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ABOUT COVER

Peer Reviewer of *World Journal of Gastrointestinal Surgery*, Adrienn Biró, MD, PhD, Assistant Professor, Surgeon, Department of Surgery, Somogy County Kaposi Mor Teaching Hospital, Kaposvár 7400, Hungary. b.adrienn5@gmail.com

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ORIGINAL ARTICLE

Retrospective Cohort Study

Endoscopic full-thickness resection *vs* surgical resection for gastric stromal tumors: Efficacy and safety using propensity score matching

Si-Qiao Zhao, Si-Yao Wang, Nan Ge, Jin-Tao Guo, Xiang Liu, Guo-Xin Wang, Lei Su, Si-Yu Sun, Sheng Wang

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Si-Qiao Zhao, Endoscopy Center, Shengjing Hospital of China Medical University, Shenyang 110000, Liaoning, China

Si-Yao Wang, Nan Ge, Jin-Tao Guo, Xiang Liu, Guo-Xin Wang, Lei Su, Si-Yu Sun, Sheng Wang, Department of Gastroenterology, Shengjing Hospital of China Medical University, Shenyang 110004, Liaoning Province, China

Co-corresponding authors: Si-Yu Sun and Sheng Wang.

Corresponding author: Sheng Wang, MD, Chief Physician, Professor, Department of Gastroenterology, Shengjing Hospital of China Medical University, No. 36 Sanhao Street, Heping District, Shenyang 110004, Liaoning Province, China. wangs@sj-hospital.org

Abstract

BACKGROUND

Endoscopic full-thickness resection (EFTR) is increasingly used for treating gastrointestinal stromal tumors (GISTs) in the stomach.

AIM

To compare the efficacy, tolerability, and clinical outcomes of EFTR *vs* surgical resection (SR) for gastric GISTs.

METHODS

We collected clinical data from patients diagnosed with GISTs who underwent either EFTR or SR at our hospital from October 2011 to July 2024. Patients were matched in a 1:1 ratio based on baseline characteristics and tumor clinical-pathological features using propensity score matching. We analyzed perioperative outcomes and follow-up data. The primary outcome measure was progression-free survival (PFS).

RESULTS

Out of 912 patients, 573 met the inclusion criteria. After matching, each group included 95 patients. The EFTR group demonstrated statistically significant advantages over the SR group in average operative time ($P < 0.001$), length of hospital stay ($P < 0.001$), time to resume liquid diet ($P < 0.001$), incidence of adverse events ($P = 0.031$), and hospitalization costs ($P < 0.001$). The *en bloc* resection rate was significantly different, with SR group at 100% and EFTR group at 93.7% (P = 0.038). The median follow-up was 2451.50 days. Recurrence occurred in 3 patients in the EFTR group and 4 patients in the SR group, with no statistically significant difference (P = 1.000). Factors associated with PFS included age, tumor size, high-risk category in the modified National Institutes of Health (NIH) risk score, and resection status. Resection status was identified as an independent prognostic factor for PFS (P = 0.0173, hazard ratios = 0.0179, 95%CI: 0.000655-0.491). Notably, there was no statistically significant difference in PFS between the two groups.

CONCLUSION

This study is a non-inferiority design. The EFTR group significantly outperformed the SR group in terms of operative time, length of hospital stay, time to resume a liquid diet, incidence of adverse events, and hospitalization costs, demonstrating its higher economic efficiency and better tolerability. Additionally, although the *en bloc* resection rate was lower in the EFTR group compared to the SR group, there were no significant differences in tumor recurrence rates and progression-free survival between the two groups. This study found no statistical difference in the primary endpoint of postoperative recurrence rates between the two groups. However, due to sample size limitations, this result requires further validation in larger-scale studies. The current results should be viewed as exploratory evidence.

Key Words: Endoscopic full-thickness resection; Gastrointestinal stromal tumors; Surgical resection; Propensity score matching; Efficacy; Progression-free survival

Core Tip: This study evaluates endoscopic full-thickness resection (EFTR) *vs* surgical resection (SR) for gastric gastrointestinal stromal tumors. EFTR shows significant advantages in operative time, hospital stay, and adverse events compared to SR, with improved economic efficiency and tolerability. Although EFTR has a lower *en bloc* resection rate, both treatments yield similar tumor recurrence rates and progression-free survival. This research highlights EFTR's potential benefits in clinical practice while emphasizing that both methods offer comparable long-term outcomes.

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INTRODUCTION

Gastrointestinal stromal tumors (GISTs) are the most common malignant mesenchymal tumors, primarily occurring in the stomach (50.0%-60.0%) and small intestine (30.0%-35.0%), with a smaller percentage in the colon and rectum (5.0%) and very rarely in the esophagus (< 1.0%)[1,2]. GISTs vary widely in clinical behavior, ranging from tumors with minimal metastatic potential to malignant and life-threatening diseases. One of the most notable features of GISTs is their unpredictable and variable behavior[3-5]. Endoscopic ultrasonography (EUS) is the preferred method for evaluating uncertain GISTs and/or tissues that cannot be diagnosed through biopsy. EUS can differentiate tumor size, invasion depth, and growth patterns, providing guidance for the diagnosis and treatment of GISTs[6,7].

Although GIST management principles have been standardized in various international guidelines, there remains significant controversy, particularly in dealing with smaller-sized GISTs (< 5 cm). According to recommendations from the National Comprehensive Cancer Network (NCCN) and the European Society for Medical Oncology (ESMO), for small gastric subepithelial lesions (SELs) < 2 cm and without malignant features, monitoring with EUS is sufficient without the need for histopathological examination. For primary, localized gastric GISTs larger than 2 cm, surgical resection (SR) is recommended. Additionally, SELs that present with ulceration, bleeding, or symptoms should be considered for resection[2,8]. However, research by Kobayashi *et al*[9] indicates that since EUS measurements are typically 0.5 cm smaller than pathological tumor diameters, even for gastric GISTs < 2 cm and without malignant features, further examination such as EUS-guided fine-needle aspiration (FNA) should be considered. Multiple factors need to be considered in the assessment and management of GISTs, particularly when choosing a resection approach, and no consensus has yet been reached.

GISTs have potential malignant characteristics, with hematogenous metastasis being the primary mode of spread, and lymph node metastasis being rare. Therefore, lymph node dissection is not necessary during SR. In recent years, based on endoscopic submucosal techniques and with the development of reliable endoscopic closure technologies and tools, endoscopic full-thickness resection (EFTR) is emerging as an option for treating subepithelial tumors and epithelial lesions with significant fibrosis[10-12]. In a 2023 retrospective study by Shichijo *et al*[13] from Japan, it was found that

EFTR is effective for treating gastric submucosal tumors (SMTs) ranging from 11 to 30 mm[13]. EFTR is primarily suited for submucosal GISTs that grow into the serosal layer. If endoscopic submucosal dissection (ESD) reveals tight adhesion to the serosal layer, EFTR can be considered. EFTR can be categorized into "exposed" and "non-exposed" types. In exposed EFTR, full-thickness resection is performed using tunnel or non-tunnel techniques, followed by defect closure. In non-exposed EFTR, resection is done safely between the serosa and serosa before isolating the lesion[14]. However, EFTR encounters three primary challenges: Restricted insufflation and visibility within the cavity, limited operational space, and insufficient exposure of the resection margins[15,16]. EFTR has certain limitations, such as cases involving GISTs located in the small intestine or retroperitoneum, which are often beyond the reach of endoscopy. Since endoscopic treatment requires a clear view within the gastrointestinal tract, some GISTs that cause bleeding or obstruction are not ideal candidates for endoscopic treatment. EFTR demands complex endoscopic techniques, including electrocautery, hemostasis, and endoscopic closure of gastrointestinal defects[17-20]. Additionally, the procedure involves creating an artificial pneumoperitoneum, which may lead to complications such as pleural or peritoneal fistulas, potentially resulting in serious infections. Thus, EFTR currently faces challenges related to standardization and broader implementation[11,21,22]. Ensuring *en bloc* resection and managing potential recurrence risks remain ongoing concerns for clinicians. There is still some debate regarding the long-term efficacy of EFTR in treating GISTs[23,24]. Many studies on EFTR for gastric GISTs have demonstrated its short-term safety. However, further clinical research and long-term follow-up are needed to assess postoperative recurrence rates, long-term survival, and patient quality of life. Previous research often shows a significant imbalance, with larger numbers of patients and larger tumor sizes in the SR group compared to the EFTR group, leading to considerable selection bias. In this study, we used propensity score matching (PSM) to create comparable cohorts and evaluate the safety and efficacy of EFTR *vs* SR for GISTs.

MATERIALS AND METHODS

Study subjects

A retrospective collection of 912 patients with primary gastric GIST who received EFTR or SR at Shengjing Hospital, China Medical University, from November 2011 to July 2023. After applying inclusion and exclusion criteria, 573 patients were ultimately selected for further analysis (Figure 1).

Inclusion criteria: (1) Age > 18 years; (2) Preoperative EUS confirming a gastric tumor originating from the muscularis propria; (3) No evidence of GIST recurrence or metastasis before treatment; (4) Underwent EFTR or SR; and (5) Postoperative pathological diagnosis of GIST.

Exclusion criteria: (1) Coexisting malignant tumors; (2) Severe heart, liver, or kidney dysfunction; (3) Incomplete treatment or lack of complete medical records; (4) Mental illness or cognitive impairment that prevents cooperation with the study; (5) Tumor size > 5 cm or already metastasized; or (6) Tumor located in parts of the digestive system other than the stomach.

EFTR and surgical procedures for gastric GIST were performed by experienced specialists and met the relevant surgical quality control standards. All patients underwent necessary examinations to exclude contraindications for endoscopic or surgical treatment, discontinued anticoagulants for more than one week, and fasted for more than 6 hours preoperatively. All patients were informed about the benefits and risks of the surgery, signed an informed consent form, and were admitted for treatment. Postoperatively, patients were closely monitored for vital signs. Depending on the condition, they were fasted for 24-72 hours, and received routine treatments such as fluid supplementation, proton pump inhibitors (PPI), and antibiotics, with gastrointestinal decompression if necessary. Depending on abdominal signs, patients were started on liquid diet on postoperative day 2-4. If patients experienced no discomfort after resuming diet and had normal temperature and laboratory tests, they could be discharged. After discharge, they continued oral PPI for 1 month. Follow-up was conducted 3 months postoperatively with endoscopy, and subsequently once a year or until death, including endoscopy, abdominal ultrasound, or computed tomography scans, to monitor wound healing, local recurrence, and metastasis.

The study design adheres to the Helsinki Declaration. All relevant procedures have been approved by the Institutional Review Board and Ethics Committee of China Medical University and have completed clinical registration, with the registration number 2024PS877K.

Data collection

Baseline and pathological clinical characteristics of enrolled patients were collected from the HIS system of Shengjing Hospital, China Medical University, including gender, age, tumor location, tumor size, growth pattern, operation time, surgical method, margin status, modified National Institutes of Health (NIH) risk score, occurrence of adverse events, time to recovery of liquid diet post-surgery, and hospital stay duration. The primary outcome was progression-free survival (PFS), defined as the interval between the tumor resection date and confirmed disease progression or death. Patients were reviewed at the final follow-up date if none of the aforementioned events had occurred.

EFTR and SR

EFTR group: The patient is positioned in either the left lateral or supine position, and the surgery is performed under endotracheal intubation and general anesthesia. CO_2 is used as the insufflation gas throughout the procedure. A triangular knife is used to dissect the mucosal layer at the edge of the lesion, and an IT knife is used to perform full-

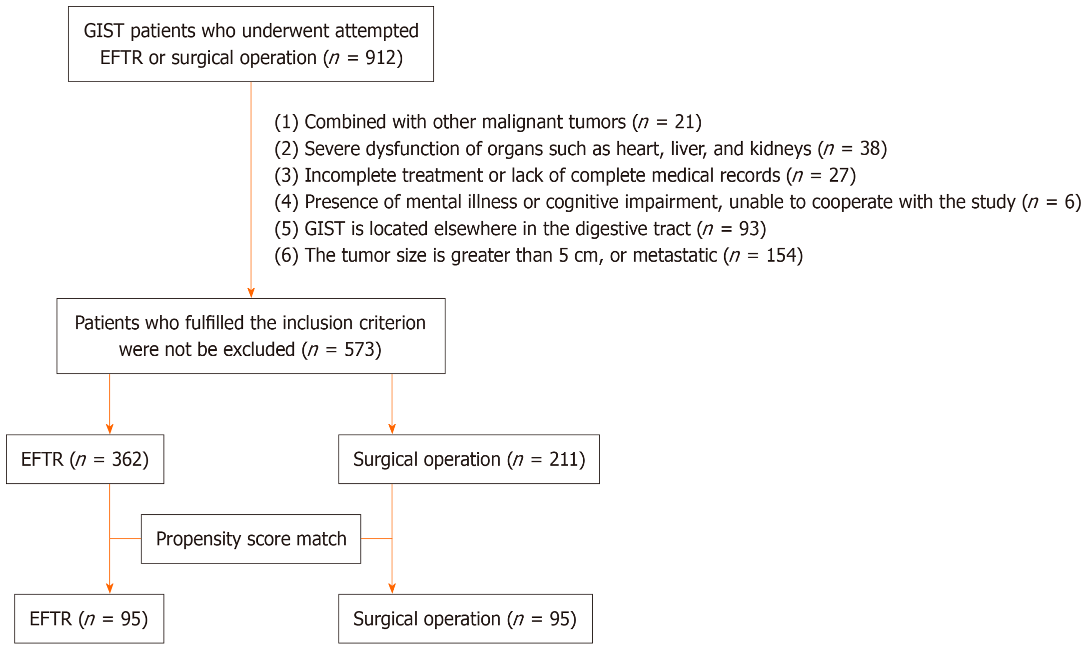

Figure 1 Flow diagram of the study. GIST: Gastrointestinal stromal tumor; EFTR: Endoscopic full-thickness resection.

thickness resection of the tumor and surrounding tissue, including the mucosa, submucosa, muscularis, and serosa. During resection, care is taken to protect the adjacent tissue of the gastric wall and the tumor capsule. Hemostasis is achieved using a thermal hemostatic clamp during the procedure. If significant pneumoperitoneum is observed intraoperatively, a puncture at the McBurney's point can be performed to release gas. The TTSC or OTSC system is used to close the wound. The resected tissue is retrieved using an endoscopic grasper and sent for pathological examination (Figure 2).

SR group: Based on tumor location and growth pattern assessed by the senior physician, an appropriate surgical method is chosen. Laparoscopic wedge resection with a linear stapler is the primary method for treating GISTs, while tumors adhering closely to surrounding tissues or vital organs and blood vessels are treated with open surgery. All EFTRs and surgical procedures are performed by qualified and experienced specialists. Postoperative pathological diagnosis for intermediate to high-risk patients, according to the modified NIH risk score, is supplemented with imatinib targeted therapy.

Statistical analysis

Data analysis and graphing were performed using SPSS 27.0 (IBM SPSS Statistics, Armonk, NY, United States: IBM Corp) and R 4.4.1 (The R Foundation for Statistical Computing, Vienna, Austria). Categorical variables were compared using Pearson's χ^2 test or Fisher's exact test. Continuous variables were compared using the Mann-Whitney *U* test. Univariate analysis of variance was used to explore factors influencing operative time. Multivariate logistic regression analysis was conducted to investigate factors affecting adverse events. All statistical tests were two-sided with a significance level of $\alpha = 0.05$; differences were considered statistically significant if $P < 0.05$. Survival analysis was performed using the Kaplan-Meier method and Log-Rank test to assess differences in survival time. The Cox proportional hazards model was used for univariate and multivariate analysis. Variables with $P < 0.1$ from univariate analysis were included in the multivariate analysis to identify independent prognostic factors. Hazard ratios (HR) and their 95%CI were calculated.

PSM

Propensity scores were calculated using logistic regression analysis. In the PSM analysis, a caliper width of 0.2 was used to match the EFTR group with the surgical group. A 1:1 PSM ratio was employed, using the nearest neighbor matching method to minimize differences in age, gender, tumor location, tumor size, modified NIH risk score, and tumor growth type. The standardized mean difference (SMD) was used to test the average distribution of baseline characteristics between groups, with an overall SMD < 0.1 indicating good balance. Figure 3 illustrates the results of the PSM.

RESULTS

Patient characteristics

After PSM, each group (EFTR and SR) included 95 patients. In the matched cohort, there were differences in sex (P = 0.124), tumor location (P < 0.001), tumor size (P < 0.001), modified NIH risk score (P < 0.001), and tumor growth type (P = 0.103). After PSM, the two groups were well balanced in all variables except age (Table 1).

Table 1 Baseline characteristics of the patients, *n* (%)

Variables	Pre-matched corhort				Matched corhort			
	EFTR, *n* = 362	SR, *n* = 211	*P* value	SMD	EFTR, *n* = 95	SR, *n* = 95	*P* value	SMD
Age (years), mean ± SD	58.98 ± 8.14	59.07 ± 10.61	0.906	0.010	59.79 ± 8.90	58.64 ± 9.13	0.328	0.127
Sex			0.124	0.140			1.000	< 0.001
Males	123 (34.0)	86 (40.8)			37 (38.9)	37 (38.9)		
Females	239 (66.0)	125 (59.2)			58 (61.1)	58 (61.1)		
Tumor location			< 0.001	0.743			0.946	0.088
Cardia	21 (5.8)	5 (2.4)			4 (4.2)	3 (3.2)		
Fundus	208 (57.5)	60 (28.4)			36 (37.9)	37 (38.9)		
Body	113 (31.2)	100 (47.4)			44 (46.3)	42 (44.2)		
Antrum	20 (5.5)	46 (21.8)			11 (11.6)	13 (13.7)		
Growth pattern			0.103	0.148			0.746	0.070
Endophytic	276 (76.2)	147 (69.7)			70 (73.7)	67 (70.5)		
Exophytic	86 (23.8)	64 (30.3)			25 (26.3)	28 (29.5)		
Tumor size (cm), mean ± SD	1.73 ± 0.84	3.08 ± 1.11	< 0.001	1.371	2.57 ± 11.1	2.62 ± 1.15	0.763	0.044
Modified NIH score			< 0.001	1.450			0.950	0.086
Very low risk	284 (78.5)	42 (19.9)			32 (33.7)	34 (35.8)		
Low risk	70 (19.3)	141 (66.8)			55 (57.9)	53 (55.8)		
Intermediate risk	5 (1.4)	18 (8.5)			5 (5.3)	4 (4.2)		
High risk	3 (0.8)	10 (4.7)			3 (3.2)	4 (4.2)		

EFTR: Endoscopic full-thickness resection; SR: Surgical resection; SMD: Standardized mean difference; NIH: National Institutes of Health.

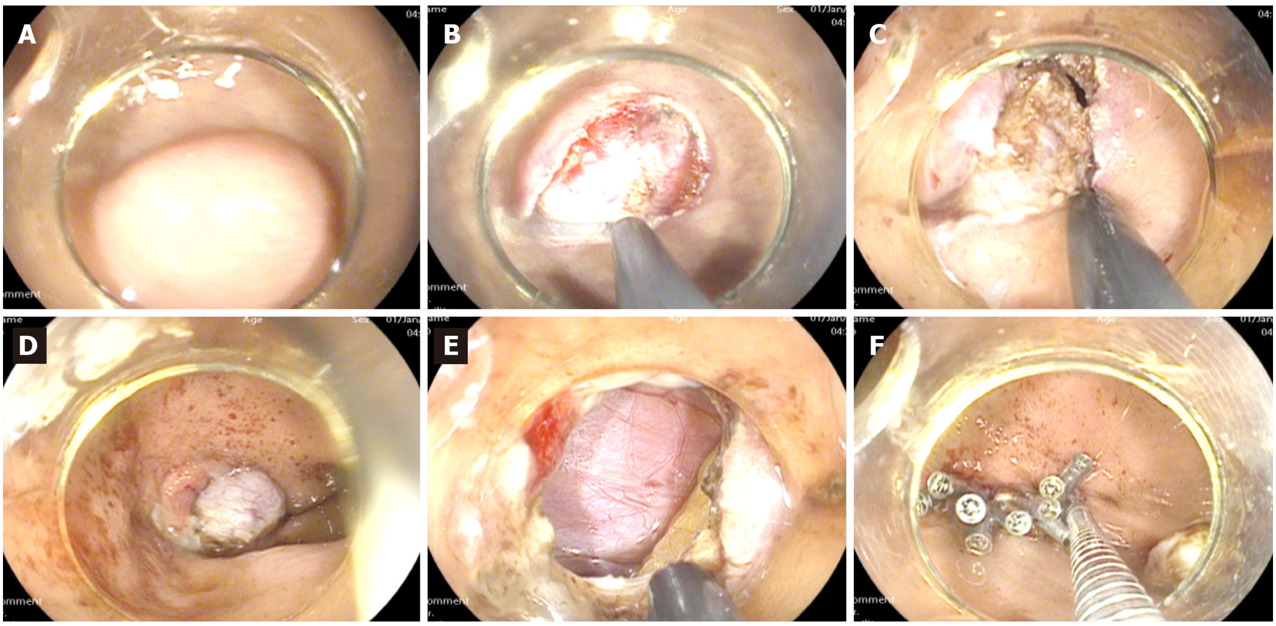

Figure 2 Intraoperative images of endoscopic full-thickness resection. A: White light observation, locating the submucosal tumor; B: Incision of the tumor's superficial mucosa; C: Layer-by-layer dissection, timely electrocoagulation for hemostasis; D: Complete exposure of the tumor; E: Tumor resection, with full-thickness gastric wall resection visible; F: Closure of the wound using a metal clip.

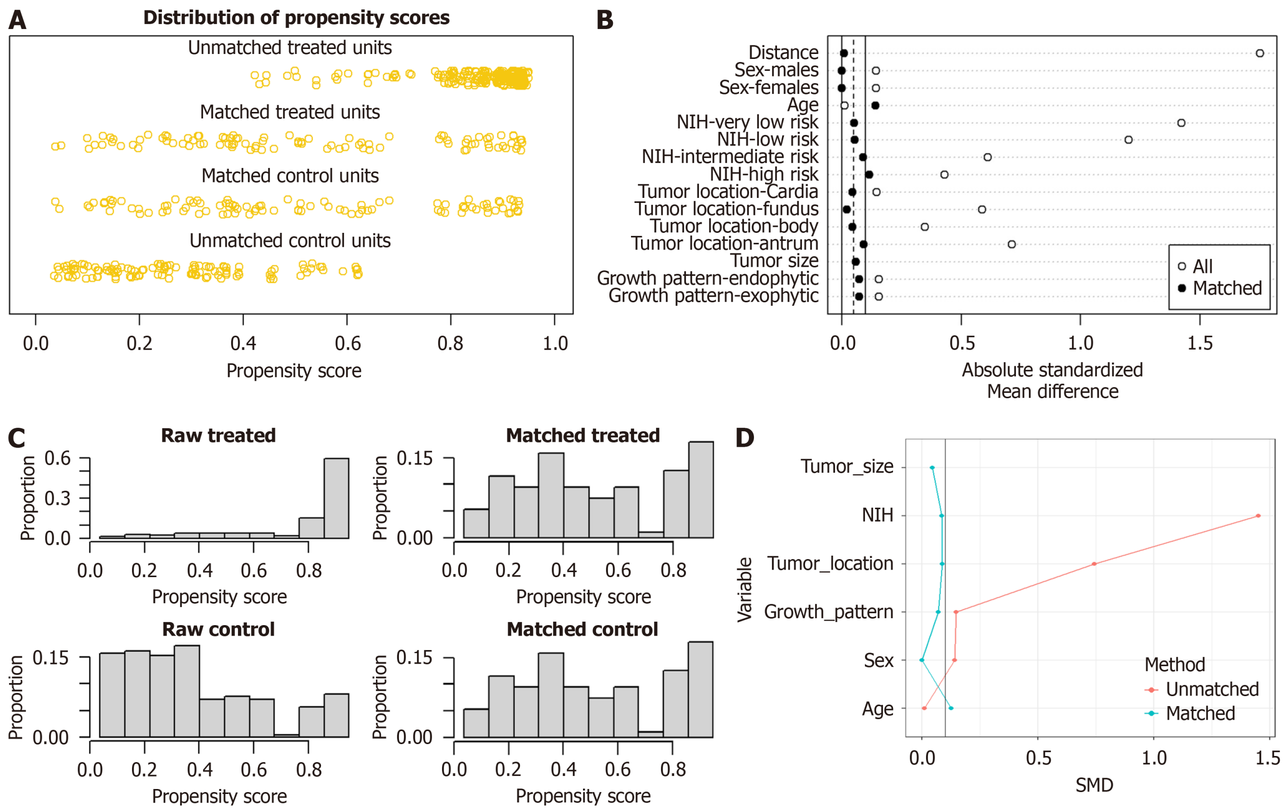

Figure 3 Data balance before and after propensity score matching. A: Jitter plot of cohort before and after propensity score matching (PSM); B: Standardized mean difference before and after PSM; C: Histogram of propensity scores; D: Line plot of individual differences before and after PSM. SMD: Standardized mean difference.

Short-term outcomes comparison

Comparing perioperative conditions (Table 2), the EFTR group had an average surgery time of 91.21 minutes, significantly shorter than the SR group's 123.11 minutes (P < 0.001). The EFTR group also returned to liquid diet in an average of 3.43 days, compared to 7.43 days for the SR group (P < 0.001). The EFTR group had an average hospital stay of 8.39 days, significantly shorter than the SR group's 16.32 days (P < 0.001). However, the SR group had a 100% *en bloc* resection rate, while the EFTR group had 93.7% (P = 0.038). Adverse event rates were significantly lower in the EFTR group (22.1% *vs* 40.0%, P = 0.031). Postoperative fever was transient and mild for both groups. Infections and peritonitis were managed effectively in both groups, with similar outcomes. The EFTR group incurred lower average hospital costs [30734.22 China yuan (CNY)] compared to the SR group (53231.56 CNY) (P < 0.05; Table 2).

Long-term prognosis

In this study, the matched cohort was followed with a median follow-up time of 2451.50 days (interquartile range: 1216.00-3464.45). The overall PSF rates at 1 year, 3 years, 5 years, and 10 years were 99.45%, 98.86%, 98.09%, and 94.01%, respectively. Prior to the last follow-up, 4 patients in the EFTR group and 3 patients in the SR group experienced tumor recurrence, with no statistically significant difference between the two groups (P = 0.37) according to Kaplan-Meier survival analysis (Figure 4).

Further analysis using the Cox proportional hazards model revealed several prognostic factors for PSF. Univariate Cox regression analysis identified age (P = 0.0621), tumor size (P = 0.0937), high-risk status in the modified NIH risk score (P = 0.0273), and resection status (P = 0.0104) as prognostic factors. Multivariate Cox regression analysis confirmed that resection status was an independent prognostic factor (P = 0.0173, HR = 0.0179, 95%CI: 0.000655-0.491; Table 3).

DISCUSSION

The latest 2020 World Health Organization guidelines classify all GISTs as malignant, regardless of size, origin, or mitotic index[25]. The most recent guidelines from the NCCN, American Society for Gastrointestinal Endoscopy (ASGE), ESMO, and the Japanese Society of Medical Oncology recommend resection for GISTs larger than 2 cm, but there is no consensus on treating GISTs 2 cm or smaller[2,14,26,27]. NCCN guidelines suggest surgical removal for high-risk GISTs, while small GISTs (≤ 2 cm) with no malignant signs should be monitored with endoscopy or imaging. European and Japanese guidelines advocate for resection of GISTs of any size. According to ASGE standards, GISTs smaller than 2 cm and asymptomatic generally do not require treatment; instead, regular endoscopic surveillance is recommended. If necessary,

Table 2 Perioperative characteristics and long-term outcomes, *n* (%)

Variables	EFTR, *n* = 95	SR, *n* = 95	*P* value
Operation time (minute), mean ± SD	91.21 ± 57.21	123.11 ± 49.03	< 0.001
Days to resume liquid diet (day), mean ± SD	3.43 ± 1.61	7.43 ± 7.44	< 0.001
Days of hospital stay (day), mean ± SD	8.39 ± 4.40	16.32 ± 8.10	< 0.001
Adverse events			0.031
Postoperative fever	5 (5.3)	13 (13.7)	
Infection	13 (13.7)	21 (22.1)	
Peritonitis	3 (3.2)	2 (2.1)	
Bleeding	0 (0.0)	2 (2.1)	
Resection status			0.038
En bloc	89 (93.7)	95 (100.0)	
Piecemeal	6 (6.3)	0 (0.0)	
Recurrence	4 (4.2)	3 (3.2)	1.000
Hospitalization expenses (CNY), mean ± SD	30734.22 ± 15741.46	53231.56 ± 24235.56	< 0.001

EFTR: Endoscopic full-thickness resection; SR: Surgical resection; CNY: China yuan; SMD: Standardized mean difference; NIH: National Institutes of Health.

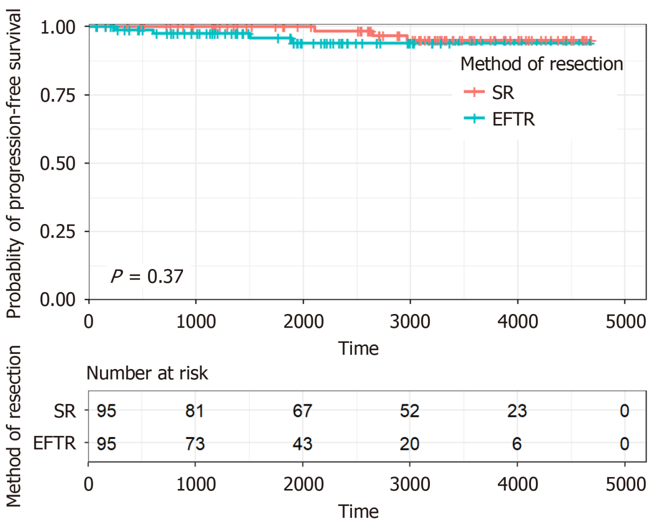

Figure 4 Kaplan-Meier survival analysis of progression-free survival. SR: Surgical resection; EFTR: Endoscopic full-thickness resection.

EUS-FNA or fine-needle biopsy can be performed for diagnosis. Based on pathological results, follow-up or surgical treatment can be chosen[9,14,28]. However, this standard has faced controversy and skepticism among many gastroenterologists in China. Given the large patient population and varying compliance in China, some patients' excessive anxiety could lead to delays in treatment, repeated endoscopic procedures, and other issues. Additionally, preoperative biopsy may increase surgical difficulty and risks such as mucosal damage, submucosal adhesion, bleeding, infection, and tumor rupture. Therefore, the 2018 consensus on GIST endoscopic diagnosis and treatment in China concludes that preoperative biopsy may not be necessary[29].

Traditional methods for GIST resection often involve open or laparoscopic surgery, which typically require large surgical sites, come with high surgical risks, longer recovery times, and higher costs[30]. With the advancement of endoscopy, endoscopic treatment offers unique advantages and is more readily accepted by patients[28]. Preoperative EUS can clarify the tumor's origin layer, size, and growth pattern, which helps in the precise selection of endoscopic treatment methods. This approach ensures the safety and effectiveness of the procedure while reducing the risk of complications[31]. Traditional endoscopic methods for GIST resection include endoscopic mucosal resection, ESD, endoscopic submucosal excavation, and EFTR[32]. EFTR can achieve complete removal of the lesion by creating a deliberate perforation, provided that the tumor remains within an intact capsule. This method offers higher resection efficiency compared to ESD[33]. The key to EFTR surgery is successfully closing the defect after resection to prevent

Table 3 Data regarding the Cox proportional hazards model

Variables	Univariate analysis		Multivariate analysis	
	HR (95%CI)	*P* value	HR (95%CI)	*P* value
Age (years)	0.921 (0.846-1.00)	0.0621	0.930 (0.848-1.02)	0.126
Sex				
Males	Reference			
Females	1.40 (0.312-6.25)	0.661		
Growth pattern				
Endophytic	Reference			
Exophytic	7.15 (1.38-36.9)	0.0189		
Tumor size (cm)	1.74 (0.910-3.33)	0.0937	2.46 (0.812-7.43)	0.112
Modified NIH score				
Very low risk	Reference		Reference	
Low risk	1.91 (0.198-18.34)	0.576	0.268 (0.00917-7.82)	0.444
Intermediate risk	7.71 (0.482-123.38)	0.149	0.463 (0.00730-29.4)	0.716
High risk	14.99 (1.35-165.33)	0.0273	1.20 (0.0239-60.2)	0.928
Resection status				
En bloc	0.0563 (0.00624-0.508)	0.0104	0.0179 (0.000655-0.491)	0.0173
Piecemeal	Reference		Reference	
Resection method				
SR	Reference			
EFTR	1.97 (0.434-8.93)	0.38		

EFTR: Endoscopic full-thickness resection; SR: Surgical resection; NIH: National Institutes of Health; HR: Hazard ratios.

peritonitis and the need for additional surgical interventions[34-36].

Shichijo *et al*[13] found through follow-up of 46 patients that EFTR is effective for treating gastric SMTs (G-SMT) ranging from 1.1 to 3.0 cm. Li *et al*[29] demonstrated through an analysis of 73 cases that endoscopic resection is safe and feasible for treating G-SMT with a diameter of less than 3 cm. In recent years, several studies have compared the efficacy of EFTR with SR for treating GISTs, but most of these studies did not perform baseline characteristic matching for the cohorts[30,37-39]. This may introduce selection bias, making endoscopic resection appear more advantageous.

In recent years, researchers have increasingly recognized that imbalances in baseline characteristics can introduce bias into study results. To mitigate this bias, a domestic study employed PSM to adjust for differences in baseline characteristics between the endoscopic and laparoscopic groups. The results indicate that, after matching, for tumors with a diameter of 2-5 cm, the endoscopic group experienced significantly higher rates of complications and longer postoperative hospital stays compared to the laparoscopic group, with these differences being statistically significant (P < 0.001)[40]. In contrast, another study utilizing PSM to compare EFTR and SR for G-SMT originating from the intrinsic muscularis propria concluded that the postoperative clinical outcomes of the two surgical approaches are comparable[41].

This study aims to compare the short-term and long-term effects of EFTR *vs* traditional SR for treating GIST after balancing patient baseline characteristics using PSM. The results indicate that the EFTR group shows significant advantages in short-term outcomes compared to the traditional surgical group, but there is little difference in long-term prognosis between the two groups. The EFTR group also demonstrates notable advantages in terms of operative time, postoperative recovery, length of hospital stay, and hospitalization costs compared to the traditional surgical group. The EFTR group had a significantly shorter operative time (91.21 minutes *vs* 123.11 minutes, P < 0.001), a notably reduced time from fasting to resuming a liquid diet (3.43 days *vs* 7.43 days, P < 0.001), and a substantially shorter hospital stay (8.39 days *vs* 16.32 days, P < 0.001). These results align with current understanding of EFTR technology, which, as a minimally invasive procedure, can reduce postoperative recovery time and hospital costs. In contrast, although traditional surgery showed a higher *en bloc* resection rate (100% *vs* 93.7%, P = 0.038), the EFTR group had a lower incidence of adverse events (22.1% *vs* 40.0%, P = 0.031), suggesting that EFTR may offer better safety and a lower complication rate.

In terms of long-term prognosis, the PFS rate was similar between the two groups (P = 0.38), and there was no significant difference in recurrence rates between the EFTR and traditional surgery groups (P = 1.0), indicating that EFTR is not inferior to traditional surgery in long-term tumor control and survival. COX regression analysis revealed that resection status is an independent prognostic factor for PFS (P = 0.0173, HR = 0.0179, 95%C: 0.000655-0.491), highlighting the importance of *en bloc* resection. Differences in resection status may be related to the surgical approach, and while EFTR may compromise resection quality, it can still offer similar long-term survival outcomes with meticulous surgical technique and postoperative management.

This study underscores the potential advantages of EFTR in reducing postoperative recovery time and hospital expenses, while demonstrating comparable long-term outcomes to traditional surgery. Although EFTR slightly lags in *en bloc* resection rates, its benefits in postoperative recovery and economic burden make it a promising treatment option.

Future research should further explore the indications for different types of GISTs to validate long-term outcomes and optimize surgical strategies. The limitations of this study include its retrospective design and sample size constraints. Although propensity matching reduced inter-group differences, large-scale prospective randomized controlled trials are needed to confirm these findings. Future studies could investigate the long-term effects and indications of EFTR, considering the impact of technological advancements on surgical outcomes. Additionally, large-scale, multicenter clinical trials will help validate these results and provide clearer guidance for clinical practice.

CONCLUSION

For GISTs ≤ 5 cm, EFTR offers significant advantages in short-term outcomes compared to traditional surgery. Resection status is an independent prognostic factor affecting PFS, highlighting the importance of *en bloc* resection. This study is a non-inferiority design. This study found no statistical difference in the primary endpoint of postoperative recurrence rates between the two groups. However, due to sample size limitations, this result requires further validation in larger-scale studies. The current results should be viewed as exploratory evidence.

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FOOTNOTES

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Country of origin: China

ORCID number: Si-Qiao Zhao 0000-0001-5439-6651; Jin-Tao Guo 0000-0001-5722-6359; Xiang Liu 0000-0001-7538-6786; Guo-Xin Wang 0000-0002-5928-3370; Sheng Wang 0000-0001-7194-9641.

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