Original Article

Current characteristics on small intestinal stromal tumor—a case control study

Lifang Zhao[1#], Zhigang Zhao[2#], Weidong Wang[1,3#], Weiwei Zhao[1], Shengjun Tuo[1], Yupeng Shi[1], Wenlong Zhang[1], Ling Chen[1], Liu Hong[1], Jianjun Yang[1], Wei Lu[1], Qiong Wu[1], Jianhong Wang[1], Kaichun Wu[1]

[1]National Clinical Research Center for Digestive Diseases and Xijing Hospital of Digestive Diseases, Air Force Military Medical University, Xi'an 710032, China; [2]Xi'an Sixth Hospital, Xi'an, 710015, China; [3]Basic Medicine College, Air Force Medical University, Xi'an 710032, China

Contributions: (I) Conception and design: L Zhao, Z Zhao, W Wang, Q Wu; (II) Administrative support: W Lu, J Wang, K Wu; (III) Provision of study materials or patients: L Chen, L Hong, J Yang; (IV) Collection and assembly of data: W Zhao, S Tuo, Y Shi, W Zhang; (V) Data analysis and interpretation: L Zhao, Z Zhao, W Wang, Q Wu; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

[#]These authors contributed equally to this work.

Correspondence to: Wei Lu; Qiong Wu; Jianhong Wang. National Clinical Research Center for Digestive Diseases and Xijing Hospital of Digestive Diseases, Air Force Medical University, Xi'an 710032, China. Emails: 13991168597@163.com; Fengling00909@163.com; wangjianhong@medmail.com.cn.

Background: Gastrointestinal stromal tumor (GIST) is the most common mesenchymal tumor in the gastrointestinal tract. Small intestine is the second most popular location of GIST, named small intestinal stromal tumor (SIST). The cumulative incidence of malignancy of SIST is twice that of gastric GIST. However, research studies on SIST are relatively rare.

Methods: The present retrospective study included 75 patients with SIST who underwent surgery resection and postoperative pathological diagnosis and analyzed the clinical manifestations, histopathological and immunohistochemical features, advantages and disadvantages of various auxiliary examinations, the treatment and prognosis of SIST.

Results: The number of Patients who had gastrointestinal bleeding was significantly higher than patients who had abdominal mass. Cases in the jejunum was significantly more than that in duodenum and ileum groups. With the increase of tumor diameter, the invasion risk also gradually increased. Patients with adverse outcome had bigger tumor diameter than patients with favorable outcome. For patients with adverse outcome, the nuclear division >5/50 HPF constitution is significantly higher than patients with favorable outcome. When categorized into 3 cell types according to cell morphology, the spindle-epithelioid cell type appeared only in patients with adverse outcome. Cox regression analysis indicated that tumor diameter 5.3 cm or higher and nuclear division > 5/50 can be independent risk factors for predicting SIST postoperative adverse outcome.

Conclusions: The present study analyzed the clinical statistics of SIST patients and improved the understanding of this disease and provided valid statistics for clinical diagnosis and treatment.

Keywords: Small intestine stroma tumor (SIST); Gastrointestinal stromal tumor (GIST); CD117, DOG1

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Introduction

Gastrointestinal stromal tumor (GIST) is the most common mesenchymal tumor in the gastrointestinal tract. GIST was firstly put forward by Mazur and Clark in 1983 (1), it accounts for less than 1% of the tumors in gastrointestinal tract. GIST can occur in any part of the gastrointestinal tract and the abdomen, stomach is the most common place (60%), followed by small intestine (30%), colorectal (10%), esophageal (0-6%),

Table 1 Association between tumor size and invasion risk of SIST under small intestine DSCT (n=71)

Tumor diameter	Extremely low risk	Low risk	Medium risk	High risk	Total	P
<5 cm	3	24	2	5	34	<0.001
≥5 cm	0	3	9	25	37	
In total	3	27	11	30	71	

DSCT, dual-source CT.

rarely in omentum and retroperitoneal (2).

Small intestine is the second most popular location of GIST, which is named small intestinal stromal tumor (SIST). The cumulative incidence of malignancy of SIST is twice that of gastric GIST (2). The most common clinical manifestations of SIST are gastrointestinal bleeding, intestinal obstruction, perforation or change in defecation habit. Because the small intestine is up to 5-6 meters in length, overlapped with each other, and the location anatomy is not fixed with large mobility, SIST is easy to be missed diagnosed in clinical work. Nowadays with the development of multislice CT, endoscopic technology and development of molecular biology, the diagnosis and treatment of SIST have been obviously improved. The main treatment of SIST is surgical resection, and the molecular targeted drugs such as imatinib and sunitinib also have made remarkable curative effect on SIST patients. However, research studies on SIST are relatively rare, the present study aims to analyze the clinical manifestations, histopathological and immunohistochemical features, advantages and disadvantages of various auxiliary examination, the treatment and prognosis of SIST, in order to improve our understanding of this disease and provide valid statistics for clinical diagnosis and treatment.

Methods

This retrospective study included 75 patients with SIST who underwent surgery resection and postoperative pathological diagnosis from January 2012 to December 2017 in Xijing hospital. The characteristics of the patients, such as incidence age, gender, clinical manifestation, incidence location, tumor size, the gastrointestinal endoscopic results, image results, operation data and postoperative pathological data were collected and analyzed.

The inclusion criteria were (I) patients' age should be above 18 years old; (II) patients should have undergone surgical treatment (including open and laparoscopic surgery); (III) patients should be diagnosed as SIST by pathological and immunohistochemical methods or genetic mutation detection (Observation of spindle cells under the microscope, Immunohistochemical analysis of CD117 positive cells or KIT/PDGFRA gene mutation detection confirmed by senior pathologist); (IV) data of cases were accessed completely; (V) patients should not underwent treatment such as chemotherapy, radiotherapy and imatinib therapy. The exclusion criteria were (I) pregnant and lactating women were excluded; (II) patients diagnosed as GIST and other malignant tumor patients should be excluded; (III) patients with serious diseases, which may interfere with the evaluation of this study were excluded; (IV) during the study period, 8 patients were excluded: 2 patients were excluded due to cardiovascular diseases, 2 cases were excluded because they were unable to be contacted due to the far distance, 3 cases were excluded because they were unable to bear the follow-up examination and treatment due to the economy, 1 patient with asthma was excluded because he cannot tolerate the post-examination and treatment. Another 4 patients were excluded because they were unable to be contacted due to the far distance or they changed their telephone numbers. In total, 12 patients were excluded at the end of the study.

The diagnostic standards of SIST

Pathological standard

In this study, the pathologic specimens were all from operation excision, diagnosis was made not only by pathologic specimens, but also imaging results and endoscopic results. Pathological diagnostic standards were referenced to the 2013 edition Chinese expert committee consensus on GIST.

Biological evaluation standard

The present study showed that there was no absolute benign tumor in GIST. In 2008, Joensuu (3) revised the principle for the risk classification of postoperative primary GIST according to the health risk classification system of the United States national institutes of health (NIH).

Definition of the outcome of patients

According to previous studies, patients' outcomes were divided into favorable outcome and adverse outcome. Favorable outcome was defined as the patients had no

Table 2 Single factor analysis for adverse outcome of SIST patients

Indicators	Favorable outcome (n=45)	Adverse outcome (n=18)	P
Gender (male, %)	28 (62.2)	12 (66.7)	0.687
Age (years)	53.2±12.0	51.9±9.7	0.680
GI bleeding (%)	28 (62.2)	12 (66.7)	0.687
Shock (%)	6 (13.3)	3 (16.7)	0.633
Incidence site			0.399
Duodenum	6 (13.3)	2 (11.1)	
Jejunum	26 (57.8)	8 (44.4)	
Ileum	13 (28.9)	8 (44.4)	
Tumor diameter (cm)	4.3 (3.0, 6.8)	6.0 (4.0, 8.5)	0.031
Hb (g/L)	102.3±28.9	110.6±36.1	0.320
CA199 (%)	5 (11.1)	0 (0.0)	0.229
AFP (%)	1 (2.2)	0 (0.0)	0.560
CA125 (%)	5 (11.1)	1 (5.6)	0.732
Cell morphology			0.009
Spindle type	36 (80.0)	15 (83.3)	
Spindle-epithelioid type	0 (0.0)	2 (11.1)	
Tumor bleeding (%)	7 (15.6)	3 (16.7)	0.929
CD34 (%)	17 (37.8)	5 (27.8)	0.490
Ki67 Index	5.0 (3.0, 6.0)	5.0 (2.5, 10.0)	0.513
Nuclear division number (>5/50, %)	21 (46.7)	15 (83.3)	0.007
lymph node hyperplasia (%)	7 (15.6)	3 (16.7)	0.878
Regularly take medicine post-operatively (%)	12 (26.7)	2 (11.1)	0.180

SIST, small intestinal stromal tumor.

recurrence, metastasis and death within 5 years after operation. While adverse outcome means the patients had recurrence, metastasis and death within 5 years after operation (3-5).

Statistical analysis

All statistical analyses were conducted using SPSS software (version 22.0, Chicago, Illinois, USA). A Chi-square or Fisher's test was used for categorical variables. Continuous variables were compared with Student's t test. If the test of homogeneity of variances between the groups was significant, the Mann-Whitney U test was adopted as appropriate. ROC curves were used to assess the feasibility of using the maximum diameter of the tumor as a predictive tool for patient prognosis. Youden index was used for the evaluation of the optimal cut-off point. The independent predictors for the patient prognosis were calculated using the Cox regression model. Two-tailed P values <0.05 were considered to be statistically significant.

Results

General statistics

There was no statistical difference in gender distribution, age, onset time, main symptoms, biochemical index, operation modes, operation time, intraoperative bleeding, blood transfusion and in hospital time (P>0.05), as shown in (*Tables S1-S3*).

Clinical symptoms

In the present study, 19 cases had abdominal mass, a total of 46 cases had gastrointestinal bleeding, 30 cases had black stool, 2 cases had hematemesis with black stool, 14 cases had dark red stool and among which 10 patients had hemorrhagic shock. The number of patients who had gastrointestinal bleeding was significantly higher than patients who had abdominal mass (P<0.05) (*Table S4*).

The primary incidence site

Eight of 75 patients (10.7%) had SIST in the duodenum, 43 patients (57.3%) in the jejunum and 24 patients (32.0%) in the ileum. Cases in the jejunum were significantly more than that in the other groups (P<0.001) (*Table S5*).

Imaging and gastrointestinal endoscopy examination

Seventy-three of 75 (97.3%) patients underwent ultrasound examination, with the positive rate 30.1% (22/73). 60 of 75 (80.0%) patients underwent gastrointestinal endoscopy, with the positive rate 23.3% (14/60). Representative figures of SIST under the detection of ultrasound or enteroscopy were shown in *Figures 1,S1*.

Preoperatively 71 patients underwent small intestine dual-source CT (DSCT) check, with the positive rate 87.3% (62/71). 42 patients (59.2%) had jejunum stromal

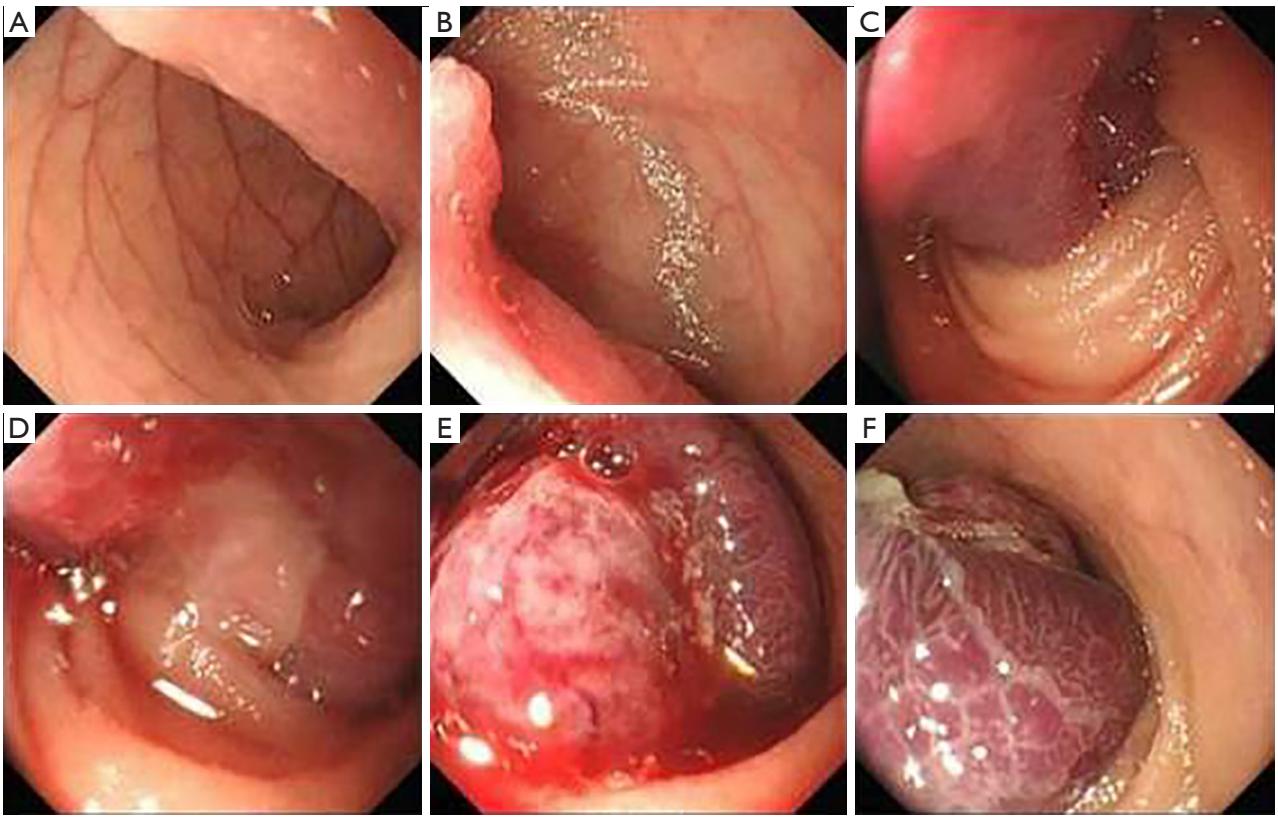

Figure 1 Malignant ileum stromal tumor under enteroscopy. A huge ellipsoidal mucosal bulge can be seen 60 cm to the ileocecal valve, with congestion surface and multiple round or strip-shaped mucosal sag. white moss can be seen underlying the lesion, no active bleeding.

tumor, 22 patients (31.0%) had ileum stromal tumor, 7 patients (9.9%) had duodenal stromal tumor, with the minimum one 0.9 cm in diameter, the maximum one 20 cm in diameter. 38 cases had tumor <5 cm in diameter, 33 cases had tumor 5 cm or more in diameter and with high degree of malignancy. Representative figures of jejunum stromal tumor under DSCT are shown in *Figure 2*.

Tumor sizes were measured using the longest diameter of the mass under DSCT. The results are shown in *Table 1*. Interestingly, from the results of this study, we can conclude that with the increase of tumor diameter, the invasion risk also gradually increased (P<0.001).

Histological and immunohistochemical results

Morphologically, 73 of 75 cases were spindle cell type, representative figures were shown in *Figure S2A*, 2 cases were spindle-epithelial cell type. All of the 75 cases were tyrosine receptor CD117 positive, representative figures were shown in *Figure S2B*, 74 of 75 cases were DOG-1 positive, 47 of 75 cases were hematopoietic stem cell antigen CD34 positive.

Surgical statistics

All of the 75 cases underwent surgery, 63 cases (84.0%) had elective surgery, 12 cases (16.0%) had emergency surgery, 8 cases (10.7%) had laparoscopic surgery. 18 cases grew intra cavitary, 37 cases grew extra cavitary (*Figure S3*), 19 cases grew intra and extra cavitary. Compared to the patients who had elective surgery, patients who underwent emergency surgery mainly manifested shock and gastrointestinal bleeding as shown in *Table S6* (P<0.05).

Single factor analysis of the related risk factors for adverse outcome

Of the 63 cases who were postoperatively followed-up, patients were divided into two groups: favorable outcome group (postoperatively no recurrence, metastasis or

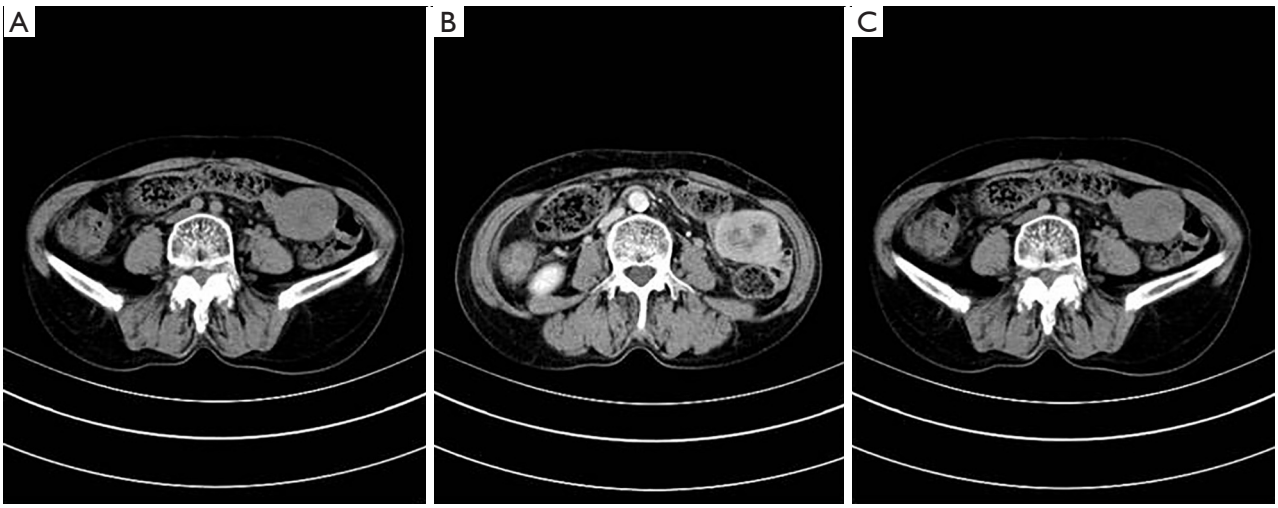

Figure 2 SIST under dual-source CT. (A) Non-contrast CT scan showing a soft tissue mass in the left lower abdomen small intestine, and is closely related to the small intestine in the corresponding area. The boundary of the mass is clear, the density is uneven, and the low-density necrotic area can be seen inside the mass; (B) under arterial phase. the mass is unevenly enhanced, no obvious enhancement was observed in the necrotic area; (C) under venous phase, the solid part of the mass continued to be enhanced, and the necrotic area remained unenhanced. SIST, small intestinal stromal tumor.

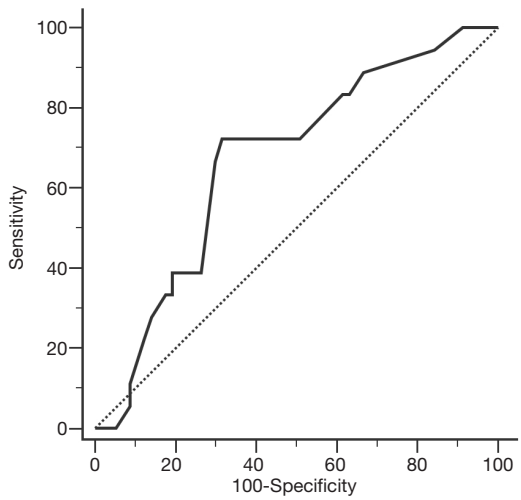

Figure 3 ROC analysis for tumor diameter prediction of postoperative adverse outcome.

death), and adverse outcome group (postoperatively with recurrence, metastasis or death). Patients with adverse outcome had bigger tumor diameter than patients with favorable outcome (P<0.05). For patients with adverse outcome, the nuclear division > 5/50 HPF constitution is significantly higher than patients with favorable outcome (P<0.05). Interestingly, when categorized into 3 cell types according to cell morphology, the spindle-epithelioid cell type appeared only in patients with adverse outcome (P<0.05) (*Table 2*).

ROC analysis for tumor diameter prediction of postoperative adverse outcome

From the present study, tumor diameter 5.3 cm or higher can predict the postoperative adverse outcome of SIST patients, with the sensitivity 72.2%, specificity 68.4%, and the area under the curve was 0.669 (P=0.032) (*Figure 3*).

Multi-variate analysis of SIST related risk factors for postoperative adverse outcome

Cox regression analysis indicated that tumor diameter 5.3 cm or higher and nuclear division >5/50 can be independent risk factors for predicting SIST postoperative adverse outcome (*Table 3*).

Discussion

GIST usually originates from gastrointestinal mesenchymal tissues and is relatively rare compared to other types of GI tumors. The main symptoms of GIST include nausea, vomiting, abdominal discomfort, abdominal pain, abdominal mass, black stool and anemia. GIST can occur

Table 3 Cox regression analysis of SIST related risk factors for postoperative adverse outcome

Indicators	ß value	SE	Wald value	df	P value	HR value	95% CI
Nuclear division	0.219	0.513	0.179	1	0.047	1.379	1.117–3.459
Maximum tumor diameter	0.178	0.218	0.102	1	0.043	1.118	1.016–4.291

SIST, small intestinal stromal tumor.

in any part of the gastrointestinal tract, mostly in the stomach (50–70%) and the small intestine (35%) (6). It was reported that in recent years, SIST, as a part of GIST, has become more common, and has more aggressive biological behaviors. In addition, the prognosis of SIST is worse than stomach GIST, and the recurrence rate of SIST is higher than GIST in other parts of the gastrointestinal tract (7,8). SIST are always concealed lesions, lack of characteristic clinical manifestations, and without any symptoms in the early stages. Thus, the early diagnosis of SIST is difficult and the prognosis is different. Because examination methods of the small intestine such as CT, capsule endoscopy and enteroscopy are rarely used as routine examination methods, the early detection rate of SIST is lower than GIST, and SIST is easier to cause missed diagnosis and misdiagnosis.

SIST mainly occurs in the elderly population and is rare in people under the age of 35, however, the younger the patients, the higher possibility that the lesion is malignant. Most of the published literature did not show clear preference of the gender (9,10), some studies showed that male patients were more than female (10,11). In the present study, we also found there were more male patients than female patients, however, there was no statistical difference between the two groups. The average onset age was 54. Other studies have reported the average onset age was 50 to 55 years old, which was similar to the results of this study (12). The incidence sites were mainly in the jejunum (43 cases 58.1%), followed by the ileum (24 cases 32.45%) and duodenal (8 cases 10.8%), which was consistent with the previously studies (9).

There are some differences between SIST and gastric stromal tumor (GIST) (13-20):

(I) The incidence rate of SIST is lower. Patients are more likely to be misdiagnosed than GIST, because patients lack the typical symptoms and signs at the early stage;

(II) GIST can be easily diagnosed by gastroscopy, the following biopsy and pathological examination. While the diagnosis of SIST is limited because double balloon enteroscopy is not quite popular and the examination process is cumbersome;

(III) GIST patients rarely have lymph node metastasis compared with SIST patients. There are about 10~15% SIST patients might have lymph node metastasis;

(IV) The malignant degree of GIST is lower than that of SIST, which are easier to relapse and metastasize after operation;

(V) The incidence rate of GIST accounts for 40-60% of the digestive tract, which is significantly higher than that of SIST (about 30% to 35%).

SIST lesions are usually conceal, and lack of specified clinical manifestations and early symptoms. Studies have reported the SIST patients often manifested as gastrointestinal bleeding, intestinal obstruction, and intestinal perforation (9). Zang *et al.* (21) used laparoscopic surgery for the treatment of patients with small intestinal bleeding, and found stroma tumor was the most common reason for intestinal bleeding (62.3%). However, patients can be asymptomatic, especially in cases with smaller tumor size (8,22). The lack of specific clinical manifestations and the small intestine location makes SIST relatively difficult to diagnose. It was reported by other studies that abdominal pain (35.5%) was the most common symptom of SIST, and uncontrolled hemorrhagic shock (6.4%) was less common (23). However, the present study showed that gastrointestinal bleeding was the most severe and common symptom, with the lowest hemoglobin 35 g/L and 10 cases (13.3%) had uncontrolled hemorrhagic shock. Miettinen *et al.* (13) described the clinical manifestations of 622 patients, and found 256 cases (42%) had gastrointestinal bleeding, which was the main symptom and also consistent with the present study. According to this study, it is vital to timely and accurately diagnose where the bleeding source is, because this kind of hemorrhage can be urgent and lead to death. The gastrointestinal bleeding of SIST usually manifested as repeated, intermittent hematochezia and black stool. The reason for gastrointestinal bleeding might be various, one reason is the blood supply of stromal tumor is rich, and the mucosa easily form ulcer and underwent

concurrent hemorrhage (2). Another reason might be the stroma tumor had less stromal collagen, and the vascular wall was thin, which can easily cause bleeding (24).

The present study used imaging and endoscopic checks such as abdominal ultrasound, gastroscopy, colonoscopy, capsule endoscopy, enteroscopy and small intestine DSCT and found the small intestine DSCT detection had the highest detection rate (87.3%). CT scan was reported to be the primary choice for the diagnosis of GIST (25,26). Under CT detection, SIST characterizes as bigger than 10 cm in diameter, calcification, irregular edge, unevenly strengthening, lobulated, ulcers and local lymph node enlargement or even metastasis (7). Most GISTs manifest as >5 cm extra cavitary lesions, with good demarcation, lobulation, necrosis or center hemorrhage, but no calcification (27,28). CT examination can clearly see SIST location, size, shape and density, as well as the relationship of the lesion with the surrounding tissues, such as extrusion, adhesion and invasion. CT also can show what is inside the mass such as cyst, hemorrhage and necrosis. It was reported that Multi-Detector-Row Computed Tomography (MDCT) with small bowel imaging can find lesions earlier than ordinary enhanced CT.

The final diagnosis of SIST relies on the pathological examination. Pathological and immunohistochemical staining showed that the origin of GIST was from c-kit gene mutation on chromosome 11, which leads to its coding protein CD117 over-expressed at a cellular level, therefore, CD117 was regarded as the most characteristic marker of GIST, with the common positive rate 85–100% (29,30). In the present study, all the patients were CD117 positive, which was similar to previous reports. CD34 was one of bone marrow hematopoietic progenitor cell markers, the expression rate of CD34 in GIST was about 60%. Most spindle cell type GIST (especially in the stomach) expresses CD34, but in the small intestine, its expression can be negative in SIST. However, the present study showed 7 of 75 cases were CD34 positive, which was consistent with previous reports that CD34 can be positive in part of small intestine SIST (24). In recent years, the diagnostic value of DOG1 in GIST has been gradually improved, DOG1 is a kind of monoclonal antibody which blocks GIST expression. DOG1 does not only exist in GIST, it also can be positive in uterus, retroperitoneal leiomyoma and leiomyosarcoma. Some studies showed DOG1 might have a potential prognostic impact for GIST (31,32), the present study showed that 74 of 75 cases were DOG-1 positive.

It was agreed by previous reports that surgical resection was the main method for SIST therapy, the final target was RO resection (there was no tumor cells at the edge of the cutting lesions). The tumors themselves were soft and fragile, and easy to be ruptured, thus it is vital to completely cut the lesions in order to avoid abdominal spread (33). Although incidence of SIST ranked the second in GI stroma tumors, the incidence site makes the stroma tumor much more malignant than other parts of the GI tract. Thus, for tumors greater than 5 cm in diameter, surgeons should cut the edge for up to 10 cm. For tumors less than 5 cm in diameter, if the coating is complete without bleeding necrosis, surgeons can appropriately reduce the cut edge distance. According to previous reports, after complete surgical removal, the five-year survival rate of SIST was about 48 to 65% (6). Tabrizian *et al.* (34) analyzed 26 cases, the median follow-up time was 56.4 months (range, 0.1 to 162.4 months), the 10-year overall survival rate and DFS rate were 91.3% and 71.6% respectively. Some reports also have considered laparoscopic resection as a safe and useful method instead of open resection (35,36). It was reported laparoscopic surgery was suitable for patients with tumor diameter less than 5 cm. For lesions located at jejunum and ileum, laparoscopic surgery could be a better choice to find the lesions (12,15).

Miettinen *et al.* (13) have reported that 60% patients with tumor diameter greater than 5 cm had poorer prognosis. H.Y also reported that prognostic factors of GIST include incidence site, onset age, tissue morphology, molecular genetics, immunohistochemical staining and tumor size, and tumor size was the most important risk factor for prognosis (37). In the present study, single factor analysis showed tumor diameters in adverse outcome patients were significantly higher than that in favorable outcome patients.

The incidence site of GIST now was also regarded as a prognostic factor in some studies. In the risk stratification of GIST, incidence site was a moderately important factor for assessment (3). However, in this study, we also did not see statistical difference on the risk classification in different parts of the gastrointestinal tract.

Although the main treatment of SIST is operation, it was reported that more than half of the patients had postoperative tumor recurrence and metastasis. GIST is not sensitive to traditional chemotherapy and radiotherapy, however, with the development of targeted therapy (tyrosine kinase inhibitor), treatment for GIST has been changing. IM is an inhibitor for tyrosine kinase receptors, it can selectively act on the c-kit tyrosine kinase receptor of GIST cells, so as to prevent the development of tumor. Yeh

et al. (38) compared 22 moderate to high risk GIST patients who took IM 400 mg/day with 33 patients who did not take IM, and found the patients who took IM had significantly more overall survival time. In the present study, 14 patients used IM postoperatively, among which 2 patients had recurrence. One patient stopped IM after 2 months because of economic reason, and had metastasis to the liver after 8 months. After radiofrequency ablation treatment, this patient continued to take IM and the tumor disappeared after 6 months. The rest of the 49 cases did not take IM, 16 cases had postoperative adverse outcome, and all of them were moderate to high risk patients. The results of the present study showed that moderate to high risk patients who did not take IM had obviously more chances to have adverse outcome. During taking IM, doctors should pay attention to the monitoring of adverse drug reactions, and help patients to get a sustained, systemic treatment.

Studies showed GIST often recurrence within 1 year after surgery, or sometimes 10 years after surgery (39). Therefore, for SIST patients, doctors should pay attention to a long-term following-up after surgery.

The results of this research were mainly from the retrospective study, which had certain limitations: (I) a small number of patients; (II) all of the patients had different clinical manifestations such as gastrointestinal bleeding, abdominal mass, abdominal pain and discomfort such as anemia, there was no asymptomatic patients; (III) there was only 1 patient with tumor diameter less than 1 cm, which was not helpful for the study of small tumors (tumor diameter <1 cm).

Conclusions

SIST can happen at any age (mostly middle aged or older) and any part of the small intestine (mostly jejunum), according to tumor size and tumor location, SIST can appear a series of clinical manifestations (most common one gastrointestinal bleeding). With the development of various imaging techniques, the detection rate of SIST has been increased, small intestinal DSCT has the highest value in SIST detection and diagnosis, it can preliminarily identify malignant tumors from benign ones. However, the final diagnosis of SIST relies on pathological morphology and immunohistochemical staining, a higher expression of CD117 and DOG-1 can be sensitive markers for SIST or GIST. Tumor diameter 5.3 cm or higher and nuclear division number >5/50 can be independent risk factors to predict postoperative adverse outcome for SIST patients.

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Footnote

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

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. All patients gave informed consent to use their clinical data for research purposes. The hospital's Protection of Human Subjects Committee approved the protocols used in this study, and the committee's reference number is No. XJYYLL-2015270.

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Supplementary

Table S1 SIST gender distribution among groups

Gender	Duodenum	Jejunum	Ileum	χ^2	p
Male	6	26	15	0.610	0.737
Female	2	17	9		

SIST, small intestinal stromal tumor.

Table S2 The onset age of SIST patients among groups

Age (year)	Duodenum	Jejunum	Ileum	χ^2	P
≤40	0 (0.00)	6 (66.67)	3 (33.33)	0.633	0.729
41–60	7 (14.89)	27 (57.45)	13 (27.66)		
≥61	1 (5.26)	10 (52.63)	8 (42.11)		

SIST, small intestinal stromal tumor.

Table S3 General statistics of SIST between male and female

Index	Male (n=47)	Female (n=28)	P
Age	53.0±11.8	52.7±11.0	0.930
Onset time (year)	0.5 (0.1, 4.8)	0.5 (0.1, 4.0)	0.948
Main symptoms (%)			
Abdominal mass	15 (31.9)	4 (14.3)	0.111
Gastrointestinal bleeding	26 (55.3)	20 (71.4)	0.228
Shock	6 (12.8)	4 (14.3)	0.852
BUN (mmol/L)	5.5±1.8	6.9±5.2	0.104
TB (mmol/)	65.1±8.5	63.5±15.1	0.565
AB (mmol/L)	38.0±8.4	35.4±11.3	0.274
HB (g)	104.5±34.1	100.2±30.1	0.584
RBC ($\times10^{12}$)	3.8±0.9	3.6±0.9	0.309
Incidence site			
Duodenum	6 (12.8)	2 (7.1)	0.737
Jejunum	26 (55.3)	17 (60.7)	
Ileum	15 (31.9)	9 (32.1)	
Operation modes	39 (83.0)	24 (85.7)	0.755
Operation time (min)	102.5 (71.3, 136.3)	105.0 (82.5, 137.5)	0.810
Intraoperative bleeding (mL)	50 (50, 100)	50 (50, 100)	0.874
Blood transfusion (%)	16 (34.0)	11 (39.3)	0.647
In hospital time (d)	9.0±3.5	8.9±3.4	0.931

SIST, small intestinal stromal tumor.

Table S4 Clinical manifestation in SIST patients

Clinical manifestation	Number of cases	%	χ^2	P
Abdominal mass	19	25.3	42.12	<0.0001
Gastrointestinal bleeding	46	61.3		
Other	10	13.3		

Table S5 The primary incidence site distribution of SIST

Incidence site	Number of cases	%	Z value	P
Duodenum	8	10.7	14.059	<0.001
Jejunum	43	57.3		
Ileum	24	32.0		

SIST, small intestinal stromal tumor.

Table S6 Comparison of indicators related to emergency surgery and elective surgery

Indicators	Elective surgery (n=63)	Emergency surgery (n=12)	P
Gender (male, %)	39 (61.9)	8 (66.7)	0.755
Age (years)	52.5±11.5	54.8±11.7	0.538
GI bleeding (%)	35 (55.6)	12 (100.0)	0.004
Shock (%)	5 (7.9)	5 (41.7)	0.002
Incidence site			0.737
Duodenum	6 (9.5)	2 (16.7)	
Jejunum	37 (58.7)	6 (50.0)	
Ileum	20 (31.7)	4 (33.3)	
Tumor diameter (cm)	5.0 (2.5, 7.1)	3.7 (2.7, 6.5)	0.267

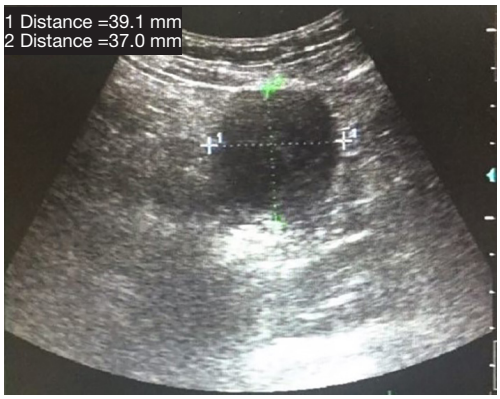

Figure S1 SIST under the detection of abdominal ultrasound. Abdominal ultrasound showing 3.9×3.7 cm^3 low echo at the left abdominal area, considering SIST. SIST, small intestinal stromal tumor.

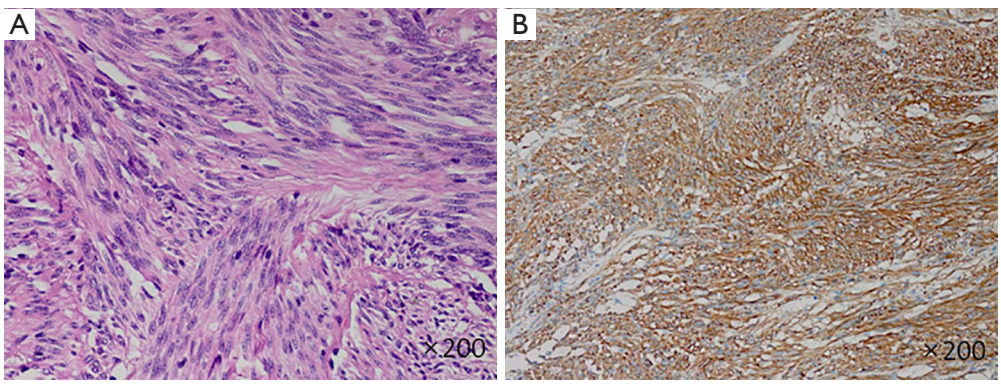

Figure S2 Spindle cell type and CD117 staining. (A) HE staining showing spindle cell type: tumor cells were in spindle-form, arranged in bundle shape; (B) immunohistochemical staining showing CD117 positive staining in the cytoplasm.

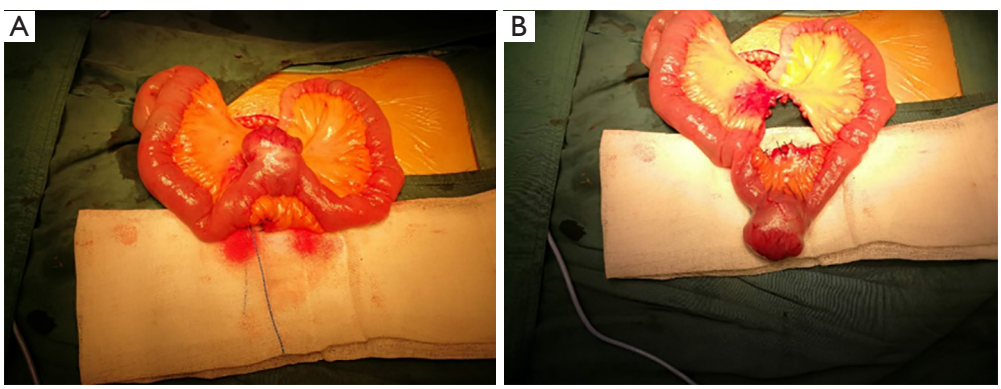

Figure S3 Exogenous mass after operation. During the operation, an exogenous mass of 4.5×5.5 cm^2 was seen in the jejunum at a distance of 150 cm from the ligament of the flexor, and the blood was rich.