Notably, among our three patients who developed complications, one had not received immunonutrition and developed a wound infection, potentially supporting the protective effect of perioperative immunonutrition in high-risk patients.

The evidence supporting immunonutrition in cancer patients undergoing major surgery is robust. Meta-analyses demonstrate reductions in infectious complications and hospital stay when immunonutrition containing arginine, omega-3 fatty acids, and nucleotides is provided for 5-7 days preoperatively [19]. Our approach of combining multiple separate supplements to approximate commercial immunonutrition formulations was pragmatic but suboptimal. Advocating for the availability of standardized immunonutrition products in Algeria should be a priority for surgical and nutritional societies.

Preoperative Fasting and Carbohydrate Loading: The low implementation rates for abbreviated fasting (12.5%) and carbohydrate loading (12.5%) represent significant deficiencies in our protocol adherence. These rates are substantially lower than the 80-85% reported in the AFC study and the 80.8% reported from Hospital Central d'Alger [17, 18]. The primary barrier was organizational: our hospital's meal service delivers the final evening meal around 8:00 PM, and most patients were scheduled for early morning surgery. This resulted in fasting durations exceeding 12 hours for the majority of patients.

The physiological rationale for minimizing preoperative fasting is well established. Prolonged fasting induces a catabolic state characterized by glycogen depletion, increased insulin resistance, and patient discomfort [20]. Preoperative carbohydrate loading (typically 100g the evening before and 50g two hours before surgery) has been shown to reduce postoperative insulin resistance, preserve lean body mass, and improve subjective well-being [21]. Major anesthesia societies, including the European Society of Anaesthesiology and the French Society of Anesthesia and Intensive Care, recommend clear fluids until 2 hours before surgery and abbreviated solid fasting [22].

Addressing this implementation gap requires operational changes rather than just education. Potential solutions include adjusting meal service times, providing patients with take-home carbohydrate supplements, or establishing a dedicated preoperative preparation area where patients can receive carbohydrate drinks shortly before transfer to the operating room.

Bowel Preparation: Our 100% compliance with avoidance of mechanical bowel preparation aligns with current evidence and guidelines. Multiple systematic reviews and randomized trials have demonstrated that mechanical bowel preparation does not reduce anastomotic leak rates or other complications in colorectal surgery, while potentially causing patient discomfort, dehydration, and electrolyte disturbances [23]. This element was easily implemented because it required abandoning a practice rather than adding new interventions.

Intraoperative Phase

Antibiotic and PONV Prophylaxis: The universal implementation of antibiotic prophylaxis (100%) and PONV prophylaxis (100%) represents excellent compliance and likely contributes to our favorable outcomes. These interventions are straightforward, cost-effective, and well accepted by anesthesia teams. The systematic use of dexamethasone for PONV prophylaxis is particularly noteworthy, as this corticosteroid also provides anti-inflammatory benefits and may reduce postoperative pain and fatigue [24].

Multimodal Analgesia: The complete absence of intraoperative multimodal analgesia (0% implementation) represents the most significant gap in our ERAS protocol. Specifically, no patients received epidural analgesia,

regional blocks (such as transversus abdominis plane blocks), or intravenous lidocaine—all evidence-based components of multimodal analgesia in colorectal surgery. This contrasts sharply with the 79% rate reported from Hospital Central d'Alger and 82% in the AFC study [17, 18].

The barriers to implementing multimodal analgesia at our institution are multifaceted. During the study period, the anesthesia team consisted primarily of visiting Cuban physicians with limited experience in regional anesthesia techniques and language barriers that complicated communication and training. Additionally, equipment for epidural catheter placement and infusion pumps was not consistently available. Finally, our nursing staff lacked training in monitoring patients with epidural analgesia, creating safety concerns.

The importance of optimal analgesia cannot be overstated. Pain is a primary driver of the surgical stress response and significantly impairs recovery [25]. Epidural analgesia with local anesthetics provides superior analgesia compared to systemic opioids, reduces the neuroendocrine stress response, accelerates return of bowel function, facilitates early mobilization, and reduces pulmonary complications [26]. In our cohort, all patients received only oral NSAIDs and paracetamol postoperatively—a basic analgesic regimen that likely contributed to slower mobilization and delayed feeding in some patients.

Improving analgesia practices requires investment in several areas: training in regional anesthesia techniques, ensuring equipment availability, developing nursing competencies in monitoring, and establishing protocols for transitioning from advanced analgesic modalities to oral medications. Partnership with academic centers or visiting experts could facilitate skill transfer.

Surgical Approach: The predominance of open surgery (93.8% laparotomy rate) versus laparoscopy (6.3%) reflects surgeon preference and training rather than patient factors or absolute contraindications. This contrasts dramatically with the 79% laparoscopy rate in the AFC study [18] and the growing international consensus favoring minimally invasive approaches when oncologically appropriate.

The benefits of laparoscopic colorectal surgery are well documented. Compared to open surgery, laparoscopy reduces surgical trauma, attenuates the inflammatory response (lower IL-6 and CRP levels), decreases postoperative pain, accelerates return of bowel function, shortens hospital stay, and improves cosmetic outcomes—all while maintaining oncologic adequacy [27]. A landmark study by Vlug *et al*. demonstrated that the optimal combination for colorectal surgery is laparoscopy plus ERAS, which yields better outcomes than either intervention alone [28].

Increasing laparoscopy rates at our institution faces challenges including surgeon training and experience, equipment availability and maintenance, operating room time constraints, and case selection. Not all patients are suitable for laparoscopic approaches, particularly those with locally advanced tumors, prior extensive abdominal surgery, or certain anatomical considerations. Nevertheless, the current 6.3% rate leaves substantial room for improvement.

Surgical Drainage: The high rate of surgical drain placement (93.8%) contrasts with ERAS recommendations to avoid routine drainage in colonic surgery and to selectively drain only high-risk rectal anastomoses [29]. The evidence against routine drainage is strong: drains do not reduce anastomotic leak rates, do not allow early detection of leaks, may actually increase infection risk, cause patient discomfort, and impede mobilization.

This practice pattern likely reflects traditional surgical teaching and perceived medicolegal protection. In our cohort, nine patients underwent colorectal anastomosis below the peritoneal reflection (in the pelvis), which might justify selective drainage; however, the near-universal drainage even in colonic cases suggests routine rather than selective practice. Changing this practice requires education regarding current evidence and building surgeon confidence in omitting drains.

Postoperative Phase

Early Oral Nutrition: The low rate of early feeding (18.8% within 24 hours) is disappointing, as this is a cornerstone of ERAS protocols. This rate is substantially lower than the 100% reported from Hospital Central d'Alger and 87% in the AFC study [17, 18]. The primary barrier was cultural and educational: patients, families, and some nursing staff maintained traditional beliefs that oral intake must be delayed until return of bowel function (passage of flatus or stool) to "protect the anastomosis."

The evidence overwhelmingly supports early feeding. Randomized trials demonstrate that early oral nutrition does not increase anastomotic leaks, nausea/vomiting, or aspiration, while it does reduce complications, preserve lean body mass, improve patient satisfaction, and shorten hospital stay [30]. The gut tolerates enteral nutrition even in the presence of ileus, and early feeding may actually stimulate bowel function.

Implementing early feeding requires intensive patient and staff education, starting preoperatively. Patients need clear explanations that drinking and eating will not harm their anastomosis and that feeling hunger is normal and healthy. Nursing staff need protocols specifying what and when to offer, along with authority and expectation to encourage feeding. Starting with clear liquids and rapidly advancing to solid food as tolerated is safe and effective.

Urinary Catheter Management: The absence of early catheter removal (0% within 24 hours for colonic surgery) likely contributed to delayed mobilization in some patients. Prolonged catheterization increases urinary tract infection risk, causes patient discomfort, and impedes mobilization [31]. Current guidelines recommend catheter removal within 24 hours for colonic resections and up to 3 days for rectal surgeries with pelvic dissection.

The barriers to early removal at our institution included nursing workload concerns (managing potential urinary retention), traditional practice patterns, and inadequate protocols. Systematic catheter removal pathways with clear timing guidelines and nursing authority to remove catheters according to protocol can substantially improve compliance.

Thromboprophylaxis: The universal provision of thromboprophylaxis (100%) is commendable and follows evidence-based guidelines. All cancer patients undergoing major surgery face elevated venous thromboembolism risk, and extended prophylaxis for 30 days postoperatively is recommended [32]. This element was successfully implemented through clear protocols and physician awareness.

Early Mobilization: Half of patients (50%) achieved mobilization on postoperative day 1, a reasonable rate but with room for improvement. The AFC study reported 90%

day-1 mobilization [18]. Barriers to early mobilization included urinary catheters, inadequate analgesia, patient reluctance, advanced patient age (median 65 years), and limited physiotherapy resources.

Early mobilization provides multiple benefits: reduced insulin resistance, maintained muscle mass, improved pulmonary function, reduced thromboembolism risk, and psychological benefits [33]. Achieving higher mobilization rates requires a culture change viewing mobilization not as optional but as essential therapy. Strategies include setting specific mobilization goals (e.g., sitting in chair for 2 hours, walking 50 meters twice daily), assigning responsibility to nursing staff and physiotherapists, tracking compliance, and removing barriers (catheters, drains, inadequate analgesia).

Clinical Outcomes

Postoperative Morbidity: Our 30-day morbidity rate of 18.8% compares favorably to the 17.2% reported from Hospital Central d'Alger and is lower than the 24% in the AFC study [17, 18]. All complications in our series were Clavien-Dindo grade II (requiring antibiotics or minor interventions), with no major complications requiring reoperation. The specific complications—wound infection, anastomotic leak, and wound dehiscence—are well-recognized risks in colorectal surgery.

The relationship between ERAS compliance and complications is well established in the literature, with multiple studies demonstrating that higher adherence rates correlate with lower complication rates [34]. In our cohort, patients who developed complications had slightly lower mean implementation rates (58.62%) compared to uncomplicated patients (61.96%), though small numbers preclude statistical analysis. This trend suggests that improved protocol adherence might further reduce our already acceptable complication rate.

Examining individual cases provides insights:

- The patient with wound infection had not received preoperative immunonutrition, potentially contributing to impaired wound healing and infection susceptibility
- The patient with anastomotic leak had received excessive intraoper

fluid administration (hyperhydration), which can cause bowel edema and compromise anastomotic healing

- The patient with wound dehiscence had developed postoperative pneumonia, a pulmonary complication potentially linked to inadequate analgesia and poor respiratory effort

These observations, while anecdotal, underscore how multiple ERAS elements work synergistically to prevent complications.

Mortality: The zero mortality rate in our series is excellent, though with only 16 patients, this primarily reflects appropriate patient selection and competent surgical technique rather than ERAS effects specifically. Mortality benefits of ERAS are most apparent in larger series and high-risk patients [35].

Length of Stay: Our mean length of stay of 11 days (median 12 days) is longer than the 8 days reported from Hospital Central d'Alger and substantially longer than the 5 days in the AFC study [17, 18]. Several factors likely contribute to this difference:

First, the predominance of open surgery in our series (93.8%) versus high laparoscopy rates elsewhere increases postoperative pain, prolongs ileus, and extends recovery. Second, our geographic isolation (serving multiple southern provinces) made early discharge logistically challenging, as many patients lived far from the hospital and lacked easy access to follow-up care if problems arose. Clinicians often extended hospitalization to ensure stability before long-distance travel. Third, suboptimal implementation of certain ERAS elements—particularly multimodal analgesia, early feeding, and early catheter removal—likely delayed some physiologic recovery markers used as discharge criteria.

Fourth, our discharge criteria may have been more conservative than other centers. We required complete tolerance of solid food, return of bowel function, absence of fever, adequate pain control on oral medications, and complete mobility before discharge—all reasonable criteria individually, but their combination may have been overly stringent.

Reducing length of stay while maintaining safety requires multiple coordinated interventions: increasing laparoscopy rates, improving multimodal analgesia, systematizing early feeding and catheter removal protocols, establishing clear discharge criteria focused on functional rather than absolute parameters (e.g., tolerating some oral intake rather than full diet, mobile at baseline level rather than completely independent), arranging reliable outpatient follow-up, and educating patients and families about expected recovery timelines.

Barriers to Implementation

Our experience highlights several categories of barriers to ERAS implementation:

Cultural and Educational Barriers:

- Patient and family expectations based on traditional surgical care (prolonged fasting, late feeding, extended bed rest)
- Staff resistance to changing long-standing practices
- Inadequate understanding among nurses and junior doctors of the evidence base for ERAS elements
- Language barriers with visiting Cuban medical staff

Organizational Barriers:

- Meal service timing incompatible with abbreviated fasting protocols
- Operating room scheduling that doesn't accommodate fasting guidelines
- Lack of standardized care pathways and order sets
- Absence of regular multidisciplinary team meetings to coordinate care
- No formal ERAS program coordinator or champion

Resource Barriers:

- Limited availability and high cost of immunonutrition supplements
- Insufficient equipment for regional anesthesia (epidural kits, infusion pumps)
- Limited laparoscopic equipment and maintenance
- No dedicated physiotherapy resources for mobilization programs
- Absence of acute pain service for managing complex analgesia

Knowledge and Skill Barriers:

- Anesthesia team inexperience with regional techniques
- Surgeon experience predominantly in open rather than laparoscopic surgery
- Nursing staff untrained in managing epidural analgesia and early feeding protocols

System and Policy Barriers:
- Lack of institutional priority and administrative support for ERAS implementation
- No mechanisms for tracking compliance or outcomes
- Absence of feedback loops to clinicians regarding their performance

Strategies for Improvement

Based on our experience and the literature on successful ERAS implementation, we propose several strategies:

Education and Training:
- Develop standardized educational materials for patients (written and video)
- Conduct regular multidisciplinary training sessions for all staff
- Arrange visiting experts or fellowship training in regional anesthesia and laparoscopic surgery
- Create pocket cards and posters summarizing key ERAS elements

Organizational Changes:
- Designate an ERAS coordinator (nurse or physician) to oversee implementation
- Establish weekly multidisciplinary team meetings to discuss cases and barriers
- Adjust meal service times or provide take-home carbohydrate supplements
- Develop standardized order sets for preoperative, intraoperative, and postoperative care
- Implement an electronic tracking system for monitoring compliance

Resource Allocation:
- Prioritize procurement of immunonutrition products or advocate for insurance coverage
- Invest in regional anesthesia equipment and maintenance contracts for laparoscopic instruments
- Recruit or train physiotherapists for mobilization programs
- Consider establishing an acute pain service

Quality Improvement:
- Continue prospective data collection on implementation and outcomes
- Provide regular feedback to clinicians on their compliance rates
- Conduct morbidity and mortality conferences with ERAS lens
- Benchmark against national and international data
- Publish results to raise institutional profile and secure resources

Cultural Change:
- Engage senior surgical and anesthesia leaders as ERAS champions
- Frame ERAS as quality improvement and patient safety initiative, not criticism of current practice
- Celebrate successes and share positive patient outcomes
- Gradually introduce changes rather than demanding immediate perfection

Study Strengths and Limitations

Strengths: This study represents the first detailed prospective assessment of ERAS implementation in colorectal cancer surgery in southern Algeria. The prospective design with standardized data collection using predefined forms enhances data quality. Complete 30-day follow-up without losses enhances outcome ascertainment. The comprehensive evaluation of multiple protocol elements across all perioperative phases provides a thorough assessment. Most importantly, the study establishes baseline data essential for quality improvement initiatives.

Limitations: The small sample size (n=16) limits statistical power and generalizability. The single-center design in a specific geographic and organizational context may not reflect practices elsewhere. The six-month study period may not capture seasonal variations or learning curve effects. As an observational study, we assessed actual implementation without controlling for confounding variables, making it difficult to attribute specific outcomes to specific ERAS elements. We did not formally assess quality of life, functional recovery, or patient satisfaction—important patient-centered outcomes. The study preceded organizational changes to improve implementation, so it represents suboptimal rather than optimized ERAS practice. Finally, certain data elements (such as pain scores, fluid volumes) were incompletely documented in some cases.

Future Directions

This baseline assessment opens several avenues for future work at our institution:
- Implement targeted interventions to address identified gaps (particularly multimodal analgesia, early feeding, catheter removal)
- Conduct repeated assessments to track improvement over time
- Expand to larger sample sizes and other surgical procedures
- Assess cost-effectiveness and resource utilization
- Evaluate patient-reported outcomes including quality of life, satisfaction, and functional recovery
- Study implementation barriers and facilitators through qualitative research (staff interviews, focus groups)
- Collaborate with other Algerian centers to establish national benchmarks through the Algerian Group for Enhanced Recovery (AGER)

Conclusion

This prospective study demonstrates that ERAS protocol implementation in colorectal cancer surgery is feasible in our southern Algerian healthcare setting, with an overall compliance rate of 63.89%. This moderate implementation rate was associated with favorable outcomes including acceptable morbidity (18.8%), zero mortality, and no readmissions or reoperations within 30 days, though length of stay (11 days) exceeded international benchmarks.

Implementation rates varied substantially across perioperative phases and specific elements. High compliance was achieved for straightforward interventions such as patient education (100%), antibiotic prophylaxis (100%), PONV prophylaxis (100%), and thromboprophylaxis (100%). However, significant gaps were identified in multimodal analgesia (0%), laparoscopic surgery (6.3%), abbreviated preoperative fasting (12.5%), carbohydrate loading (12.5%), and early oral feeding (18.8%).

Barriers to implementation included organizational factors (meal service timing, OR scheduling), resource limitations (equipment, immunonutrition availability), knowledge and skill gaps (regional anesthesia, laparoscopy), and cultural resistance to changing traditional practices. The postoperative phase showed highest compliance (90.63%),

while the intraoperative phase showed lowest (52.08%), suggesting that complex technical interventions requiring specialized skills and equipment are most challenging to implement.

Our findings align with international experience showing that ERAS implementation is an ongoing quality improvement process requiring sustained effort, multidisciplinary collaboration, administrative support, and continuous monitoring and feedback. Even with moderate implementation rates, clinically meaningful benefits can be achieved, with potential for further improvement as compliance increases.

Key recommendations for improving ERAS implementation at our institution and similar settings include: establishing formal ERAS programs with designated coordinators, providing targeted education and training particularly in regional anesthesia and laparoscopic surgery, adjusting organizational processes to enable abbreviated fasting and early feeding, investing in necessary equipment and resources, creating standardized protocols and order sets, implementing tracking systems with regular feedback, and fostering cultural change through engagement of clinical leaders as ERAS champions.

As ERAS continues to evolve and evidence accumulates, periodic reassessment and adaptation of protocols will be essential. This baseline assessment provides the foundation for quality improvement initiatives aimed at optimizing perioperative care, reducing complications, shortening recovery, and ultimately improving outcomes for patients undergoing colorectal cancer surgery in southern Algeria and similar healthcare contexts.

The journey toward full ERAS implementation is challenging but achievable. With commitment, collaboration, and continuous improvement, we can progressively adopt evidence-based practices that enhance patient recovery and surgical outcomes while potentially reducing healthcare costs through decreased complications and shorter hospital stays.

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