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Abstract: Background: Total gastrectomy with D2 lymph node dissection is standard for resectable esophagogastric junctional and gastric cancer, but high morbidity challenges perioperative care. ERAS guidelines advise against routine drains, yet conflicting evidence leads to inconsistent practice. Methods: The DRAG (DRains After Gastrectomy) Trial is a prospective, non-randomized study conducted from February 2020 to March 2023 at the 1st Propaedeutic Surgery Department, Hippocration General Hospital, Athens. Patients undergoing open D2 total gastrectomy had perianastomotic drains placed based on newly established criteria, offering a more tailored approach. Immediate and short-term postoperative outcomes, including recovery milestones and complications, were assessed. Results: Sixty patients were included, with 40 receiving a drain. The non-drain group had significantly lower pain scores, earlier mobilization, less postoperative nausea and vomiting, and a shorter hospital stay. Among those with complications, significant differences in surgical site infections, delayed mobilization, extra-abdominal issues, length of stay, readmissions, and reoperations suggest that drain use may increase complications and hinder recovery. Conclusion: Our study suggests that routine prophylactic drain use can be avoided in gastrectomy for esophagogastric junctional and gastric cancer when experienced surgeons in high-volume centers follow predefined criteria. Implementing these criteria may improve patient outcomes and reduce complications. Trial registration: Clinical Trials.gov NCT 04288661

Keywords: prophylactic drain; total gastrectomy; gastric cancer; esophagogastric anastomosis leak; drain criteria

1. Introduction

Gastric cancer ranks as the fifth most common and fifth most lethal cancer globally [1]. For patients with AJCC (American Joint Committee on Cancer) stages IB to IIIC, representing the majority

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of cases, the current gold standard of surgical treatment involves total gastrectomy combined with D2 lymph node dissection, followed by gastrointestinal tract reconstruction [2,3]. The 5-year survival rates following R0 resection vary significantly, ranging from 89.9% for stage IB to 20.2% for stage IIIC, as reported in the 8th edition of the TNM classification[4]. Given the significant morbidity associated with this extensive surgical procedure, there has been a growing focus on improving perioperative management and quality of life for these patients over the past two decades[5,6].

It has long been established that minimizing surgical intervention correlates with faster patient recovery [5-7]. The Enhanced Recovery After Surgery (ERAS) guidelines provide globally recognized perioperative recommendations for a variety of surgical procedures, grounded in research, audits, and evidence-based practice [6]. In 2014, Mortensen et al. [8] introduced ERAS guidelines specifically tailored for gastrectomy in gastric cancer. These guidelines include both procedure-specific and general recommendations applicable to the perioperative management of abdominal surgeries. However, much of the data underpinning these guidelines have been extrapolated from research on perioperative management in pancreaticoduodenectomy and colectomy for malignancies [9,10].

Since the publication of ERAS guidelines, evidence suggests limited and inconsistent global adherence to the protocol in gastrectomy, particularly regarding surgical drain use. Historically, drain placement during gastrectomy was routine [11], with literature reporting usage rates ranging from 57.7% to 62.8% [12-14]. The ERAS guidelines advise against drain placement to reduce complications like pain, delayed mobilization, and infections. This recommendation, based on two meta-analyses (400 cases) and two prospective trials, lacked robustness due to heterogeneity in surgery type and data collection [15-18]. These studies found no significant differences in hospital stay, morbidity, mortality, or complications between patients with and without drains, leading many to view the data as insufficient. Although the ERAS guidelines provide clear direction on drain use in surgeries such as pancreaticoduodenectomies and colectomies, recommending drains for the former but not the latter [9,10], the debate for gastrectomy remains unresolved. Japanese guidelines support routine use of intraperitoneal drains after total gastrectomy, with removal by the fifth postoperative day [19]. Studies from Japan further investigate the prognostic value of drain contents post-gastrectomy, reinforcing this practice [11,20-24]. In contrast, Western guidelines, such as those from the American College of Surgeons, advise against routine drain use, suggesting placement only in exceptional cases [25]. This divergence among experts contributes to uncertainty regarding drain use in gastrectomy, resulting in limited adherence to ERAS recommendations in Western practices [26,27].

This prospective, non-randomized controlled clinical trial aims to assess the impact of one perianastomotic drain when it is placed under specific, predefined criteria. The trial evaluates the immediate and short-term postoperative outcomes in patients who underwent D2 total gastrectomy for gastric cancer which were performed in a high-volume centre and under the care of a highly experienced team. To our knowledge, this is the first study to propose specific criteria tailored to the question of routine prophylactic drain use in total gastrectomy. This novel approach aims to fill an existing gap in the literature, offering a structured framework for clinical decision-making in high-volume centres.

2. Materials and Methods

The DRAG (DRains After Gastrectomy) Trial is a prospective, non-randomized, controlled clinical trial involving patients diagnosed with gastric or esophagogastric juctional neoplasm. All surgeries were performed by a single, highly experienced surgeon in the 1st Propaedeutic Surgery Department at Hippocration General Hospital in Athens, Greece. The patients underwent open total gastrectomy with D2 lymph node dissection, followed by Roux-en-Y gastrointestinal tract reconstruction, in accordance with a predefined, ERAS-compliant perioperative departmental protocol. Despite performing an open procedure, dissections were carried out with surgical instruments utilizing ultrasonic vibration scalpel. Saline used for irrigating the surgical field was carefully monitored and excluded from the total calculated blood loss. Our institution's protocol does not routinely incorporate exploratory laparoscopy or peritoneal cytology.

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It is acknowledged that certain special or more complex cases may require lymphadenectomy beyond a standard D2 dissection [28]. However, to maintain uniformity, only patients undergoing D2 gastrectomy were included in this study.

The participants were divided into two groups. The first group adhered to the department's standard practice, which involved placing a 10 mm (approximately 30 Fr) silicone drain near the esophagojejunal anastomosis (drain group). The drain used in this study was a silicone tube provided by Shanghai International Holding Corp. GmbH. In contrast, no drain was placed in the second group (non-drain group). The decision to place a drain was based on the following criteria:

a) Pulmonary diseases under oxygen therapy

b) Chronic oral steroid use (≥5mg/day prednisone equivalent for >1month)

c) Intraoperative hemodynamic instability requiring vasopressors

d) Intraoperative blood loss exceeding 250 mL

e) Vessel injury (celiac axis or its branches)

f) Injury to adjacent structures (pancreas, spleen, duodenum)

g) Tension of the anastomosis

h) Concerns about the integrity of the duodenal stump arising from potential staple misfiring or compromised tissue quality.

These criteria were informed by existing literature on gastrectomy and their presence denotes increased risk for postoperative complications [11,29-41].

All patients meeting the eligibility criteria (Table 1) underwent comprehensive preoperative evaluations, including clinical examinations, blood tests, imaging studies, and consultations with other specialties. The detailed preoperative assessment is outlined in Appendix 1.

Table 1. Eligibility criteria.

ELIGIBILITY CRITERIA
INCLUSION CRITERIA
Age over 18 years old
Histologically proven EGJ (Siewert II or III) or non-EGJ gastric adenocarcinoma (intestinal, diffuse, or mixed Lauren type)
Surgical candidates for total gastrectomy plus D2 lymph node dissection
ECOG performance status 0 or 1
Signed informed consent from
Preoperative evaluation of cTanyNanyM0 according to the American Joint Committee on Cancer Staging Manual, 7th edition
EXCLUSION CRITERIA
M1 disease
Other unplanned organ excision
Massive ascites or cachexia
Current participation in any other clinical trial
Severe cardiovascular, respiratory tract, kidney, liver, or psychiatric disease.
Poor compliance to the clinical protocol
Pregnancy

Per our departmental protocol, patients were gradually mobilized starting directly after surgery, when feasible. On the second postoperative day, an oral gastrografin study was conducted for each patient to detect any early anastomotic leaks. Following a normal radiological study, patients were initiated on a liquid diet, which was then advanced to pureed food on the third postoperative day, and a soft diet on the fourth day. For patients in the drain group, the drain was removed on the fifth postoperative day, provided that the drainage volume was less than 50 mL over the preceding 48 hours, in line with departmental protocol. A descriptive timeline of the protocol is presented in Appendix 2.

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The primary outcomes measured in this study were: a) pain levels, assessed using the Visual Analog Scale (VAS) during the first 5 postoperative days, b) postoperative nausea and vomiting (PONV) within the first 5 days, c) initiation of feeding, d) postoperative bowel mobilization, e) patient mobilization, f) length of hospital stay (LOS)

Secondary outcomes included: a) mortality, b) surgically related readmissions and c) reoperations

This study was conducted in accordance with the principles outlined in the Helsinki Declaration of Human Rights [42] and with the Guidelines of Good Clinical Practice [43]. The final study protocol and the informed consent form for participant inclusion received approval from the Institutional Review Board (IRB). The IRB also conducted regular assessments, as required, to ensure the ongoing compliance with lawful medical practice throughout the trial.

The statistical analysis was performed using the R software (R foundation for Statistical Computing) version 4.3.0 for Windows. Descriptive characteristics for the quantitative data were expressed as median and Quartile 1 (Q1) to Quartile 3 (Q3) range and for completeness reasons the mean ± standard deviation (SD), for the qualitative data was reported the frequency of occurrence and the relevant percentage. Comparisons were preformed between patients with drainage and those without drainage; for the qualitative parameters statistical tests were performed via the chi-square test (and if required a Fisher exact test) and for the arithmetic data (as normality was not possible to be ensured using the Shapiro Wilk test), were applied not parametric tests, specifically the Mann Whitney U test. The significance level (p-value) was set to 0.05, thus statistically significant difference between compared groups was for $p<0.05$ and all tests were two sided.

3. Results

The study was conducted from February 2020 to March 2023. Among the 60 eligible participants, 40 were assigned to the drain group, while 20 were included in the non-drain group. The mean age of the patients was 71 ± 9.6 years, ranging from 48 to 87 years. Among the participants, 32 (53.33%) were male. The preoperative histological diagnosis primarily identified intestinal-type gastric cancer in 46.6% of the cases, with the most common lesion location being the body of the stomach (43.3%). Additionally, 25% of the patients had undergone preoperative chemotherapy due to node positivity at diagnosis (N≥1) or unresectability on exploratory laparotomy. Detailed descriptive statistics, categorized by various factors, are provided in Table 2.

The mean duration of the gastrectomy was 197 ± 37 minutes. Blood transfusion was required in 13.3% of patients, while 8.3% received only fresh frozen plasma (FFP). Among patients in the drain group, the most common indications for drain placement were significant blood loss (33.3%) and tension of the anastomosis (18.3%). A very small percentage of patients exhibited preoperative risk factors that would typically warrant drain placement. Further details on the intraoperative characteristics are provided in Table 2.

Postoperatively, 23.3% (n=14) of patients developed vital abnormalities, with 9 patients in the drain group exhibiting concerning findings in their drains. Full blood counts (FBC) and biochemical abnormalities were detected within the first 3 days when present. Approximately 56% of patients experienced severe pain during the first 5 postoperative days, and postoperative nausea and vomiting were also common. Surgical site infections (SSI) were observed in 12 patients (20%).

Mobilization was impeded in 37% of patients, and feeding initiation was delayed in 28.3%, contrary to protocol. Gut motility began on average at 3.58 ± 1 days. Two patients required admission to the intensive care unit (ICU) postoperatively. The mean length of hospital stay was 9 ± 9 days.

Fifteen percent (n=9) of patients experienced intra-abdominal complications, and 8.3% had extra-abdominal complications. These complications resulted in a 3% mortality rate, 5% readmission rate, and 6% reoperation rate within the first 30 postoperative days. The Clavien-Dindo classification of postoperative complications [44,45] identified one patient with a grade IIIa complication, three patients with grade IIIb, two patients with grade II, and one patient with grade IV complications in the drain group, whereas one patient grade V and one patient grade II were identified in the non-drain group.

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In specific, four patients developed anastomotic leaks two of which underwent reoperation with hybrid intraoperative stent suturing [46]. The third patient received endoscopic stenting, while the fourth was managed conservatively, but unfortunately passed away. All four patients were in the drain group.

Postoperative bleeding occurred in two patients. The first patient experienced bleeding on day zero, evident in the drain, and required reoperation. The second patient exhibited delayed bleeding on the 9th postoperative day and was treated conservatively. One patient was diagnosed with duodenal stump leak on the 7th postoperative day by means of computed tomography (CT). One patient in the non-drain group developed necrotizing pancreatitis due to a postoperative pancreatic leak, detected on the 3rd postoperative day and necessitating reoperation; unfortunately, this patient passed away. Finally, one patient developed postoperative ileus requiring nasogastric tube placement. Table 2 provides a detailed summary of these findings.

Table 2. Descriptive statistics of perioperative characteristics.

Group	Characteristic	Value
Demographics and patient characteristics	Age	71±9.6, median (Q1-Q3): 73 (65-77.5), min: 48, max: 87
	Gender (male)	32 (53.33%)
	Charlson score	2.45±0.85, median (Q1-Q3): 2 (2-2.5), min:2, max: 5
	ECOG	8 patients (13.3%) had score 1, 52 patients had score 0
Histology	Diffuse	22 (36.67%)
	Intestinal	28 (46.67%)
	Other	7 (11.67%)
Location	EGJ	12 (20%)
	Fundus	5 (8.33%)
	Body	26 (43.33%)
	Prepyloric antrum	16 (26.67%)
	Pylorus	1 (1.67%)
Preoperative chemotherapy	Positive	15 (25.42%)
Laboratory results abnormality	FBC	6 (10%)
	Biochemical	4 (6.67%)
	Clotting	none
Cancer antigens positivity *	CA 19.9	8 (13.33%)
	CA 15.3	6 (10%)
	CA 125	3 (5%)
	CEA	7 (12%)
Intraoperative characteristics	Duration of operation (min)	197.5±37.2, median (Q1-Q3): 200 (180-227.5), min 120, max 180
	Blood transfusion	8 (13.33%)
	FFP transfusion	5 (8.33%)
	Allergic reaction to drugs	0 (%)
	Intraoperative incidents	7 (11.67%)
Criteria for drain placement	Blood loss >250mls	20 (33.33%)
	Vessel injury	3 (5%)
	Anastomosis concerns	11 (18.33%)
	Adjacent structures injury	None
	Stump integrity concerns	3 (5%)
	Chronic respiratory comorbidity	3 (5%)
Post-operative characteristics	Derangements of vital signs	14 (23.33%)

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	Drain quantity abnormality	4 (9.76%)
	Drain quality abnormality	5 (11.9%)
	FBC abnormality	16 (26.67%)
	FBC abnormality day (POD)	1.1±2.3, median (Q1-Q3): 1 (0-1), min 0, max 11 Day 0: 71.7%, day 1: 10%, after day 1: 18.3%
	Biochemical abnormality	15 (25%)
	Biochemical abnormality day (POD)	0.7±1.8, median (Q1-Q3): 0 (0-1), min 0, max 11 Day 0: 73.3%, day 1: 10%, after day 1: 16.7%
	Clotting abnormality (POD)	1 (1.67%)
	Swallow test negative	58 (96.67%)
	VAS score (high)	34 (56.67%)
	SSI	12 (20%)
	Mobilization delay	22 (36.67%)
	Oral feeding delay	17 (28.33%)
	Intra-abdominal complication	9 (15%)
	Extra-abdominal complication	5 (8.33%)
	ICU treatment	2 (3.33%)
	PONV	29 (48.33%)
	Bowel movement start (POD)	3.58±1.04, median (Q1-Q3): 3 (3-4), min: 2, max 6
	LOS (post-op to exit)	9.5±9.01, median (Q1-Q3): 6.5 (5-8), min: 5, max: 59
AJCC staging	1A	9 (15.0%)
	1B	10 (16.7%)
	2A	16 (26.7%)
	2B	12 (20.0%)
	3A	5 (8.3%)
	3B	6 (10.0%)
	3C	2 (3.3%)
Outcomes	Mortality	3 (5%)
	Re-admission	5 (8.33%)
	Re-operation	6 (10%)

CA 125: Cancer antigen 125, CA 153: Cancer antigen 153, CA 19-9: Cancer antigen 19-9, CEA: Cancer embryonic antigen, ECOG: Eastern Cooperative Oncology Group, EGJ: Esophago-gastric Junction, FBC: Full Blood Count, FFP: Fresh Frozen Plasma, ICU: Intensive Care Unit, LOS: Length of Stay, POD: Postoperative Day, PONV: Postoperative Nausea and Vomiting, SSI: Surgical Site Infection, VAS: Visual Analogue Score. *Cancer antigen test normal values: CA 125 (0-31 U/ml), CA 153 (0-36 U/ml), CA 19-9 (0-37 U/ml), CEA: 0-5ng/ml

Demographic and intraoperative characteristics between the two groups were compared to identify any potential differences that could impact the study outcomes. The results of these comparisons are detailed in Table 3. Statistical tests with p-values <0.05 indicated significant differences between the groups. However, no statistically significant differences were observed between the two groups overall.

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Table 3. Comparison of demographics and preoperative characteristics between the two groups.

Group of characteristics	Characteristic	Without drain n=20	With drain n= 40	p- value
Demographics and patient characteristics	Age(years)	73 (66.5-77.5)	73.5 (63-78)	0.8138
	Gender (male)	9/45%	23/57.5%	0.4180
	Charlson score	2 (2-2)	2 (2-3)	0.1567
	ECOG	0 (0-0)	0 (0-0)	0.5943
Histology	Diffuse	7/35%	15/37.5%	1.0000
	Intestinal	11/55%	17/42.5%	0.4180
	Mixed	1/5%	6/15%	0.4065
Location	EGJ	6/30%	6/15%	0.1893
	Fundus	3/15%	2/5%	0.3216
	Body	7/35%	19/47.5%	0.4162
	Pre-pyloric antrum	4/20%	12/30%	0.5408
	Pylorus	1/5%	0/0%	0.3333
Preoperative chemotherapy	Positive	5/25%	10/25.64%	1.0000
Laboratory results abnormality	FBC	2/10%	4/10%	1.0000
	Biochemical	2/10%	2/5%	0.5948
	Clotting	None	None	NA
Cancer antigens positivity*	CA 19.9	2/10%	6/15%	0.7068
	CA 15.3	1/5%	5/12.5%	0.6532
	CA 125	0/0%	3/7.5%	0.5441
	CEA	3/ 15%	4/10%	0.6760

CA 125: Cancer antigen 125, CA 153: Cancer antigen 153, CA 19-9: Cancer antigen 19-9, CEA: Cancer embryonic antigen, ECOG: Eastern Cooperative Oncology Group, EGJ: Esophago-gastric Junction. *Cancer antigen test normal values: CA 125 (0-31 U/ml), CA 153 (0-36 U/ml), CA 19-9 (0-37 U/ml), CEA: 0-5ng/ml.

Similar comparisons were conducted for intraoperative characteristics. Specifically, the duration of the operation, red blood cell (RBC) and FFP transfusion rates, drug allergies, and intraoperative incidents did not differ significantly between the two groups (see Table 4).

Table 4. Comparison of intraoperative characteristics between the two groups.

Characteristic	**Without drainage device n=20**	**With drainage device n=40**	**p**	**OR and 95% CI***
Duration of operation (minutes)	195 (160-205)	200 (180-230)	0.2095	NA
Blood transfusion	4/20%	4/10%	0.4218	2.25 (0.5-10.14)
FFP transfusion	2/10%	3/7.5%	1.0000	1.37 (0.21-8.94)
Allergic reaction to drugs	None	None	NA	NA
Intraoperative incidents	2/10%	5/12.5%	1.0000	0.78 (0.14-4.41)

FFP: Fresh Frozen Plasma, NA: not applicable. *OR: Odds Ratio, CI: Confidence Interval.

Postoperative characteristics and outcomes were assessed using various factors, and Fisher's exact tests were applied for comparisons. The percentage of patients reporting high pain (VAS) scores was significantly lower in the no-drain group (15%) compared to the drain group (77.5%). Additionally, delays in mobilization and oral feeding were notably less frequent in the no-drain group, occurring in only 10% of cases for each, versus 50% and 37.5% in the drain group, respectively (p=0.0038 and p=0.0340).

Significant differences were also observed in postoperative nausea and vomiting (PONV), with a lower incidence in the no-drain group (25%) compared to the drain group (60%, p=0.0142, OR: 0.22), indicating approximately five times higher odds of PONV in the drain group.

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Moreover, the initiation of bowel movement and length of hospital stay were significantly shorter in the no-drain group. The median time of gut motility start was 3 days in the no-drain group compared to 4 days in the drain group (p=0.0142). The median length of stay (LOS) was also shorter for the no-drain group, at 5 days, compared to 7 days for the drain group (p=0.0001).

Box and whisker plots illustrating some of these results are presented in Figure 1. No significant differences were found in AJCC classification, mortality, reoperations, or readmissions (see Table 5).

Table 5. Comparison of postoperative characteristics and short-term outcomes between the two groups.

Group of characteristics	Characteristic	Without drain (n=20)	With drain (n=40)	p	OR and 95% CI*
Post operative characteristics	Derangements of vital signs	4/20%	10/25%	0.7556	0.75 (0.2-2.78)
	Drain quantity abnormality	0/0%	4/10%	1.0000	NA
	Drain quality abnormality	0/0%	5/12.5%	1.0000	NA
	FBC abnormality	3/15%	13/32.5%	0.2182	0.37 (0.09-1.48)
	FBC abnormality on day 0	17/85%	26/65%	0.1051	3.1 (0.76 - 12.23)
	Biochemical abnormality	4/20%	11/27.5%	0.7529	0.66 (0.18-2.41)
	Biochemical abnormality on day 0	15/75%	29/72.5%	0.8365	1.1 (0.33 - 3.89)
	Clotting abnormality	0/0%	1/2.5%	1.0000	NA
	Swallow test positive	0/100%	2/5%	0.5480	NA
	VAS score (high)	3/15%	31/77.5%	<0.0001	19.52 (4.65-81.91)
	SSI	4/20%	8/20%	1.0000	1 (0.26-3.83)
	Mobilization delay	2/10%	20/50%	0.0038	0.11 (0.02-0.54)
	Oral feeding delay	2/10%	15/37.5%	0.0340	0.19 (0.04-0.91)
	Intra-abdominal complication	2/10%	7/17.5%	0.704	0.52 (0.1-2.79)
	Extra-abdominal complication	2/10%	3/7.5%	1.0000	1.37 (0.21-8.94)
	ICU treatment	1/5%	1/2.5%	1.0000	2.06 (0.12 - 34.62)
	PONV	5/25%	24/60%	0.0142	0.22 (0.07-0.73)
	Bowel movement start(POD)	3 (2-4)	4 (3-4)	0.0141	NA
	LOS (post-op to exit)	5 (5-6)	7 (6-10)	0.0001	NA
AJCC stage	1A	2 (10.0%)	7 (17.5%)		
	1B	5 (25.0%)	5 (12.5%)		
	2A	6 (30.0%)	10 (25.0%)		

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	2B	5 (25.0%)	7 (17.5%)	0.736	NA
	3A	1 (5.0%)	4 (10.0%)		
	3B	1 (5.0%)	5 (12.5%)		
	3C	0 (0%)	2 (5.0%)		
Short- Term outcomes	Mortality	2/10%	1/2.5%	0.2554	4.33 (0.37-50.95)
	Re-admission	none	5/12.5%	0.1588	NA
	Re-operation	2/10%	4/10%	1.0000	1 (0.17-5.98)

FBC: Full Blood Count, ICU: Intensive Care Unit, LOS: Length of Stay, POD: Postoperative Day, PONV: Postoperative Nausea and Vomiting, SSI: Surgical Site Infection, VAS: Visual Analogue Score, NA: not applicable. * OR: Odds Ratio, CI: Confidence Interval.

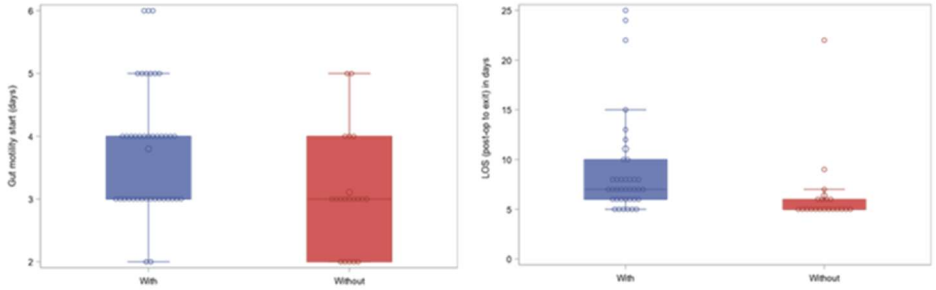

Figure 1. Box and whisker plots for gut mobilization days (left) and length of hospital stay (right). In each diagram, the box limits indicate the lower (1st) and higher (3rd) quartiles (Q1 & Q3 respectively), horizontal lines within the boxes indicate median value, while the limits of the whiskers indicate minimum and maximum values after excluding outliers. Mean values are big circles and smaller circles outside the whisker areas indicate outliers. In the right picture not all outliers are visible due to vertical axis crop to enhance the dynamic range of the figure.

Comparison of Intra-Abdominal Complications

Out of the 60 patients, nine (15%) experienced intra-abdominal complications classified as Clavien-Dindo II or higher [45]. We compared these patients with those who did not experience such complications to identify any preoperative, intraoperative, or postoperative characteristics that might influence or be influenced by these complications. All tests for categorical data in this section utilized Fisher's exact test.

Regarding demographic and preoperative characteristics, statistical analyses are summarized in Table 6. No significant differences were found in demographic factors, histological types, or the location of gastric lesions. Additionally, no differences were observed in preoperative blood test abnormalities or cancer antigen positivity between the groups

Table 6. Demographics and pre-operative characteristics between the patients with and patients without intra-operative complications.

Group of characteristics	Characteristic	With intra-abdominal complications (n=9)	Without intra-abdominal complications (n=51)	p-value	OR and 95% CI**
	Age	73 (67-76)	73 (64-78)	0.9257	NA

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Demographics and patient characteristics	Gender (male)	Yes vs. Male (6/66.67%)	No vs. Male (26/50.98%)	0.4820	1.92 (0.43-8.54)
	Charlson score	2 (2-2)	2 (2-3)	0.3258	NA
	ECOG	0 (0-0)	0 (0-0)	0.8329	NA
Histology	Diffuse	3/33.33%	19/37.26%	1.0000	0.84 (0.19-3.77)
	Intestinal	3/33.33%	25/49.02%	0.4820	0.52 (0.12-2.31)
	Other	1/11.11%	6/11.76%	1.0000	0.94 (0.1-8.86)
Location	EGJ	1/11.11%	11/21.57%	0.6713	0.45 (0.05-4.03)
	Fundus	0/0%	5/9.8%	1.0000	NA
	Body	6/66.67%	20/39.22%	0.1574	3.1 (0.69-13.83)
	Antrum	2/22.22%	14/27.45%	1.0000	0.76 (0.14-4.08)
	Pylorus	1/11.11%	0/0%	0.1500	NA
Preoperative	Positive	2/22.22%	13/26%	1.0000	0.81 (0.15-4.42)

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chemotherapy					
Laboratory results	FBC	1/11.11%	5/9.8%	1.0000	1.15 (0.12-11.18)
	Biochemical abnormality	0/0%	4/7.84%	1.0000	NA
	Clotting	none	none	NA	NA
Cancer antigens positivity*	CA 19.9	0/0%	8/15.69%	0.3394	NA
	CA 15.3	0/0%	6/11.76%	0.5777	NA
	CA 125	0/0%	3/5.88%	1.0000	NA
	CEA	1/ 11%	6/ 12%	1.0000	0.94 (0.10-8.87)

CA 125: Cancer antigen 125, CA 153: Cancer antigen 153, CA 19-9: Cancer antigen 19-9, CEA: Cancer embryonic antigen, ECOG: Eastern Cooperative Oncology Group, EGJ: Esophago-gastric Junction. *Cancer antigen test normal values: CA 125 (0-31 U/ml), CA 153 (0-36 U/ml), CA 19-9 (0-37 U/ml), CEA: 0-5ng/ml. ** Odds ratio and 95% confidence interval.

Intraoperatively, patients who developed intra-abdominal complications had a significantly higher rate of FFP transfusion compared to those without complications (p=0.0208, OR: 12.3). Moreover, marginal statistical significance was observed in postoperative complications associated with vessel injury (p=0.05, OR: 14.3) (Table 7).

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Table 7. Intra-operative characteristics between the patients with intra-operative complications and those without such complications.

Group of characteristics	Characteristic	With Intra-abdominal complications (n=9)	Without Intra-abdominal complications (n=51)	p-value	OR and 95% CI*
Intraoperative characteristics	Duration of operation (minutes)	200 (190-225)	200 (170-230)	0.4164	NA
	Blood transfusion	1/11.11%	7/13.72%	1.0000	0.79 (0.08-7.28)
	FFP transfusion	3/33.33%	2/3.92%	**0.0208**	12.25 (1.69-88.71)
	Allergic reaction to drugs	none	none	NA	NA
	Intraoperative incidents	2/22.22%	5/9.8%	0.2805	2.63 (0.42-16.26)
Criteria for drain placement	Blood loss >250mls	4/44.44%	16/31.37%	0.4644	1.75 (0.41-7.4)
	Vessel injury	2/22.22%	1/1.96%	0.0561	14.29 (1.14-178.87)
	Anastomosis concerns	2/22.22%	9/17.65%	0.6644	1.33 (0.24-7.51)

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Adjacent structures injury	none	none	NA	0 (0-0)
Stump integrity concerns	1/11.11%	2/3.92%	0.3914	3.06 (0.25-37.84)
Chronic respiratory comorbidity	0/0%	3/5.88%	1.0000	NA

FFP: Fresh Frozen Plasma. *Odds ratio and 95% confidence interval.

A range of postoperative characteristics differed significantly between patients with and without intra-abdominal complications, which are summarized in Table 8. Vital sign abnormalities from day 0 were observed in 77.8% of patients with complications, compared to 13.7% of patients without complications, showing a statistically significant difference (p=0.0003, OR: 22).

Significant differences were also spotted in full blood count (FBC) results (p<0.0001, OR: 43) and biochemical parameters (p=0.0355, OR: 5.1) among patients with intra-abdominal complications, from POD #0 and onwards. The quality of drain content was significantly different (p=0.0029, OR: 33) when an intra-abdominal complication was present, and oral contrast studies were more frequently required in patients with complications (p=0.0203, OR: 0.13).

Surgical site infections (SSI) occurred more frequently in patients with complications (55.6% vs. 13.7%, p=0.0203, OR: 7.9). These patients also experienced significantly greater delays in mobilization (p<0.0001) and oral feeding (marginal significance, p=0.1014), with a notably longer length of stay (LOS) in the hospital (24 days vs. 6 days, p<0.0001).

Intra-abdominal complications were also associated with a higher incidence of simultaneous extra-abdominal complications (33.3%) compared to 4% in the non-complication group (p=0.0208, OR: 12.3). The rates of readmission and reoperation were significantly higher in the complication group (p=0.0208 and p=0.0383, respectively). The incidence of complications stratified by staging was as follows: 11.1% in Stage 1A patients (n=1), 33.3% in Stage 1B patients (n=3), 22.2% in Stage 2A patients (n=2), and 33.3% in Stage 2B patients (n=3). Notably, no complications were observed in Stage 3 patients. As shown in Table 8, there was no statistically significant difference in the occurrence of complications across the various stages. Lastly, while mortality was higher in the complication group (22% vs. 2%), this difference approached, but did not achieve, statistical significance (p=0.0531).

Table 8. Post-operative characteristics between the patients with and without intra-operative complications.

Characteristic	**With Intra-abdominal complications (n=9)**	**Without Intra-abdominal complications (n=51)**	**p-value**	**OR and 95% CI***
Vital abnormality	7/77.78%	7/13.72%	**0.0003**	22 (3.78-128.16)

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Drain quantity abnormality		2/25%	2/6.06%	0.1649	5.17 (0.6-44.18)
Drain quality abnormality		4/50%	1/2.94%	**0.0029**	33 (2.92-372.82)
FBC abnormality (POD)		8/88.89%	8/15.69%	**<0.0001**	43 (4.71-392.6)
FBC abnormality on day 0 (POD)		1/11.1%	42/82.4%	**<0.0001**	0.03 (0.003 - 0.242)
Biochemical abnormality (POD)		5/55.56%	10/19.61%	**0.0355**	5.13 (1.16-22.64)
Biochemical abnormality on day 0 (POD)		3/33.3%	41/81.39%	**0.0079**	0.12 (0.03 - 0.57)
Clotting abnormality (POD)		1/11.11%	0/0%	0.1500	NA
Swallow test positive		2/33.22%	0/0%	**0.0203**	NA
VAS score (high)		8/88.89%	26/50.98%	0.0642	0.13 (0.02-1.12)
SSI		5/55.56%	7/13.72%	**0.0116**	7.86 (1.69-36.57)
Mobilization delay		9/100%	13/25.49%	**<0.0001**	NA
Oral feeding delay		5/55.56%	12/23.53%	0.1014	4.06 (0.94-17.59)
Extra-abdominal complication		3/33.33%	2/3.92%	**0.0208**	12.25 (1.69-88.71)
ICU treatment		1/11.11%	1/1.96%	0.2797	6.25 (0.35-110.29)
PONV		7/77.78%	22/43.14%	0.0756	4.61 (0.87-24.42)
Gut motility start (POD)		4 (3-4.5)	3 (3-4)	0.4008	NA
LOS (post-op to exit)		24 (22-30)	6 (5-7)	**<0.0001**	NA
AJCC stage	1A	1 (11.1%)	8 (15.7%)	0.689	NA
	1B	3 (33.3%)	7 (13.7%)		
	2A	2 (22.2%)	14 (27.5%)		
	2B	3 (33.3%)	9 (17.6%)		
	3A	0 (0%)	5 (9.8%)		
	3B	0 (0%)	6 (11.8%)		
	3C	0 (0%)	2 (3.9%)		
Mortality		2/22.22%	1/1.96%	0.0561	14.29 (1.14-178.87)
Re-admission		3/33.33%	2/3.92%	**0.0208**	12.25 (1.69-88.71)

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Re-operation	3/33.33%	3/5.88%	**0.0383**	8 (1.31-48.95)

FBC: Full Blood Count, ICU: Intensive Care Unit, LOS: Length of Stay, POD: Postoperative Day, PONV: Postoperative Nausea and Vomiting, SSI: Surgical Site Infection, VAS: Visual Analogue Score; *Odds ratio and 95% confidence interval.

A characteristic diagram for the LOS is depicted in Figure 2.

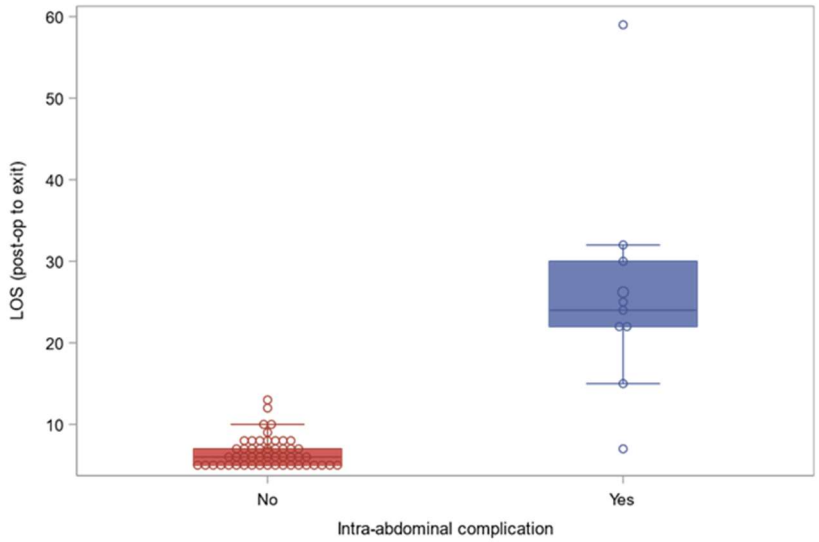

Figure 2. Box and whisker plots for LOS in patients with and without intra-abdominal complications.

As previously reported, nine patients experienced intra-abdominal complications, with seven in the drain group and two in the no-drain group. The most common complication was anastomotic leak, occurring in four cases, followed by two cases of bleeding. These complications significantly affected both the length of hospital stay (LOS) and reoperation rates. The median day of complication detection was 5.8 (range: 1 to 11). Although the number of cases in this subgroup is relatively small, for the sake of completeness the statistical analysis was performed and the outcomes are presented in Table 9. As anticipated, no statistically significant differences were found regarding the detection of anastomotic leaks, the postoperative day of complication detection, diagnosis based on drain content, hospitalization duration, reoperation rates, or mortality.

Table 9. Statistical analysis outcomes for the subgroup of patients with intra-abdominal complications.

	Without drain (n=2)	With drain (n=7)	P-value
Anastomotic leak detection			
No	2 (100%)	3 (42.9%)	0.444
Yes	0 (0%)	4 (57.1%)	
POD			
Mean (SD)	5.00 (2.83)	6.14 (2.73)	0.445
Median [Min, Max]	5.00 [3.00, 7.00]	7.00 [1.00, 9.00]	
Drain relation			
(-)	1 (50.0%)	3 (42.9%)	1
(+)	1 (50.0%)	4 (57.1%)	
Diagnosis by drain content			
No	1 (50.0%)	3 (42.9%)	1
Yes	1 (50.0%)	4 (57.1%)	
Diagnosis by vitals			
No	1 (50.0%)	2 (28.6%)	1
Yes	1 (50.0%)	5 (71.4%)	

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	Without drain (n=2)	With drain (n=7)	P-value
Diagnosis by fbc			
No	2 (100%)	4 (57.1%)	0.5
Yes	0 (0%)	3 (42.9%)	
Prolonged hospitalization			
No	1 (50.0%)	1 (14.3%)	0.417
Yes	1 (50.0%)	6 (85.7%)	
Reoperation			
No	1 (50.0%)	4 (57.1%)	1
Yes	1 (50.0%)	3 (42.9%)	
Death			
No	1 (50.0%)	6 (85.7%)	0.417
Yes	1 (50.0%)	1 (14.3%)	

POD: postoperative day.

With regards to the complications only in the drain group, four cases were identified through drain content analysis, while three were detected based on clinical presentation and blood tests. The statistical analysis showed no significant differences regarding the method of complication detection, the postoperative day of diagnosis, LOS, or mortality rates among these patients (Table 10).

Table 10. Statistical analysis outcomes for the drain group with intra-abdominal complications to examine if diagnosis by drain content was a differentiation factor.

	Diagnosis by other means (n=3)	Diagnosis by drain content (n=4)	P-value
Anastomotic leak			
No	1 (33.3%)	2 (50.0%)	1 †
Yes	2 (66.7%)	2 (50.0%)	
POD			
Mean (SD)	6.67 (2.52)	5.75 (3.20)	0.714
Median [Min, Max]	7.00 [4.00, 9.00]	7.00 [1.00, 8.00]	
Diagnosis by vitals			
No	1 (33.3%)	1 (25.0%)	1 †
Yes	2 (66.7%)	3 (75.0%)	
Diagnosis by labs			
No	2 (66.7%)	2 (50.0%)	1 †
Yes	1 (33.3%)	2 (50.0%)	
Prolonged hospitalization			
Yes	3 (100%)	3 (75.0%)	1 †
No	0 (0%)	1 (25.0%)	
Reoperation			
No	1 (33.3%)	3 (75.0%)	0.486 †
Yes	2 (66.7%)	1 (25.0%)	
Death			
No	3 (100%)	3 (75.0%)	1 †
Yes	0 (0%)	1 (25.0%)	

POD: postoperative day; †: Fisher's exact test.

4. Discussion

The use of drains after elective total D2 gastrectomy remains a contentious issue in surgical practice. The ERAS guidelines generally recommend avoiding drains when possible, citing benefits such as faster recovery, reduced hospital stay, and quicker return to daily activities [5,6,8-10,47]. Despite this, many surgeons continue to use drains to manage abdominal fluid collections and detect postoperative complications such as intra-abdominal abscesses, anastomotic leaks, bleeding, and

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pancreatic fistulas. In cases of severe complications (Clavien-Dindo II to IV) [44], drains can also play a therapeutic role. Many researchers support the use of smaller drainage tubes, which appears reasonable from a clinical perspective. However, even with reduced drain size, the psychological effects on patients and the rates of surgical site infections (SSIs) remain largely unaffected [12,48,49]. Expertise is a critical factor in this study, as it directly influences the quality of care provided. In this context, the perspective of an experienced surgeon plays a significant role in assessing the risk of postoperative complications and determining the individualized approach to drain placement, ensuring optimal patient outcomes [48,50]. This study does not aim to establish definitive guidelines but rather seeks to propose specific criteria to assist in the clinical decision-making process regarding the appropriate use of drain placement following total gastrectomy for gastric cancer, based on individual patient circumstances.

Our study yielded no significant differences between patients with and without drains in terms of preoperative or demographic characteristics, nor between patients who developed complications and those who did not. While this study's sample size is relatively small, these findings should be considered in decisions about drain placement. Larger studies are warranted for more definitive conclusions.

Interestingly, patients who required FFP transfusion during reoperation developed a higher incidence of complications, particularly anastomotic leaks. It is well-established that blood transfusions can adversely affect postoperative outcome [51-53]. Recent research suggests that FFP transfusion may also provoke an immunomodulatory response, leading to altered cytokine profiles with reduced pro-inflammatory and increased anti-inflammatory cytokines [51,54].

In this analysis, vessel injury was identified as a significant risk factor for postoperative complications, while other commonly evaluated factors showed no notable differences. This finding highlights the need to carefully consider vessel injury when deciding on drain placement during gastrectomies. The literature identifies various risk factors associated with postoperative complications, including advanced age (>65 years), male sex, cardiopulmonary comorbidities, diffuse tumor histology, extensive lymphadenectomy, intraoperative blood loss, extended operative time anastomotic tension, and impaired blood supply [29-34]. Although we observed no differences in these factors, they warrant careful consideration due to their established relevance in larger studies.

In our study, the gastrografin swallow test performed on the second postoperative day identified two true positive cases out of four patients with anastomotic leaks, resulting in a sensitivity of 50%. Although the small sample size introduces some variability, these results highlight the limited sensitivity of this diagnostic method. This finding aligns with existing literature, which recognizes oral contrast radiography as a low-sensitivity test for confirming the integrity of esophagojejunal anastomoses [55-57]. Historically, it has been routinely employed following gastrectomy for gastric cancer to assess anastomotic integrity before initiating oral feeding. Thus, following our department's ERAS-based protocol, the patients were advanced to oral feeding on the second postoperative day, prompting our evaluation of this test's early postoperative efficacy.

With regards to the VAS score, we found marginal statistical significance in pain levels between the drain and no-drain groups when complications were present, but significant difference when the complication was absent, suggesting that drain placement may be avoidable in the absence of complications. This finding aligns with the literature, which indicates that drains can significantly influence postoperative pain and may exacerbate it [16,17,47].

The current analysis revealed a significant difference in PONV between the drain and no-drain groups in uncomplicated patients. This suggests that prophylactic drain use might be unnecessary and could contribute to PONV. Although numerous studies have investigated postoperative nausea and vomiting (PONV) in bariatric surgery [58,59], there is limited research specifically addressing gastrectomy for gastric cancer. Given that PONV contributes to prolonged hospital stays, it is important to consider and attempt to mitigate this complication.

Evidence from our study showed no overall difference in surgical site infections (SSIs) between the drain and no-drain groups. However, in patients with postoperative complications, the drain group experienced a significantly higher rate of SSIs. The relationship between drains and SSIs

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remains debatable; while several studies report no association ([14,17,18,60], others suggest that retrograde bacterial contamination or leakage of protein-rich ascitic fluid may play a role [12]. Therefore, careful consideration of drain use in patients with complications is warranted to minimize the risk of SSIs.

Our research demonstrated that extra-abdominal complications, particularly respiratory tract infections, were more prevalent in patients with drains when intra-abdominal complications occurred. This finding suggests that drain irritation may facilitate the dissemination of pathogens, although the literature on this relationship remains limited [12,61]. Other studies also support that drain-induced pain leads to microatelectases and consequently respiratory tract infections [48]. However, several retrospective studies, concerning both total and subtotal gastrectomies, have found no statistically significant differences in the incidence of pulmonary infections between groups that received postoperative drains and those that did not [14,17]. This discrepancy highlights the need for further investigation into the role of postoperative drains in pulmonary infections.

In this analysis, we found that drain placement was associated with delays in mobilization and oral feeding, although the differences were marginal when complications were present. Our study observed that gastrointestinal tract mobility was negatively impacted by drains, supporting the notion that prophylactic drains may be unnecessary, despite the lack of significant differences in the presence of complications. The literature presents mixed results regarding the impact of drains on mobilization and gastrointestinal function, with some studies reporting no significant differences between drain and no-drain groups while others suggest that drains may hinder recovery [11,12,14,15,47].

The presence of drains in this study significantly impacted the length of stay (LOS), as patients who experienced delays in mobilization, dietary resumption, and restoration of gastrointestinal motility were less likely to be discharged in a timely manner. This correlation is well-documented in the literature [15-18,47,62]. Furthermore, the authors believe that daily management of drains can present considerable challenges, especially in regions with limited community healthcare services. The occurrence of complications further complicates this situation, often resulting in extended hospital stays due to concerns from both patients and surgeons, as well as the ongoing need for regular drain monitoring.

From a financial perspective, extended hospital stays significantly increase healthcare costs globally, placing a burden on hospital resources and reducing the availability of beds for other patients. Prolonged admissions not only escalate direct costs, such as staffing and resource utilization, but also indirectly affect the overall efficiency and capacity of healthcare systems worldwide [63,64].

Data from our trial indicated that both readmissions and reoperations were statistically significant only among patients in the drain group who developed complications. This suggests that the use of drains may be associated with an increased risk of additional complications when they occur. The existing literature supports this finding in relation to reoperations [11]. However, regarding readmissions, the evidence presents a contrasting view [62,65]. These two meta-analyses demonstrated higher readmission rates in the non-drain groups, primarily due to undetected complications during the initial hospital stay. The authors attribute the observed findings to the predefined criteria employed in selecting patients for whom it was deemed safe to omit the perianastomotic drain.

In this study, mortality was only marginally significant in patients with intra-abdominal complications, which aligns with our expectations. Importantly, no significant difference in mortality rates was observed between the drain and no-drain groups. Unfortunately, the existing literature on mortality differences between these groups is limited. The two extensive studies [17,18] that reported on mortality also found no statistically significant differences between the drain and non-drain groups.

The findings of this study may, in part, be influenced by the presence of comorbidities within the drain group; however, this represents only one aspect of the broader context. Notably, there were no statistically significant differences between the groups in terms of the Charlson Comorbidity Index, ECOG performance status, tumor histology or location, AJCC staging or the use of

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preoperative chemotherapy, suggesting a comparable baseline risk for high-risk operations, whether influenced by patient-specific factors or intraoperative events. Furthermore, while multiple comorbidities can affect overall patient outcomes, not all comorbidities are directly relevant to the risk of anastomotic complications. It is also important to recognize that much of the evidence in this field originates from retrospective studies, which we have incorporated into the framework of this prospective trial. Rather than establishing definitive guidelines, this study aims to contribute to the ongoing discourse and encourages further investigation through larger, multi-center studies.

A final key consideration in minimizing the use of unnecessary drains is the incorporation of green surgery principles. In recent decades, there has been a concerted effort to minimize CO_2 and CO_2-equivalent emissions through education and actionable strategies. The implementation of theatre checklists that include parameters for improvement before, during, and after surgery is a step in this direction [66,67]. While specific guidelines for intraoperative drain use are lacking, similar to recommendations for urinary catheters, which advocate for their avoidance when not clinically necessary, a parallel approach could be applied to drains [68]. Despite these recommendations, adherence to minimizing unnecessary catheterization remains unsatisfactory [69]. Avoiding clinically unnecessary interventions, including drains, can significantly reduce the carbon footprint of surgical procedures and promote environmental sustainability. This approach not only benefits the environment but also mitigates financial costs associated with excessive use of medical resources [70].

The authors acknowledge the limitations of this study. Firstly, the sample size is relatively small for a study of this nature, largely due to constraints imposed by the COVID-19 pandemic. This limited sample size may have hindered the detection of statistical significance in areas where differences might have otherwise been observed. Larger studies could offer more definitive insights. Additionally, no data regarding Helicobacter pylori (H. pylori) was available in the histopathology reports. However, it is reasonable to assume that H. pylori-positive cases were detected and treated during the preceding preoperative gastroscopies. Given the ongoing debate regarding the relationship between H. pylori, prognosis, and disease relapse, the authors highlight the importance of considering H. pylori status in future research, especially as existing literature presents mixed findings regarding the impact of a negative H. pylori status [71-75]. Furthermore, the study's focus on patients undergoing D2 gastrectomy may introduce a selection bias, as it excludes more complex cases requiring extended lymphadenectomy, thus limiting the generalizability of the findings. Lastly, the absence of randomization in this study may also introduce a minor bias; however, due to the specific design and objectives of the study, randomization was not feasible.

5. Conclusions

Our study suggests that routine prophylactic drain use may be unnecessary in gastrectomy for gastric cancer when performed by experienced surgeons at high-volume centers, provided the criteria introduced in this study are applied. To our knowledge, no other studies have proposed such parameters to address this clinical question, underscoring the novelty of our approach. However, larger-scale studies are needed to further validate these guidelines and strengthen the recommendation.

Supplementary Materials: No supplementary material

Author Contributions: Conceptualization: M.M.E and D.T, methodology: M.M.E, software: D.K and A.P, validation: D.K and T.T., formal analysis: M.M.E and T.T., data curation: K.T and G.Z, writing—original draft preparation: M.M.E, writing—review and editing: MD, supervision: D.T All authors have read and agreed to the published version of the manuscript.

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Institutional Review Board Statement: This study was conducted in accordance with the prin-ciples outlined in the Helsinki Declaration of Human Rights and with the Guidelines of Good Clinical Practice. The final study protocol received approval from the Institutional Review Board (IRB) of Hippocration General Hospital (1678 / 31-01-2020).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

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Conflicts of Interest: The authors declare no conflicts of interest.

Abbreviations

AJCC: American Joint Committee on Cancer, aPTT: activated partial thrombo-plastin time, CA 125: Cancer antigen 125, CA 153: Cancer antigen 153, CA 19-9:Cancer antigen 19-9, CEA: Cancer embryonic antigen, CT: computed tomography DRAG: DRain After Gastrec-tomy, ECOG: Eastern Cooperative Oncology Group, EGJ: Esophago-gastric Junction, ERAS: En-hanced Recovery After Surgery, FBC: Full Blood Count, FFP: Fresh Frozen Plasma, ICU: Intensive Care Unit, INR: international normalised ratio, IRB: Institutional Review Board, LOS: Length of Stay, LFTs: Liver Function tests, POD: Postoperative Day, PONV: Postoperative Nausea and Vomiting, PT: prothrombin time, RFTs: Renal function Tests, SSI: Surgical Site Infection, TNM: Tumor- Nodes-Metastasis, U&E: Urea and Electrolytes, VAS: Visual Analogue Score

Appendix A

PREOPERATIVE EVALUATION	
History and physical examination	
Blood exams	FBC, RFTs, LFTs, U&E, blood sugar, albumin and total protein levels
Blood clotting sufficiency	PT, INR, aPTT
Thyroid function	T3, T4, TSH, FT3, FT4
Hepatitis virulence	anti- HCV antibodies, anti- HBV antibodies, HBs antigen
Blood type cross-match	
Chest x-ray	
Anesthesiologist check	Incentive spirometry, Mallabati score evaluation, ASA score, necessity for ICU stay after the operation
Electrocardiogram and cardiology examination	
Previous colonoscopy to exclude secondary/second primary tumor in colon	

aPTT: activated partial thromboplastin time, FBC: Full Blood Count, HBV: hepatitis B virus, HCV: hepatitis C virus, INR: international normalised ratio, LFTs: Liver Function tests, PT: prothrombin time, RFTs: Renal function Tests, T3: Triiodothyronine , T4,: Thyroxine ,TSH: thyroid stimulating hormone, U&E: Urea and Electrolytes.

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Appendix B. Timeline of Study protocol

STUDY PERIOD									
	ENROLLMENT DAYS		DAY OF SURGERY	POSTOPERATIVE DAYS					
TIMEPOINT	**-7 TO -2**	**-1**	**0**	**1**	**2**	**3**	**4**	**5**	**Ω**
ENROLLMENT									
PATIENT SELECTION	X								
PREOP CHECK	X								
CONSENT SIGN		X							
PROTOCOL EDUCATION		X							
INTERVENTION									
DRAIN PLACEMENT			X						
INTRAOPERATIVE DATA RECORDING			X						
MONITORING									
CLIN. EXAMINATION &VITALS				X	X	X	X	X	X

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LABS				X	X	X	X	X	X
DRAIN CONTENT MONITORING			X	X	X	X	X	X	X
ORAL CONTRAST STUDY					X				
PONV				X	X	X	X	X	
PAIN (VAS SCORE)			X	X	X	X	X	X	
SSI				X	X	X	X	X	
MOBILIZATION				X	X	X	X	X	
ORAL FEEDING				X	X	X	X	X	
GUT MOTILITY				X	X	X	X	X	X
EXTRAABDOMINAL COMPLICATIONS				X	X	X	X	X	X
LOS				X	X	X	X	X	X
MORTALITY				X	X	X	X	X	X
READMISSIONS				X	X	X	X	X	X
REOPERATIONS				X	X	X	X	X	X

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