RESEARCH ARTICLE

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Upstaging of Operable Adenocarcinoma of the Stomach and Gastroesophageal Junction Following Staging Laparoscopy (SL): High-Risk Clinicopathological Features Requisite for Mandatory SL

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Abstract

Background: Accurate staging is paramount in optimizing outcomes for patients with operable adenocarcinoma of the stomach and gastroesophageal junction (GEJ). Cross-sectional imaging frequently underestimates the true extent of disease, particularly occult peritoneal metastases. Adding Staging laparoscopy (SL) enhances diagnostic precision, but its universal application remains debated. Identifying clinicopathological predictors of upstaging may enable the selective yet mandatory use of SL in high-risk subgroups. **Methods:** In this single-centre retrospective study, we analysed 182 patients with clinically operable adenocarcinoma of the stomach and GEJ who underwent SL as part of their staging work-up between June 2018 and December 2024. Clinical, radiological, and pathological variables were assessed to determine their association with upstaging. The primary endpoint was the detection of unsuspected metastatic disease or positive peritoneal cytology on SL. The secondary endpoint was to identify independent predictors of upstaging using multivariate logistic regression. **Results:** Of 182 patients evaluated, 37 patients (20.3%) were upstaged on SL, precluding curative-intent surgery. The most common route of upstaging was detection of peritoneal metastases 33(18.1%) and the rest of the patient had isolated positive cytology 4 (2.2%). High-risk features significantly associated with upstaging included minimal ascites (OR 5.87, p<0.001), signet ring cell histology (OR 4.15, p=0.007), linitis plastica morphology (OR 3.42, p=0.002), and tumor thickness ≥15 mm (OR 2.21, p=0.034). Notably, radiologically node-negative patients with none of the high-risk features had a low probability of upstaging. A risk-stratified algorithm based on these parameters improved the diagnostic yield of SL and reduced non-therapeutic laparotomies. **Conclusion:** Universal incorporation of staging laparoscopy into treatment algorithms for operable gastric and GEJ adenocarcinoma is challenging in many settings due to resource and economic constraints. While established guidelines endorse SL in selected scenarios, our findings suggest that, in addition to these proven indications, the consideration of SL in patients with linitis plastica morphology, tumour thickness >15 mm, signet ring cell carcinoma histology, and even mild ascites can further refine the staging accuracy. Targeting these high-risk subgroups enables a more personalised treatment approach, maximises the detection of occult metastases, and, importantly, reduces the incidence of non-therapeutic laparotomies.

Keywords: Staging laparoscopy- Gastric adenocarcinoma- Gastroesophageal junction cancer- Linitis plastica

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Introduction

Gastric cancer remains one of the leading causes of cancer-related mortality worldwide, despite a decline in incidence over recent decades in some regions. According to GLOBOCAN 2022, over 1 million new cases and approximately 770,000 deaths occur annually, ranking it fifth in incidence and fourth in mortality globally [1]. The burden is disproportionately high in East Asia, Eastern Europe, and parts of South America, whereas North America and much of Africa report substantially lower rates. Within Asia, significant regional heterogeneity exists; for example, Japan and Korea have robust screening programmes enabling earlier detection, whereas in South Asia including India patients frequently present at advanced stages, limiting curative treatment opportunities [2, 3].

Accurate staging is fundamental to determining optimal treatment strategies in operable gastric and gastroesophageal junction (GEJ) adenocarcinoma.

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Cross-sectional imaging modalities such as contrast-enhanced computed tomography (CECT) and positron emission tomography–computed tomography (PET-CT) form the cornerstone of initial staging. However, these techniques have limited sensitivity in detecting low-volume peritoneal metastases, particularly in diffuse-type tumours, leading to underestimation of the true disease extent [4]. The presence of occult peritoneal disease at laparotomy often results in aborted curative resections so-called non-therapeutic laparotomies with associated morbidity, resource wastage, and psychological impact on patients [5].

Staging laparoscopy (SL) addresses this gap by enabling direct visualisation of the peritoneal cavity and acquisition of peritoneal washings for cytological analysis. Multiple studies have demonstrated that SL detects occult peritoneal metastases in 20–40% of patients deemed resectable on imaging, substantially altering management plans [6]. International guidelines, including those from the National Comprehensive Cancer Network (NCCN) [7], European Society for Medical Oncology (ESMO) [8], and Japanese Gastric Cancer Association (JGCA) [9], recommend SL in potentially resectable stage T3/T4 gastric cancers, particularly for diffuse histology or when imaging suggests ascites or peritoneal thickening. However, resource limitations and variability in surgical practice have hindered its universal adoption, especially in low- and middle-income countries.

Despite these recommendations, there remains a lack of consensus on a refined, evidence-based set of clinicopathological parameters that can reliably predict occult peritoneal disease and guide selective yet mandatory use of SL. Existing studies vary widely in their inclusion criteria, methodological rigour, and reported diagnostic yields, limiting the development of universally applicable selection algorithms. In resource-constrained settings, where the indiscriminate application of SL to all operable cases may not be feasible, however, robust, context-specific evidence will help to optimise patient selection while maintaining diagnostic accuracy.

The present study aims to evaluate the yield of SL in clinically operable gastric and GEJ adenocarcinoma and to identify clinicopathological features that justify its selective but mandatory use of SL. By focusing on real-world data from a tertiary cancer centre, this work seeks to refine patient selection for SL, reduce non-therapeutic laparotomies, and contribute to the development of personalised staging strategies within the constraints of diverse healthcare systems.

Materials and Methods

Study Design

This retrospective observational study was conducted at Department of Surgical Oncology, KMC Manipal , a tertiary cancer centre between June 2018 and December 2024. All consecutive patients aged ≥18 years with histologically confirmed adenocarcinoma of the stomach or gastroesophageal junction (GEJ) who were deemed operable on clinical and radiological assessment and underwent staging laparoscopy (SL) were included. Patients with prior gastric surgery, previous chemotherapy or radiotherapy for gastric cancer, incomplete staging records, or unfitness for general anaesthesia were excluded. The study protocol was approved by the Institutional Ethics Committee(IEC1:309/2025), with a waiver of informed consent for retrospective analysis.

Procedure

SL was performed under general anaesthesia following a standardised institutional protocol. Pneumoperitoneum was established, and a systematic inspection of the peritoneal cavity was conducted, including the diaphragmatic surfaces, greater omentum, pelvis, serosal surfaces of bowel loops, and lesser sac. Any suspicious lesions were biopsied and peritoneal lavage was performed were sent for cytological analysis. Positive SL findings were defined as the presence of macroscopic peritoneal metastases and/or positive peritoneal cytology.

Data Collection

Patient demographics, performance status (ECOG), tumour location, histological subtype, clinical T and N stage, and imaging findings were obtained from institutional electronic medical records and operative notes. Radiological measurements were extracted from contrast-enhanced computed tomography (CECT) images. Tumour thickness was recorded as the maximal perpendicular distance from the mucosal to the serosal surface at the site of greatest wall thickening on axial images. Tumour volume was estimated using the ellipsoid formula: $(\pi/6) \times \text{length} \times \text{width} \times \text{thickness}$, where length and width were obtained from multiplanar reconstructions. All measurements were independently assessed by two gastrointestinal radiologists, with discrepancies resolved by consensus. Additional variables included serum tumour markers (CEA, CA19-9), presence of ascites, SL findings, and operative decision (curative resection vs aborted procedure).

Statistical Analysis

Continuous variables were summarised as mean ± standard deviation or median (interquartile range), depending on distribution. Categorical variables were reported as frequencies and percentages. Univariate comparisons were performed using the chi-square or Fisher's exact test for categorical variables and the Student's t-test or Mann–Whitney U test for continuous variables. Variables with $p < 0.05$ in univariate analysis were entered into a multivariate logistic regression model to identify independent predictors of upstaging. Odds ratios (OR) with 95% confidence intervals (CI) were reported. Statistical significance was set at $p < 0.05$. Analyses were conducted using SPSS version (Version 26 IBM Corp).

Results

Patient Demographics and Clinical Characteristics

Out of 210 patients evaluated, 182 met inclusion criteria and underwent staging laparoscopy. The median age at presentation was 59 years (IQR: 52–66), with a

male predominance (61.5%, n = 112). Most patients had good performance status, with 71.4% (n = 130) having ECOG 0–1 and 84.1% (n = 153) classified as ASA II or III (Table 1).

Comorbidities were present in 96 patients (52.7%), including hypertension (34.6%), diabetes mellitus (22.5%), and ischemic heart disease (6.6%). On radiological staging, 144 patients (79.1%) had T3–T4 tumors, and 140 (76.9%) had clinically node-positive (cN+) disease.

Tumor location was distributed across three major anatomical regions of the stomach. Distal tumors involving the antrum and pylorus were the most prevalent, observed in 75 patients (41.2%). Proximal tumors, including those at the fundus, gastroesophageal junction, and body, accounted for 64 cases (35.1%). Notably, linitis plastica was identified in 43 patients (23.6%), representing a distinct morphological subtype. Tumor thickness ≥15 mm was observed in 53.3%, with a median tumor volume of 38.5 cm^3 (IQR: 22.4–65.3 cm^3).

Histologically, poorly differentiated adenocarcinoma accounted for 50% of cases (n=91), while signet ring cell morphology was noted in 70 (38.4%). CA 19-9 was elevated in 44.5% of patients.

Staging Laparoscopy Findings

In staging laparoscopy findings, among the 182 patients who underwent the procedure, 37 patients (20.3%) had positive findings, leading to the deferral of curative-intent surgery. The positive findings were defined as either gross peritoneal metastasis and/or positive peritoneal cytology. Of these, 33 patients (18.1%) had gross peritoneal metastases and 4 patients (2.2%) had isolated positive cytology. Among the 37 patients with a positive findings, 22 (59.5%) had minimal ascites on laparoscopy that was not detected on imaging. No visceral metastases were found (Table 2).

Table 1. Baseline Demographic, Clinical and Tumor Characteristics (n=182)

Variable	Result
Age (years), median	59
Sex	Male: 112 (61.5%), Female: 70 (38.5%)
ECOG performance status	0–1: 130 (71.4%), ≥2: 52 (28.6%)
ASA physical status	I: 11 (6.0%), II: 94 (51.6%), III: 59 (32.4%), IV: 18 (9.9%)
Comorbidities present	96 (52.7%)
Hypertension	63 (34.6%)
Diabetes mellitus	41 (22.5%)
Ischemic heart disease	12 (6.6%)
Clinical T stage (cT)	T1–T2: 38 (20.9%), T3–T4: 144 (79.1%)
Clinical N stage (cN)	N0: 42 (23.1%), N+: 140 (76.9%)
Tumor location	Proximal (Fundus, GE junction and body): 64 (35.1%)
	Distal (antrum, pylorus): 75 (41.2%)
	Linitis Plastica: 43 (23.6)
Tumor thickness ≥15 mm	97 (53.3%)
Tumor volume (cm^3), median (IQR)	38.5 (22.4–65.3)
Histological differentiation	Well: 29 (15.9%),
	Moderate: 62 (34.0%),
	Poor: 91 (50%),
Signet ring cell histology	70 (38.4%)
CA 19-9 elevated (> ULN)	81 (44.5%)

Univariate Analysis of Predictors for Positive Staging Laparoscopy

On univariate analysis, tumor location, tumor thickness and tumor volume, minimal ascites on laparoscopy and linitis plastica as morphology were significantly associated with positive laparoscopy findings (Table 3).

Multivariate Analysis

Variables with significance on univariate analysis were included in a multivariate logistic regression model. Linitis plastica morphology, minimal ascites on laproscopy, signet ring cell histology, tumor volume ≥40 cm^3 and tumor thickness ≥15 mm emerged as independent predictors of positive staging laparoscopy findings (Table 4).

Impact of Staging Laparoscopy on Treatment Strategy

Among 33 patients with gross peritoneal disease, 30 received palliative chemotherapy and 3 patients with PCI < 6, underwent neoadjuvant chemotherapy followed by cytoreductive surgery with hypertherimic intraperitoneal chemotherapy (HIPEC). Of the 4 (2.2%) patients with cytology-only positivity, all showed a favourable response to neoadjuvant chemotherapy and were able to undergo curative-intent gastrectomy. The remaining 145 patients (79.7%) with negative laparoscopy findings proceeded with curative-intent treatment. Of this group, 52 patients underwent upfront surgery, while 93 patients received neoadjuvant chemotherapy (NACT) followed by surgery, in line with modern guideline-based management protocols for locally advanced gastric cancer.

Procedural Outcomes

The procedural outcomes were favourable, with no conversions to laparotomy (0%) in any of the patients. A low rate of complications was observed, with only 4 patients (2.2%) experiencing minor issues that were managed conservatively. These complications included two cases of surgical site infection (SSI), one case of wound dehiscence at port site, and one patient who required prolonged intubation.

Table 2. Impact of Staging Laparoscopy on Treatment Plan (n = 182)

Finding	Number of Patients (n, %)
No metastasis detected	145 (79.6%)
Gross peritoneal metastasis	33 (18.1%)
Positive peritoneal cytology only	4 (2.2%)
Total positive findings (gross + cytology)	37 (20.3%)
Procedure-related complications	4 (2.2%)

Table 3. Univariate Analysis of Factors Associated with Positive Findings on Staging Laparoscopy (n = 182)

Variable	Category	Positive findings f/n* (%)	p-value
Age	<40 vs ≥40	11/38(28.9%) vs 26/144(18.1%)	0.184
Sex	Male vs Female	22/112 (19.6%) vs 15/70 (21.4%)	0.77
ECOG	0–1 vs ≥2	20/130 (15.4%) vs 1752 (32.7%)	0.065
ASA grade	I–II vs III–IV	14/105 (13.3%) vs 23/77 (29.9%)	0.083
Comorbidities	Present vs Absent	23/96 (23.9%) vs 14/86 (16.3%)	0.219
T stage	T1–T2 vs T3–T4	2/38 (5.3%) vs 35/144 (24.3%)	0.061
N stage	N0 vs N+	4/42 (9.5%) vs 33/140 (23.6%)	0.097
Tumor location	Distal (antrum, pylorus) vs Proximal (Fundus, body, GE junction) vs Linitis plastica	6/75 (8%) vs 10/64 (15.6%) vs 21/43 (48.8%)	<0.001
Tumor thickness	<15 mm vs ≥15 mm	9/85 (10.6%) vs 28/97 (28.9%)	<0.001
Tumor volume	≥40 cm^3 vs <40 cm^3	23/92 (25.0%) vs 14/90 (15.6%)	0.048
CA 19-9	Elevated vs Normal	26/81 (32.1%) vs 11/101 (10.9%)	0.089
Minimal ascites (SL-confirmed ascites)	Present vs Absent	22/29 (75.9%) vs 15/153 (9.8%)	<0.001
Signet ring cell	Present vs Absent	18/70 (25.7%) vs 19/112 (17%)	0.154
Linitis Plastica morphology	Present vs Absent	21/43 (48.8%) vs 16/139 (11.5%)	<0.001

*f-positive findings; *n-total number of patients

Table 4. Multivariate Logistic Regression of Independent Predictors for Positive Staging Laparoscopy

Variable	Odds Ratio (OR)	95% CI	p-value
Linitis plastica morphology	3.42	1.56–7.51	0.002
Minimal ascites (SL-confirmed ascites)	5.87	2.48–13.87	<0.001
Signet ring cell histology	4.15	1.47–11.74	0.007
Tumor thickness ≥15 mm	2.21	1.06–4.62	0.034
Tumor volume ≥40 cm^3	0.34	1.6 – 7.2	0.007

Discussion

This study highlights the continuing value of staging laparoscopy (SL) in the contemporary management of gastric and gastroesophageal junction (GEJ) adenocarcinoma. In our cohort, SL upstaged 20.3% of patients who were radiologically operable, preventing non-therapeutic laparotomies and redirecting patients to appropriate systemic therapy. These findings underline that even in the era of advanced imaging, SL remains indispensable for accurate staging.

Despite extensive clinical experience, consensus regarding optimal indications and techniques for staging laparoscopy in gastric cancer remains elusive. The National Comprehensive Cancer Network explicitly recommends staging laparoscopy with cytology for all patients presenting with clinical stage T2 or higher gastric cancer. Conversely, the European Society of Surgical Oncology advocates for staging laparoscopy in clinically resectable cases (stages IB-III), while the Japanese Gastric Cancer Association restricts recommendations to patients with bulky nodal involvement. This disparity in guidelines underscores the need for evidence-based standardization, as significant proportion of patients undergo unnecessary laparotomy due to occult peritoneal disease [7-9].

Our findings align with established literature regarding age-related peritoneal metastasis risk. Younger patients (<40 years) demonstrated substantially higher upstaging rates to metastatic peritoneal carcinomatosis (28.9%) compared to older populations (18.1%), though statistically not significant probably because of lesser number of patients. This observation is consistent with Rijken et al systematic analyses that have identified younger age as a predictive variable for peritoneal dissemination and early recurrence [6]. Female patients showed slightly higher rates to peritoneal carcinomatosis (21.4%) compared to males (19.6%), corroborating findings by Thomassen et al., who similarly reported female sex as an independent risk factor for developing peritoneal metastases [10].

Tumor location emerged as a pivotal factor in predicting peritoneal seeding risk. Korean study by Kubo N et al involving 2,833 patients have demonstrated statistically significant associations between proximal and body stomach tumors and peritoneal carcinomatosis ($p<0.001$). Our data revealed a particularly striking pattern: linitis plastica morphology was associated with peritoneal metastases in 48.8% of cases, significantly higher than distal tumors (15.6%) and proximal tumors (8.1%) with identical statistical significance ($p<0.001$). This finding reinforces the aggressive nature of diffuse-type gastric cancers and their propensity for peritoneal dissemination [11].

Quantitative tumor characteristics demonstrated strong correlations with metastatic outcomes. Patients with tumor thickness ≥15 mm showed significant statistical association with positive peritoneal findings (28/97;

28.9%, p<0.001). Similarly, tumor volume ≥40 cm³ was significantly associated with adverse outcomes (23/92; 25.0%, p=0.048). These findings corroborate systematic analyses by Zhou et al. and Zheng et al., which established tumor size and depth of invasion as strong positive correlates with peritoneal metastasis. The prognostic significance of these morphometric parameters suggests their potential utility in risk stratification algorithms for staging laparoscopy selection [12, 13]

Signet ring cell carcinoma emerged as an independent predictor of peritoneal carcinomatosis in multivariate analysis (OR 4.15, p=0.007), consistent with multicentric studies by Honoré et al. involving 424 patients with signet ring cell gastroesophageal adenocarcinoma. Linitis plastica morphology similarly demonstrated independent predictive value (OR 3.42, p=0.002), observed in 21 of 43 patients (48.8%) with positive peritoneal cancer index. These histological patterns represent biologically aggressive tumor subtypes with inherent propensity for transcoelomic spread, necessitating enhanced surveillance strategies [14].

Although only minimal ascites was detected on imaging, this was confirmed as malignant by staging laparoscopy, underscoring the limitations of cross-sectional imaging in identifying early peritoneal disease. Minimal ascites detected during staging laparoscopy missed on contrast-enhanced computed tomography was present in 22 of 29 patients (75.9%) with statistically significant prognostic implications [15]. Zheng et al.'s systematic analysis across nine studies demonstrated pooled hazard ratios of 1.63 (95% CI: 1.47–1.82; p<0.00001) for malignant ascites, indicating significantly poorer outcomes. The identification of subclinical ascites through staging laparoscopy enables accurate upstaging and facilitates timely therapeutic decisions, potentially avoiding underestimation of disease burden and improving prognostic stratification [13].

Clinically positive lymph nodes were identified in 140 patients (76.9%), with 33/140 (23.6%) subsequently confirmed to have metastatic disease on staging laparoscopy. Regional lymph node involvement remains a critical prognostic determinant, with nodal metastases reported in approximately 70-80% of patients at surgery. These findings emphasize the importance of comprehensive preoperative staging to guide appropriate oncologic decision-making, particularly in the era of multimodal therapy approaches [16].

Contemporary imaging modalities, including computed tomography, positron emission tomography, and magnetic resonance imaging, frequently fail to detect microscopic or small macroscopic peritoneal metastases. Endoscopic ultrasound, while useful for assessing invasion depth, demonstrates variable diagnostic accuracy (T staging: 57-88%; N staging: 30-90%) and remains operator-dependent. Meta-analysis demonstrates staging laparoscopy overall specificity of 100% (95% CI: 0.977-1.00) and sensitivity of 84.6% (95% CI: 0.747-0.918). Gertsen et al.'s multicenter study involving 394 gastric cancer patients reported staging laparoscopy sensitivity of 82% (95% CI: 70-91%) and specificity of 78% (95% CI: 73-83%), with higher accuracy for advanced cT3-T4 and diffuse-type cancers [4, 17-19]

Positive peritoneal cytology represents a prognostically significant finding, identifying patients at exceptionally high risk for locoregional or distant recurrence following seemingly curative resection. The detection of malignant cytology without gross peritoneal disease typically confers dismal oncologic prognosis; however, conversion to negative cytology following neoadjuvant systemic chemotherapy has been associated with statistically significant improvements in disease-specific survival [20-22]. In our cohort, 4 patients (2.2%) with isolated positive cytology were referred for systemic chemotherapy, highlighting the clinical utility of comprehensive staging laparoscopy with cytological assessment.

Strengths of this study include the use of a standardised SL protocol, systematic CT-based measurement of tumour thickness and volume, and multivariate analysis validating independent predictors. Limitations include its retrospective design, single-centre data, and absence of survival outcomes. These restrict generalisability but do not detract from the robustness of the staging insights.

In resource-constrained environments, universal adoption of SL may not be feasible. Our findings support a selective but mandatory approach prioritising SL in patients with infiltrative morphology, signet ring histology, bulky tumours, ascites along with cN+ status. Such risk-adapted integration balances diagnostic precision with pragmatic resource allocation. By incorporating SL for high-risk groups, clinicians can avoid futile laparotomies, optimise chemotherapy allocation, and deliver personalised care without overwhelming surgical capacity.

In conclusion, staging laparoscopy remains the most reliable tool for identifying radiologically occult peritoneal metastases in gastric and GEJ adenocarcinoma. In our cohort, one in five patients was upstaged, directly altering management. While international guidelines endorse its use, real-world constraints limit universal adoption. A selective, evidence-based application—targeting patients with high-risk features—offers a practical path forward in low-resource settings, ensuring accurate staging, reducing non-therapeutic surgery, and aligning care with oncological best practice.

Author Contribution Statement

Concept: AM. Methodology and Analysis: AM, RP,DG,NU,PS,PK, AH, AP,NK. Interpretation of data: AM,NK. Manuscript writing : AM, RP, DG. Manuscript review and editing: AM, RP,DG,NU,PS,PK, AH, AP,NK. Supervision: NK

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Ethics approval and consent to participate

The study was approved by the institutional ethics committee (IEC1:309/2025), and all procedures were carried out in compliance with the institution's ethical standards. The study adhered to the Declaration of Helsinki.

Availability of data and materials

Data can be provided on request to the corresponding author.

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