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Diagnosis and Analysis of Retroperitoneal Tumor Combined with Digestive Tract Resection: A Retrospective Study

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Abstract

Purpose

The surgical management of retroperitoneal tumors involving digestive tract resection remains controversial.. This study examined cases of retroperitoneal tumors requiring concomitant digestive tract resection, with analysis focused on postoperative complication rates, prognostic outcomes, and histopathologic organ invasion (HOI) of resected organs, aiming to provide evidence to guide surgical decision-making.

Methods

We retrospectively analyzed the clinical data of 119 patients who underwent retroperitoneal tumor surgery with concomitant digestive tract resection at our institution between January 2018 and December 2023.

Results

The most common resection sites were the large intestine (41.2%), small intestine (30.3%), and both (17.6%). HOI was identified in 32.8% of resected organs. The rate of severe complications (Clavien-Dindo ≥ III) was 15.1%, with intra-abdominal infections occurring more frequently following colectomy. Complete resection (R0/R1) was achieved in 108 cases (90.8%). For 99 malignant cases, the 3- and 5-year overall survival rates were 76.5% and 73.0%, respectively. Multivariable Cox analysis identified tumor size, resection margin status (R0/R1 vs. R2), and HOI as independent risk factors for overall survival ($P < 0.05$), and tumor size, resection margin status, recurrence, and HOI as independent risk factors for disease-free survival ($P < 0.05$).

Conclusion

In this retrospective cohort, retroperitoneal tumor resection combined with digestive tract resection was associated with acceptable postoperative morbidity and facilitated complete tumor removal in a high proportion of cases. The complication profile was broadly consistent with rates reported by major international sarcoma registries. These findings suggest that, in appropriately selected patients—particularly those with suspected organ invasion on intraoperative assessment—combined digestive tract resection is a feasible strategy to achieve complete resection. However, given the limitations of this single-center retrospective study, our results should be interpreted cautiously and validated in larger, prospective, multi-institutional cohorts.

1. Introduction

Retroperitoneal tumors are uncommon in clinical practice, and the majority are soft-tissue sarcomas. Approximately 70% to 80% of retroperitoneal soft tissue tumors are malignant, representing 10% to 15% of all soft tissue sarcomas and 0.1% to 0.2% of all malignant tumors [1]. The vast majority of retroperitoneal malignant tumors are retroperitoneal sarcomas (RPS). While there are more than 70 histological types of sarcomas, the most common subtypes are liposarcoma and leiomyosarcoma, followed by undifferentiated pleomorphic sarcoma (UPS), Synovial sarcomas, malignant peripheral nerve sheath tumor, and other rare subtypes [2]. Borderline tumors, including desmoid fibromatosis, inflammatory myofibroblastic tumor, and solitary fibrous tumor, carry a high risk of local recurrence after surgery. Benign retroperitoneal tumors include lipoma, angiomyolipoma, and leiomyoma.

Complete surgical resection is the primary treatment modality for retroperitoneal tumors. The first complete surgical resection, in particular, represents a critical opportunity for cure.Due to their deep retroperitoneal location and lack of specific early clinical manifestations, these tumors are often detected at an advanced stage. Consequently, at presentation, they are typically large and frequently invade or involve adjacent abdominal organs. Intraoperative combined resection of involved organs is often required to achieve radical tumor removal, reduce local recurrence, and improve long-term survival. Gronchi et al. reported that the rate of combined digestive tract resection was as high as 76.2% in their retrospective analysis of 1007 patients who underwent surgery for RPS [3]. In a follow-up study of 1,207 patients who underwent resection for primary retroperitoneal tumors, 256 patients experienced severe complications such as abscess, sepsis, and bleeding; additionally, 16 patients died within 30 days postoperatively. When three or more organs were resected simultaneously, the risk of postoperative complications increased significantly [4].

The Transatlantic Retroperitoneal Sarcoma Working Group (TARPSWG) reported 165 (16.4%) postoperative serious adverse events (Clavien-Dindo grade ≥ 3) and 18 (1.8%) deaths within 30 days among 1007 consecutive patients undergoing resection for primary RPS between January 2002 and December 2011[5]. Pancreaticoduodenectomy, macrovascular resection, and splenectomy/pancreatectomy were associated with the highest resection risk. These data demonstrated that combined digestive tract resection in retroperitoneal tumor surgery is increasingly common and is associated with a substantial rate of serious complications. Although several risk stratification systems have been developed to quantify surgical morbidity following multi-visceral resection in RPS—such as the TARPSWG surgical complexity score and the nomogram proposed by Fairweather et al. [4, 6] —these tools are typically derived from heterogeneous cohorts without dedicated focus on gastrointestinal resection-specific outcomes. There remains a paucity of detailed analysis focusing exclusively on patients undergoing retroperitoneal tumor resection with concurrent digestive tract resection, particularly regarding the relationship between HOI, resection type, and complication profiles.

The role of chemotherapeutics in the treatment of localized retroperitoneal tumors is uncertain, and the potential benefits of radiotherapy remain debated. Despite the growing availability of multimodal treatments for retroperitoneal tumors, surgery remains the cornerstone of therapy. However, the optimal extent of resection has been contentious since 2009. Proponents advocate for systematic en-bloc

resection of adjacent organs, either wholly or partially, to reduce local recurrence; however, the removal of tumor-adjacent organs to achieve negative margins remains controversial[6–9].

This study retrospectively examined the clinical characteristics, surgical methods, prognosis, postoperative complications, and HOI rate in 119 cases of retroperitoneal tumor combined with digestive tract resection from January 2018 to December 2023 at the Soft Tissue Diagnosis and Treatment Center of our hospital. The findings may provide a valuable evidence base for guiding the feasibility and extent of resection in retroperitoneal tumors requiring concomitant digestive tract resection.

2. Materials and Methods

2.1 Study design

A total of 119 patients with retroperitoneal tumors who underwent surgery at the Soft Tissue Diagnosis and Treatment Center of our hospital between January 2018 and December 2023 were reviewed. Inclusion criteria were: (1) completion of preoperative enhanced CT/MRI or color Doppler ultrasound imaging; (2) age under 90 years; and (3) concurrent intraoperative resection of the digestive tract. Exclusion criteria were: (1) identification of non-retroperitoneal tumors via intraoperative exploration or postoperative pathology; (2) palliative tumor resection performed intraoperatively; and (3) absence of combined digestive tract resection.

2.2 Data collection

Patient demographics and tumor variables, including age at diagnosis, gender, primary tumor treatment status, primary tumor site, surgery-related conditions, and postoperative pathology, were collected by reviewing medical records or through telephone follow-up. Surgical records and pathology reports were reviewed to determine the number and type of organs removed. Additional pathology studies (e.g., submission of additional material, section resection, or immunohistochemical studies) were not performed.

Definition of histopathologic organ invasion (HOI)

HOI was defined as postoperative pathologic confirmation of tumor cell infiltration of a resected organ. The rationale for organs resection was classified into five categories based on intraoperative findings

Category 1

Organs resected because intraoperative visual inspection suggested direct tumor invasion.

Category 2

Organs resected because the tumor involved the vascular supply of the organ (e.g., mesenteric involvement necessitating intestinal resection).

Category 3

Organs in which the tumor extended beyond 180° of the organ circumference.

Category 4: Organs that appeared inseparable from the tumor due to dense adhesions.

Category 5 ("other"): Organs removed for indications unrelated to the tumor (e.g., incidental appendectomy).

HOI positivity was defined as pathologically confirmed tumor cell infiltration in the resected organ (regardless of resection category). This definition was applied consistently throughout the analysis.

Statistical outcomes were overall survival (OS) and disease-free survival (DFS). OS was defined as the time from surgery to death or the last known follow-up date. DFS was defined as the time from surgery to tumor recurrence, death, or the last known follow-up date.

2.3 Statistical analysis and Follow-up

Follow-up was conducted via outpatient clinic visits, telephone calls, and letters, scheduled every 3 months for the first 2 years after surgery and every 6 months thereafter.

Statistical analysis was performed using the SPSS 26.0 software. Continuous variables were compared using the Mann-Whitney U test or t-test as appropriate. Categorical variables were compared using the chi-square test or Fisher's exact test. Kaplan-Meier survival analysis was used to estimate survival distributions, with comparisons made using the log-rank test. Cox proportional hazards regression was used for univariable and multivariable analyses to identify independent prognostic factors. Variables with $P < 0.10$ in univariable analysis were entered into the multivariable model. For multivariable analysis, the number of variables was limited to avoid overfitting given the sample size (approximately 1 variable per 10 events). $P < 0.05$ was considered statistically significant.

Due to the limited sample size, multivariable analysis for postoperative complications as a dependent variable was not performed.

3. Results

3.1 Patient characteristics

A total of 119 patients were enrolled. Among them, there were 47 males (39.5%) and 72 females (60.5%), with a male-to-female ratio of 1:1.5. The age ranged from 17 to 79 years (mean age 54 years). There were 35 primary cases (29.4%) and 84recurrence cases (70.6%). Complete resection (R0) was achieved in 100 cases (84.0%), R1 resection in 8 cases (6.7%), and R2 resection in 11 cases (9.2%). Malignant tumors were confirmed in 99 cases (83.2%), and benign or borderline tumors in 20 cases (16.8%). The distribution of combined organ resections was as follows: partial large intestine resection, 49 cases(41.2%); partial small intestine resection, 36 cases(30.3%); partial large and small intestine

resection, 21 cases(17.6%); partial stomach resection,5 cases (4.2%); large intestine and stomach resection, 1 case (0.8%); small intestine and stomach resection, 2 cases (1.7%), and large intestine, small intestine, and stomach resection, 5 cases (4.2%).

Table 1
Presents baseline demographic and clinicopathological characteristics.

Characteristics	Case, n (%)
Age (years)	
≤ 60	78 (65.5)
> 60	41 (34.5)
Gender	
Male	47 (39.5)
Female	72 (60.5)
Tumor Diameter	
≤ 15cm	59 (49.6)
> 15cm	60 (50.4)
Tumor status	
Primary	35 (29.4)
Recurrent	84 (70.6)
Surgical margin	
R0	100 (84.0)
R1	8 (6.7)
R2	11 (9.2)
HOI status	
Positive	39 (32.8)
Negative	80 (67.2)
Pathology	
Liposarcoma	48 (40.3)
Leiomyosarcoma	16 (13.4)
Other Malignant	35 (29.4)
Benign/borderline	20 (16.8)

3.2 Surgical outcomes

The mean operative time was 137.2 ± 43.6 minutes, and the mean estimated blood loss was 449.4 ± 437.6 mL. One patient experienced bleeding within 24 hours of surgery. The incidence of postoperative complications classified by Clavien-Dindo (Table 2) was 15.1% (including 9 cases of anastomotic leakage and 18 cases of intra-abdominal infection). The mean length of hospital stay was 18.5 ± 7.5 days.

Table 2
Postoperative Complications by Clavien-Dindo Classification

Clavien-Dindo Grade	Cases, n (%)
I	2 (1.7)
II	7 (5.9)
IIIa	2 (1.7)
IIIb	5 (4.2)
IV	1 (0.8)
V	1 (0.8)
Total (Grade ≥ III)	18 (15.1)

3.3 Pathology and HOI analysis

Pathological types among the 119 patients included: liposarcoma in 48 cases (40.3%), leiomyosarcoma in 16 cases (13.4%), benign or borderline tumors in 20 cases (16.8%), and other malignant tumors in 35 cases (29.4%).**HOI analysis**: Postoperative pathology confirmed HOI in 39 cases (32.8%). Among the 119 cases, the indications for organ resection were: suspected tumor invasion (31.9%), adhesions (38.7%), vascular involvement (15.1%), and other (14.3%). The HOI rate was 14.3% for organs resected during primary surgery and 40.5% for organs resected during non-primary (recurrent) surgery (Fig. 1B). Among organs resected due to suspected tumor invasion, the HOI rate was highest (Fig. 1C).

There was no significant difference in anastomotic leakage between patients who underwent large intestine resection versus those who underwent small intestine resection (Fig. 1D). However, postoperative intra-abdominal infection was more frequently observed in patients who underwent large intestine resection (Fig. 1E).

1. Quantitative comparison of the number of combined organ resections between initial surgeries and non-initial surgeries across different clinical subgroups.
2. Comparative analysis of the proportion of pathologically confirmed higher-order organ involvement (HOI) in combined organ resection specimens from initial versus non-initial operations.

3. Distribution of the proportion of resected organs with postoperative pathological confirmation of HOI, stratified by distinct clinical conditions.
4. Inter-group comparison of the incidence of postoperative anastomotic leakage following resection of different target organs.

E. Comparative assessment of the incidence of postoperative intra-abdominal infection across subgroups undergoing different types of organ resection.

3.4 Survival analysis

The median follow-up duration was 42 months (range: 6–72 months). During follow-up, 8 patients (6.7%) were lost to follow-up. For the 99 patients with malignant tumors, the 3- and 5-year overall survival rates were 76.5% and 73.0%, respectively. The 3- and 5-year disease-free survival rates for the 99 malignant cases were 78.5% and 65.6%, respectively.

Univariable and multivariable Cox regression analysis for OS (n = 99 malignant cases):

As shown in Table 3, univariable analysis identified tumor size (> 15 cm), surgical margin (R2), and HOI positivity as significant prognostic factors for OS (all $P < 0.01$). Multivariable analysis confirmed tumor size (> 15 cm: HR9.41, 95% CI 1.20–73.85, $P = 0.03$), surgical margin (R2: HR 4.99, 95% CI 1.81–13.78, $P = 0.01$), and HOI positivity (HR 11.36, 95% CI 2.58–49.98, $P < 0.01$) as independent risk factors for worse OS.

Univariable and multivariable Cox regression analysis for DFS (n = 99 malignant cases):

As shown in Table 4, univariable analysis identified tumor size (> 15 cm), tumor status (recurrent), surgical margin (R1/R2), and HOI positivity as significant prognostic factors for DFS (all $P < 0.01$). Multivariable analysis confirmed tumor size (> 15 cm: HR 5.33, 95% CI 1.96–14.53, $P = 0.01$), tumor status (recurrent: HR 3.82, 95% CI 1.12–13.30, $P = 0.03$), surgical margin (R1: HR 3.53, 95% CI 1.45–8.60, $P < 0.01$; R2: HR 8.14, 95% CI 3.26–20.35, $P < 0.01$), and HOI positivity (HR 3.09, 95% CI 1.47–6.45, $P = 0.01$) as independent risk factors for worse DFS.

Kaplan-Meier survival curves for OS and DFS are shown in Fig. 2.

Table 3
Univariable and Multivariable Cox Analysis for Overall Survival (Malignant Cases, n = 99)

Characteristics	Case, n (%)	Univariable HR (95% CI)	*P*	Multivariable HR (95% CI)	*P*
Age (≤ 60 vs. >60)	64 (64.6) / 35 (35.4)	1.22 (0.48–3.11)	0.67	/	/
Gender (Male vs. Female)	40 (40.4) / 59 (59.6)	0.76 (0.31–1.90)	0.56	/	/
Tumor diameter (> 15cm)	55 (55.6)	21.71 (2.88–163.67)	< 0.01	9.41 (1.20–73.85)	0.03
Tumor status (Recurrent)	76 (76.8)	2.20 (0.64–7.56)	0.21	/	/
Margin	80(80.8)	0.89(0.11–6.98)	< 0.01	0.71(0.09–5.63)	0.01
R0	8(8.1)	9.89 (3.78–25.89)		4.99(1.81–13.78)	0.01
R1	11 (11.1)		< 0.01		
R2					
HOI positive	39 (39.4)	16.68 (3.85–72.26)	< 0.01	11.36 (2.58–49.98)	< 0.01
Pathology	48 (48.5)	0.45 (0.01–2.07)	0.59	/	/
LPS	16 (16.2)	0.85(0.32–2.21)	0.59		
LMS	35(35.4)				
Other					

HOI: histopathologic organ invasion. **LMS**: leiomyosarcoma. **LPS**: liposarcoma. The "/" mark in the table indicates that the variable was not included in the multivariate regression analysis.

Table 4
Univariable and Multivariable Cox Analysis for Disease-Free Survival (Malignant Cases, n = 99)

Characteristic	Case, n (%)	Univariable HR (95% CI)	*P*	Multivariable HR (95% CI)	*P*
Age (≤ 60 vs. >60)	64 (64.6) / 35 (35.4)	1.16 (0.57–2.34)	0.68	/	/
Gender (Male vs. Female)	40 (40.4) / 59 (59.6)	1.10 (0.55–2.23)	0.79	/	/
Tumor diameter (> 15cm)	55 (55.6)	7.48 (2.87–19.48)	< 0.01	5.33 (1.96–14.53)	0.01
Tumor status (Recurrent)	76 (76.8)	4.51 (1.37–14.80)	< 0.01	3.82 (1.12–13.03)	0.03
Margin (R1 vs. R0)	8 (8.1)	5.69 (2.40–13.50)	< 0.01	3.53 (1.45–8.60)	< 0.01
Margin (R2 vs. R0)	11 (11.1)	13.49 (5.68–32.07)	< 0.01	8.14 (3.26–20.35)	< 0.01
HOI positive	39 (39.4)	4.14 (2.02–8.51)	< 0.01	3.09 (1.47–6.45)	< 0.01
Pathology	48 (48.5)	0.67(0.24–1.84)	0.72	/	/
LPS	16(16.2)	0.84(0.40–1.77)	0.72		
LMS	35(35.4)				
Other					

HOI: histopathologic organ invasion. **LMS**: leiomyosarcoma. **LPS**: liposarcoma. The "/" mark in the table indicates that the variable was not included in the multivariate regression analysis.

4. Discussion

Retroperitoneal tumors originate from the retroperitoneal space and encompass a diverse range of pathological types, of which malignant tumors—including liposarcoma, leiomyosarcoma, and undifferentiated pleomorphic sarcoma—are the most common.. Due to the expansive nature and deep anatomical location of the retroperitoneal space, tumors often remain undetected during the early stages. Diagnosis is frequently established only after the tumor has invaded or compressed adjacent organs, precipitating clinical symptoms.

Surgical resection is currently the preferred treatment for retroperitoneal tumors, and all patients eligible for tumor resection are advised to undergo surgery with the goal of complete resection (R0). Although the survival difference between R0 and R1 resection remains uncertain [10], the prognosis following R2 resection is worse. Complete resection can improve patient survival and reduce local recurrence [11].

When the pancreatic head is involved, whether pancreaticoduodenectomy is necessary to improve the R0 resection rate remains controversial [12]. To improve the complete resection rate, multi-visceral resection is often performed, with the kidney and colon being the most common organs requiring combined resection [13]. However, previous studies have found that the incidence of postoperative complications significantly increases when three or more organs are resected concurrently, and the risk varies depending on the organs resected [14]. Surgery-related complications do not appear to affect overall survival [4]. Therefore, combined resection of surrounding tissues and organs to achieve complete resection remains an important strategy to improve prognosis. In this cohort of 119 patients, 108 cases (90.8%) underwent R0/R1 resection, with no increase in surgery-related complications beyond rates reported in the literature.

For patients with recurrent retroperitoneal tumors who have undergone multiple surgeries, deciding intraoperatively whether to repair extensive adhesions or resect the involved bowel presents a significant clinical challenge. This study included 35 primary cases and 84 recurrent cases. For patients found to have tumor invasion or close adhesions to bowel segments during surgery, resection of the corresponding segments is recommended to avoid tumor residue, which plays a decisive role in improving prognosis.

An important question addressed by this study is whether bowel segment resection increases the incidence of postoperative complications. The Transatlantic Australasian Retroperitoneal Sarcoma Working Group (TARPSWG) has validated several surgical complexity scoring systems to predict postoperative morbidity following multi-visceral resection. Fairweather et al. [6] recently developed a surgical complexity score incorporating the number and type of resected organs, which demonstrated good predictive performance for severe complications. In comparison, our cohort—with a Clavien-Dindo ≥ III rate of 15.1%—is consistent with the TARPSWG-reported serious adverse event rate of 16.4% in 1,007 patients, confirming that well-selected patients tolerate combined GI resection with acceptable morbidity [15].

Judge et al. [16] reported that 233 patients (41%) underwent combined organ resection. The most commonly involved organs were the intestine (19%), kidney (15%), and blood vessels (3%). The risk of complications was higher when the pancreas (2%) and liver (1%) were resected, while the risk was lower with intestine and kidney resection. In our cohort, one patient experienced bleeding within 24 hours postoperatively. The postoperative Clavien-Dindo complication rate was 15.1% (including 9 cases of anastomotic leakage and 18 cases of abdominal infection). We found no significant difference in the incidence of anastomotic leakage between retroperitoneal tumors requiring large bowel resection and/or small bowel resection (Fig. 1D). However, patients undergoing large bowel resection for retroperitoneal tumors exhibited a higher incidence of postoperative intra-abdominal infection (Fig. 1E). Therefore, when large bowel resection is performed, careful attention should be paid to monitoring for postoperative intra-abdominal infection, ensuring adequate preoperative bowel preparation, and adhering to strict aseptic technique.

Advances in surgical techniques have contributed to improved survival. The 5-year survival rate for retroperitoneal sarcoma increased from 47.0% in 1998–2005 to 58.4% in 2002–2012, while the 10-year survival rate increased from 27.0% to 45.3% [17–18]. In this study, the 3- and 5-year overall survival rates were 76.5%, and 73.0%, respectively, while the 3- and 5-year disease-free survival rate were 63.6% and 57.9%. The relatively higher survival rates in our cohort may be attributable to the inclusion of patients with benign or borderline tumors and the high proportion of complete resections achieved.

Among the 119 patients who underwent surgical resection, 39 (32.8%) had specimens showing HOI. The indications for organ resection included suspected tumor invasion (31.9%) and adhesions (38.7%). The HOI rate was 14.3% during primary surgery and 40.5% during non-primary surgery. These figures are slightly higher than the 26% HOI (invasive pattern) reported by Mussi et al. [19]. Bonvalot S et al. [7] found that 80% of patients who underwent simple tumor stripping had minimal residual lesions, suggesting that a more aggressive surgical strategy is necessary for patients undergoing non-primary surgery. Furthermore, our analysis showed that suspected tumor invasion and tumor adhesions were the primary indications for organ resection, and among these cases, postoperative pathology indicated the highest rates of HOI. Therefore, combined organ resection should be considered when tumor invasion is suspected intraoperatively.

For patients with recurrent retroperitoneal tumors, surgical resection remains the most effective approach to enhance survival, provided overall health allows and the tumor is localized without extensive metastasis [20]. Combined organ resection can increase the rate of complete tumor resection and decrease the recurrence [21]. In this study, the complete tumor resection rate (R0/R1) reached 90.8%, and this group demonstrated significantly superior survival compared to the incomplete resection group. The HOI rate in resected organs from patients undergoning non-primary surgery was markedly higher than that in primary surgery patients (40.5% vs. 14.3%). Furthermore, higher HOI rates were more frequently associated with organs resected due to suspected tumor invasion. Consequently, for retroperitoneal tumors—particularly recurrent cases—active combined organ resection should be pursued when tumor invasion is suspected or confirmed intraoperatively.

Our multivariable analysis identified tumor size > 15 cm, R2 resection, and HOI positivity as independent risk factors for worse OS, and tumor size > 15 cm, recurrent disease, R1/R2 resection, and HOI positivity as independent risk factors for worse DFS. These findings are consistent with the existing literature and underscore the importance of achieving complete resection whenever feasible.

Limitations

Several limitations of this study warrant acknowledgment. First, this is a single-center retrospective analysis with inherent selection bias and limited generalizability. Second, the heterogeneity of tumor histology (including benign, borderline, and multiple sarcoma subtypes) precludes detailed subtype-specific analyses. Third, due to the relatively small sample size (n = 119), we were unable to perform multivariable analysis for complications as a dependent variable, limiting our ability to adjust for potential confounders. Fourth, the absence of a control group (retroperitoneal tumor patients without GI

resection) prevents direct comparison of complication rates attributable specifically to the GI resection component. Fifth, follow-up duration varies among patients, and the retrospective HOI classification based on surgical reports may introduce information bias. Finally, detailed data on neoadjuvant or adjuvant radiotherapy and chemotherapy were not systematically captured, limiting our ability to assess their impact on survival outcomes. Despite these limitations, our study provides focused, granular data on GI resection outcomes in a well-characterized retroperitoneal tumor cohort, complementing larger but less disease-specific datasets.

5. Conclusion

In this retrospective cohort, retroperitoneal tumor resection combined with digestive tract resection was associated with acceptable postoperative morbidity and facilitated complete tumor removal in a high proportion of cases (90.8%). The complication profile (Clavien-Dindo ≥ III: 15.1%) was broadly consistent with rates reported by major international sarcoma registries. Tumor size, resection margin status, recurrence, and HOI were identified as independent prognostic factors. These findings suggest that, in appropriately selected patients—particularly those with suspected organ invasion on intraoperative assessment—combined digestive tract resection is a feasible strategy to achieve complete resection. However, given the limitations of this single-center retrospective study, our results should be interpreted cautiously and validated in larger, prospective, multi-institutional cohorts.

Declarations

Contributions

WHb and ZHq designed the research protocol and analytical methods. QGl, QXl, QZh and PS conducted data retrieval and analysis. WYx and CDa collected and organized the data. WKw wrote the first draft of the paper. All authors participated in the review of the manuscript.

Availability of Data and Materials

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

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Conflict of Interest

The authors declare no conflict of interest, financial or otherwise.

Ethical approval, patient consent and clinical trial registration

Given the retrospective natureof this study, ethical approval and informed consent were waived by the institutional review board. Clinical trial registration was not required.

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Data Availability Statement

The contributions presented in the study are included in the article. Further inquiries can be directed to the corresponding authors.

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Figures

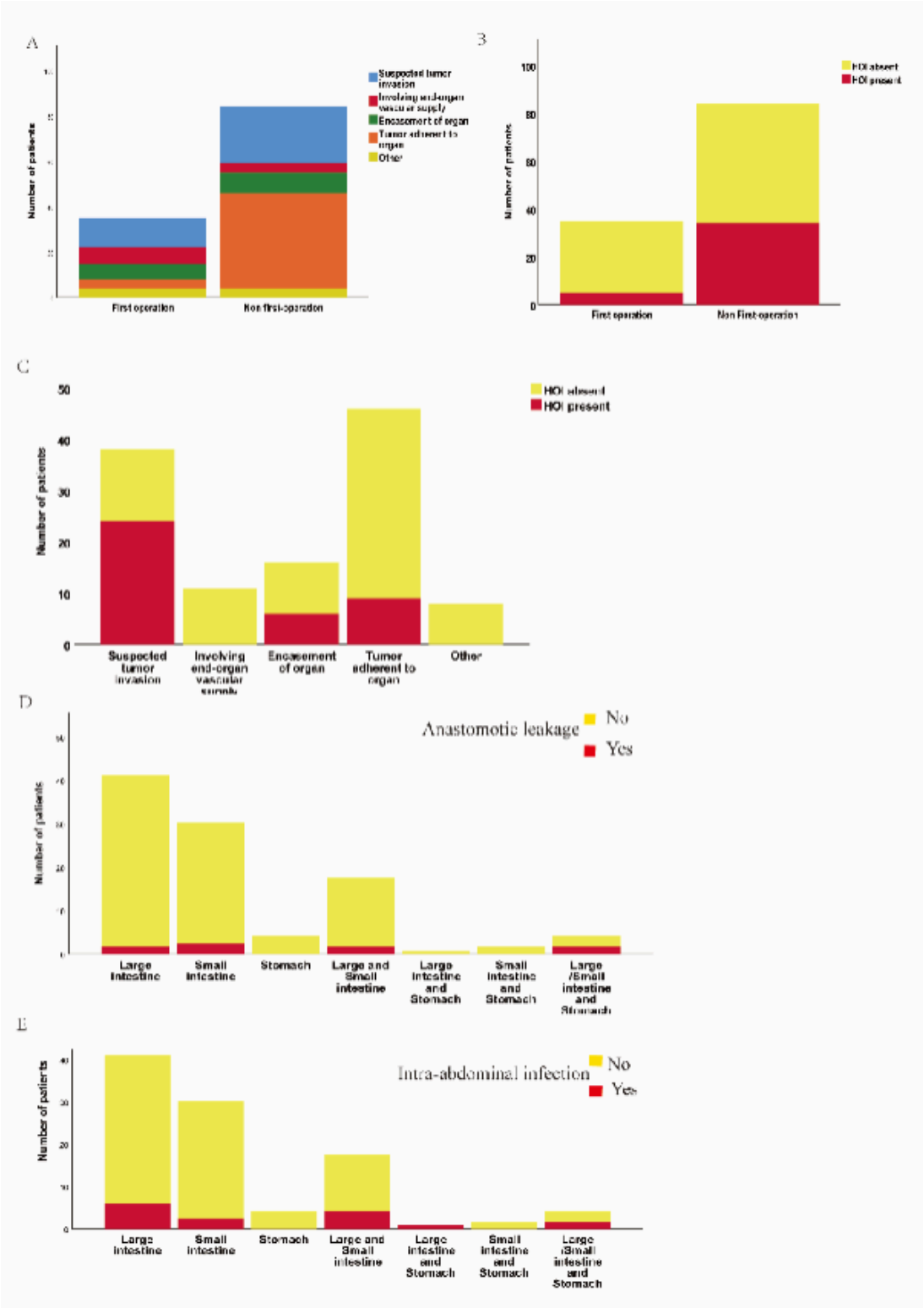


Figure 1

Postoperative follow-up outcomes of the enrolled patients.

A. Quantitative comparison of the number of combined organ resections between initial surgeries and non-initial surgeries across different clinical subgroups.

B. Comparative analysis of the proportion of pathologically confirmed higher-order organ involvement (HOI) in combined organ resection specimens from initial versus non-initial operations.

C. Distribution of the proportion of resected organs with postoperative pathological confirmation of HOI, stratified by distinct clinical conditions.

D. Inter-group comparison of the incidence of postoperative anastomotic leakage following resection of different target organs.

E. Comparative assessment of the incidence of postoperative intra-abdominal infection across subgroups undergoing different types of organ resection.

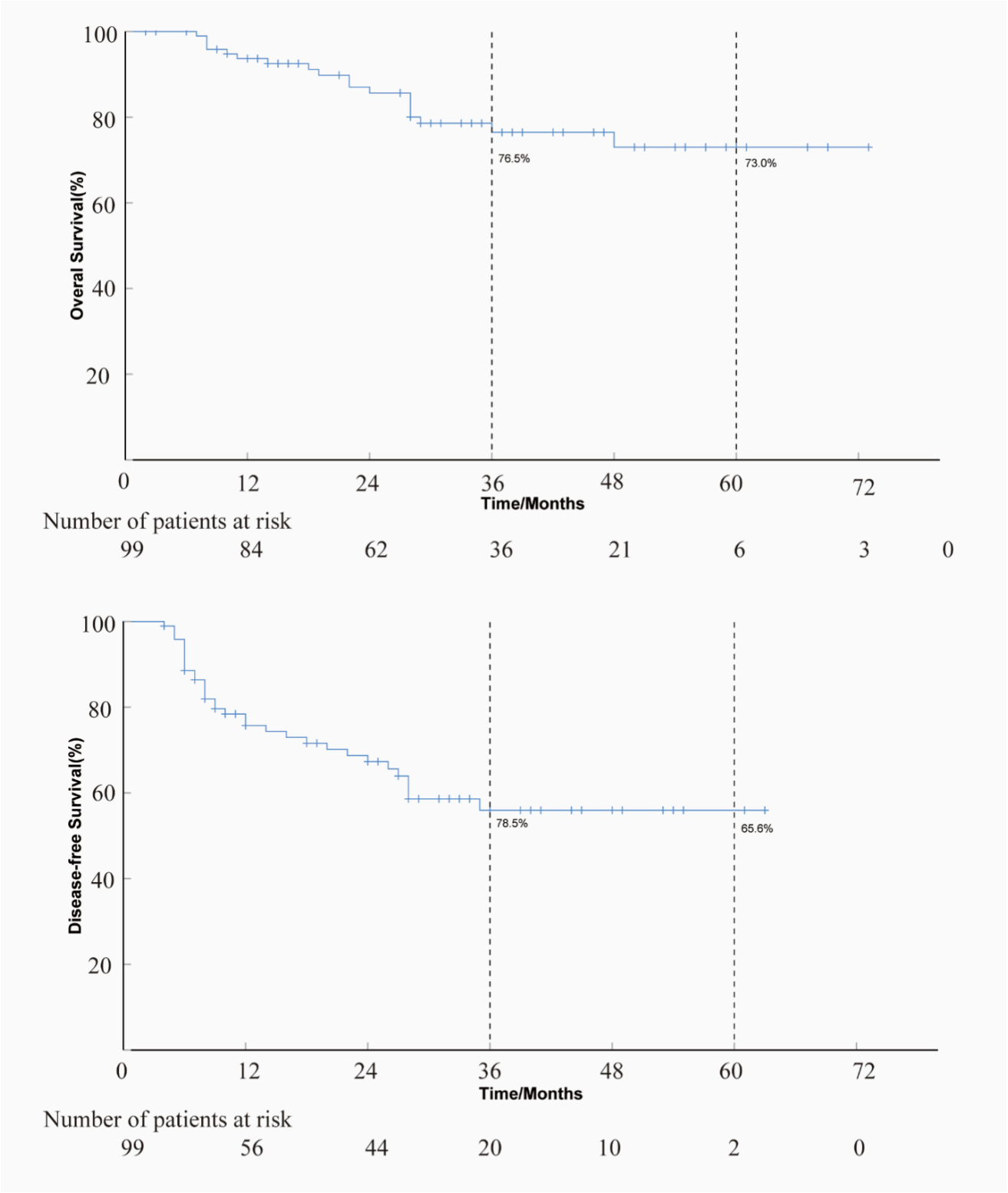


Figure 2

The Overall survival and Disease-free recurrence survival of 99 patients.