Gastrointestinal Stromal Tumor: Computed Tomographic Features

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Objective: *To describe anatomical distribution and CT findings of gastrointestinal stromal tumors in Srinagarind Hospital.*
Material and Method: *The abdominal CT images of 16 patients (12 men, 4 women: mean age 49 ± 17SD) with pathologically proven GISTs during 1998-2005 were retrospectively reviewed. The tumor sites, sizes, borders, growth patterns, patterns of enhancement, and sign of malignancy were evaluated. The findings of benign and malignant GISTs were compared.*
Results: *Among sixteen patients, the most common location of GISTs was stomach (56.25%). The others were small bowel (43.75%), and tumor size larger than 5 cm. The present study found that the smooth and mixed smooth and irregular surface lesions are equal in number (50%). The growth was extraluminal in 56.25%. Almost all tumors had inhomogeneous density (n = 15). Intratumoral gas (43.75%), fluid (37.5%), and calcification (50.00%), were present in the tumors. All cases showed inhomogeneous contrast enhancement. The CT signs of malignancy found were invasion of the adjacent organ(s) (62.5%), lymphadenopathy (25%), liver metastasis/nodule (18.75%), ascites (6.25%), perilesional fat plane stranding (93.75%), and pleural effusion (6.25%).*
Conclusion: *The most common site of GISTs is the stomach. The typical tumors appear as inhomogeneous enhancing inhomogeneous extraluminal mass with either well-defined or irregular border. The CT findings cannot be used as a single tool for differentiating the benign from malignant GISTs.*

Keywords: *Gastrointestinal stromal tumors, Tomography, X-ray computed*

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Gastrointestinal stromal tumors (GISTs) are the rare type of tumors, but the most common mesenchymal neoplasms of the GI tract. The term "gastrointestinal stromal tumors" does not encompass leiomyomas and leiomyosarcomas[1]. Until 1983, when electronmicroscopy and immunohistochemistry findings demonstrated a lack of smooth muscle and Schwann cells. The c-kit protooncogene protein product CD117 was found by immunohistochemistry in GIST. Moreover, the recent availability of the KIT tyrosine kinase inhibitor has revolutionized the treatment of malignant GISTs[2]. GISTs can originate anywhere along the GI tract or beyond. They usually occur between the muscularis propia and muscularis mucosa. The clinical manifestations of GISTs are highly variable[3]. Approximately 60-70% of GISTs are found in the stomach, and 20%-30% arise in the small intestine. The less common sites are the rectum, colon, esophagus, mesentery, or omentum[4]. CT and endoscopy of the upper GI tract are the minimally invasive means for the diagnosis of asymptomatic GISTs[5]. Enteroclysis may depict intraluminal tumor growth. However, the barium study has a disadvantage. It lacks the ability to detect extraluminal tumor growth,

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in contrast to US, CT, and MRI. Furthermore, CT may offer clues for dignity of these lesions by demonstrating organ or peritoneal metastases, assessment of tumor size, tumor extension, and its relationship to the intestinal wall and adjacent visceral organs. The precise CT finding of GISTs is helpful for the clinicians to provide optimal treatment of their patients.

Objective

To analyze the CT findings of GISTs in the patients who underwent preoperative CT scan of the abdomen, and describe the anatomic and imaging features of benign and malignant GISTs.

Material and Method

Between 1998 and 2005, 237 patients were randomized by computer search from the Srinagarind Hospital database and their medical treatment charts. Thirty-seven patients who underwent surgery or biopsy with pathologically proven GISTs were selected. Twenty-one patients were excluded because the preoperative abdominal CT examinations were not performed.

The data of 16 patients (Males = 12, Females = 4, age range 13-80 years, mean 49 years $\pm$ 17 SD) were analyzed for demographic data, clinical presentations and pathological records. All cases of GISTs are positive for CD117 and negative for desmin. The benign GISTs have less than 5 mitotic count per 50 HPF. The malignant GISTs have more than 5 mitotic count per 50 HPF[6]. The present study was approved by The Institutional Review Board of Srinagarind Hospital. Two patients underwent conventional helical CT examination (Exvision/EX; Toshiba cooperation medical system division, Tokyo, Japan). The scan area included the liver and both kidneys or whole abdomen with 10 mm collimation and a pitch of 1. Scanning parameters were 120kV, 100 mA; 1 second scanning time. A multi-detector CT scanner (Somatom Plus4 Volume zoom: Siemens, Forchherim, Germany) was used in another 14 patients. The scan included the liver and both kidneys or whole abdomen with 2.5 mm collimation, a pitch of 0.25 with 8 mm reconstruction. Scanning parameters were 120kV, 120 mA; scanning time 0.5 seconds. Each patient received 100 ml of a water-soluble nonionic contrast material through 18 gauge angiographic catheter inserted into a forearm vein. The contrast material was injected at a rate of 2.5 ml/sec by an automatic injector. Biphasic helical CT scans were obtained at 30 second delayed for arterial phase and 70 second delayed for portovenous phase after initiation of the contrast material injection.

The hard copies of CT images of all proven cases were retrospectively and independently reviewed by two radiologists (N.C and V.L). Clinical data and pathologic findings were blind. Disagreement was solved by consensus. The images were analyzed to determine the site, size, shape, margin, growth pattern, precontrast, postcontrast enhancement patterns, presence of intralesional fluid, gas, and calcification. The tumor sizes were divided in < 5 cm, 5-10 cm or > 10 cm, respectively. The tumor margins were categorized as smooth surface, irregular surface and combined. Growth patterns were classified as intraluminal, extraluminal, or combined intraluminal and extraluminal. The intraluminal growth was defined as those tumor masses that were attached to the bowel wall, completely confined to the bowel lumen without bulging into the extraluminal space. The extraluminal growth pattern referred to the masses that were confined to the extraluminal space without bulging into the bowel lumen. Signs of malignancy were also evaluated and recorded. These included invasion of adjacent organ(s), intraabdominal lymphadenopathy, liver metastasis, ascites and perilesional fat plane stranding.

Statistical analysis

The data was demonstrated in number and percentage. The Fisher's exact test was used in comparing the CT findings between benign and malignant groups to facilitate the differential diagnosis among these groups.

Results

The study group comprised of 12 men and 4 women. Their age ranged from 13-80 years (mean age 49 $\pm$ 17(SD)). The presenting symptoms were abdominal mass (n = 6), melena (n = 5), anemia (n = 2), epigastric pain (n = 1), massive upper GI bleeding (n = 1), and acute urinary retention (n = 1) (Table 1). Thirteen patients underwent surgical removal of the tumor, and three patients had surgical biopsy only.

There was high level of agreement [87.97% (43.52-100 of 95% confidential interval)] in identifying the origin of the lesion on the CT finding and pathologic report. The tumor location were stomach (n = 9, 56.25%) (Fig. 1), small bowel (n = 7, 43.75%) (Fig. 2). CT scans of all tumors were larger than 5 cm in size. Half of all tumors had smooth margins. The growth patterns were identified as extraluminal in nine patients (56.25%)

Table 1. The clinical presentation in 16 patients

Clinical presentation	Number
Melena	5
Anemia	2
Epigastric pain	1
Acute urinary retention	1
Abdominal mass	6
Massive UGIB	1

(Fig. 1). The remaining 43.75% had extraluminal combined with intraluminal growth pattern (Fig. 2). Precontrast CT scans of almost all GISTS had inhomogeneous density (n = 15, 93.75%) (Fig. 1). Seven tumors contained intratumoral gas (43.75%), 6 contained intratumoral fluid (37.5%), and 8 contained intratumoral calcification (50%) (Fig. 1). Only one case (6.25%) had homogeneous hypodensity.

All tumors had inhomogeneous contrast enhancement (Fig. 2). Three patients were identified as the benign or low grade GISTs and five patients were classified as malignant GISTs in the pathologic report. The remaining eight patients who were not documented as malignant or benign in pathologic report were treated with KIT tyrosine kinase inhibitor so they were presumed to be malignant GISTs.

All tumors showed CT signs of malignancy. Invasion of the adjacent organ(s) was found in 62.5% (including two patients who were benign GISTs). Intraabdominal lymphadenopathy was found in 25% (including one benign GISTs). Liver metastases were found in 18.75%. One patient had multiple liver metastases (Fig. 1), and another two cases had solitary liver metastasis. Liver nodule was present in one benign GIST. Ascites were found in 6.25%. Perilesional fat plane stranding was found in 93.75% (including three benign GISTs). There was only one case without perilesional fat plane stranding. One malignant GIST had bilateral pleural effusion. These results of CT scans findings are percentage in parenthesis in Table 2.

There was no significant difference in the CT signs between the benign and malignant GISTs ($p > 0.05$) (Table 3). (A) Hypodense extraluminal GIST at greater curvature of the stomach containing intratumoral gas and calcification (black arrow). (B) Axial portovenous phase CT abdomen shows slightly inhomogeneous enhancement of the lesion with intratumoral fluid and perilesional fat plane

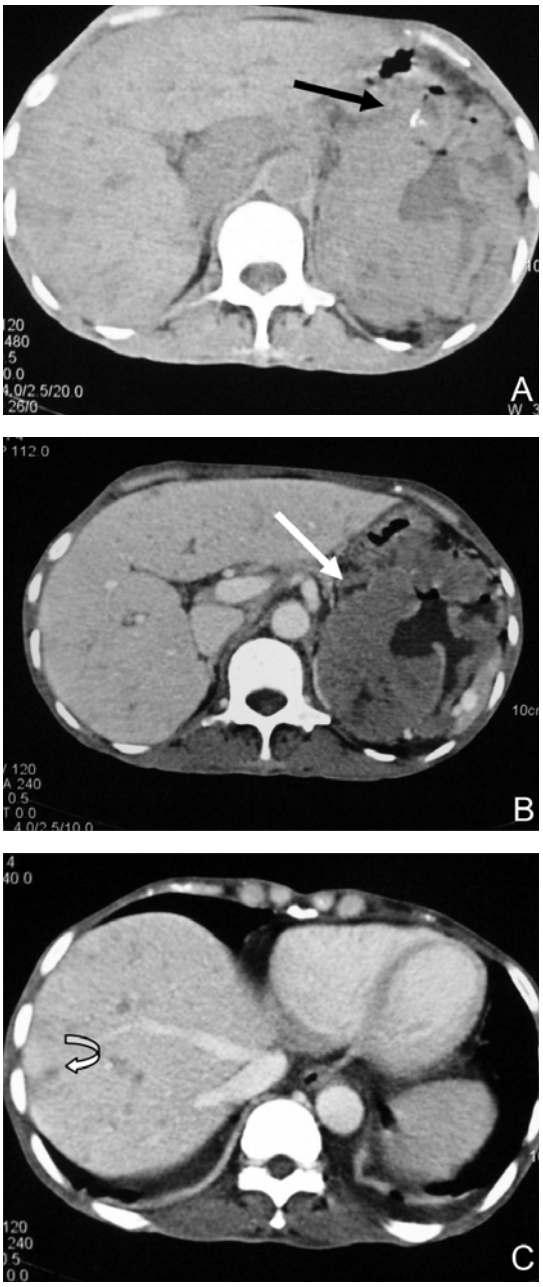
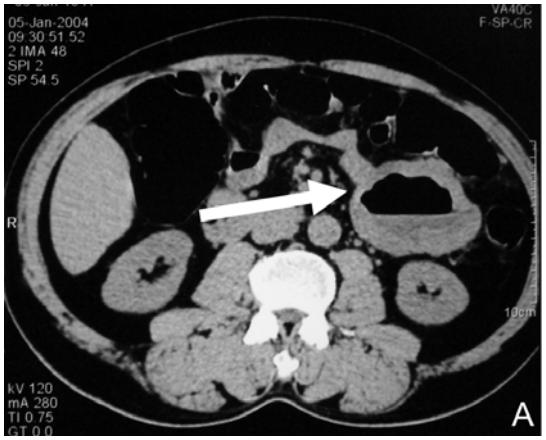


Fig. 1 A 54-year-old woman with anemia and weakness
(A) Axial precontrast CT abdomen shows a lobulated well-defined, inhomogeneous hypodense extraluminal GIST at greater curvature of the stomach containing intratumoral gas and calcification (black arrow)
(B) Axial portovenous phase CT abdomen shows slightly inhomogeneous enhancement of the lesion with intratumoral fluid and perilesional fat plane stranding (white arrow)
(C) Axial portovenous phase shows multiple liver metastases (curve arrow)



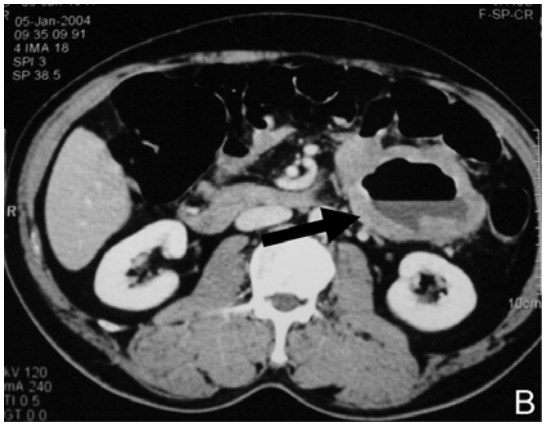


Fig. 2 A 62-year-old man with anemia and chronic weight loss
(A) Axial precontrast CT abdomen shows combination of intraluminal and extraluminal mass with irregular and smooth border jejunum (white arrow)
(B) Axial portovenous phase CT abdomen shows inhomogeneous enhancement of the lesion with intratumoral fluid (black arrow)

Table 2. The percentage of CT findings in16 GIST patients

CT parameters	Number (Percentage)
Site of primary GIST	
Stomach	9 (56.25%)
Small bowel	7 (43.75%)
Size	
< 5 cm	0
5-10 cm	8 (50.00%)
> 10 cm	8 (50.00%)
Number of tumor	
One tumor	15 (93.75%)
More than one tumor	1 (6.25%)
Tumor border	
Smooth surface	8 (50.00%)
Irregular surface	0
Combined	8 (50.00%)
Tumor growth patterns	
Extraluminal	9 (56.25%)
Intraluminal	0
Combined	7 (43.75%)
Pre contrast findings	
Homogeneous hypodense	1 (6.25%)
Homogeneous hyperdense	0
Inhomogeneous density	15 (93.75%)
With gas	7 (43.75%)
With fluid	6 (37.50%)
With calcified	8 (50.00%)
Post contrast enhancement	
Homogeneous	0
Inhomogeneous	16 (100%)
Signs of malignancy	
Invasion of adjacent organ(s)	10 (62.50%)
Lymphadenopathy	4 (25.00%)
Liver metastases/nodule	3 (18.75%)
Ascites	1 (6.25%)
Fat plane stranding	15 (93.75%)
Other findings (pleural effusion)	1 (6.25%)

Percentage in parenthesis

stranding (white arrow). (C) Axial portovenous phase shows multiple liver metastases (curve arrow).

Discussion and Conclusion

Six patients in the present study presented with palpable abdominal mass. They were larger than 5 cm at CT. Six patients presented with melena and massive upper GI bleeding. About 56.25% of these tumors originated from the stomach. Thus, the presenting symptoms of GISTs vary according to their origin of the tumors[3].

There was high agreement [87.97% (43.52-100 of 95% confidential interval)] in CT findings and pathologic report regarding the origin of the tumors. According to a report by Chi-Ming Lee et al[7], 70% of GISTs were located in the stomach and 5% located in the jejunal mesentery. The authors found 56.25% of GISTs located in the stomach, 43.75% in small bowel. The present study corresponds with their studies regarding tumor distribution.

The authors had a similar number of smooth tumors surface and mixed smooth and irregular surface. Extraluminal growth pattern outnumber intraluminal growth pattern. Nadir Ghanam et al[8] also found that larger than 5 cm GISTs had irregular margin with extraluminal growth pattern.

Table 3. The comparison between benign and malignant CT findings of GISTs

CT Findings	Benign GIST (n = 3)	Malignant GIST (n = 13)	p-value
Site of primary GISTs			0.048
Stomach	33.3%	53.84%	
Small bowel	66.6%	46.15%	
Sizes			0.999
< 5 cm	0	0	
5-10 cm	66.6%	46.15%	
> 10 cm	33.3%	53.84%	
Number of tumors			0.999
One tumor	100%	92.3%	
More than one tumor	0	7.69%	
Tumor margins			0.999
Smooth surface	66.6%	53.84%	
Irregular surface	0	0	
Combined	33.3%	46.15%	
Tumor growth patterns			0.999
Extraluminal	66.6%	53.84%	
Intraluminal	0	0	
Combined	33.3%	46.15%	
Pre contrast findings			0.999
Homogeneously hypodense	0	7.69%	
Homogeneously hyperdense	0	0	
Inhomogeneous density	100%	92.30%	
With gas	66.6%	38.46%	0.550
With fluid	33.3%	46.15%	0.999
With calcification	33.3%	53.84%	0.999
Post contrast enhancement			
Homogeneous enhancement	0	0	
Inhomogeneous enhancement	100%	100%	
Signs of malignancy			
Adjacent organ invasion	66.6%	61.5%	0.999
Lymphadenopathy	33.3%	23.07%	0.999
Liver metastases/nodule	33.3%	15.38%	0.489
Ascites	0	15.38%	0.999
Fat plane stranding	100%	92.3%	0.999
Other findings (pleural effusion)	0	7.69%	0.999

In the presented series precontrast study showed that nearly all tumors had inhomogeneous density, 43.75% contained intratumoral gas, 37.5% contained intratumoral fluid, and 50% contained intratumoral calcification. These air bubbles can be seen within the tumor in superimposed infection of necrotic tumor areas[9]. Nadir Ghanem et al[8] also reported calcification in eight of 35 patients. Calcification is an unusual feature of GISTs, found in only one of 64 patients by Levy AD et al[10].

The post contrast enhancement CT scans of all tumors showed inhomogeneous enhancement. The present report correlated with the report by Levy AD et al[10] who found inhomogeneous enhancement among 92% of cases on intravenous contrast-enhanced CT images, and homogeneous enhancement in only 8% of cases.

Levy AD et al[10] found evidence of adjacent organ invasion, ascites, omental, and peritoneal spread of tumors, or liver metastasis without evidence of metastatic lymphadenopathy. Burkill GJC et al[11] reported liver metastasis in 13/38, peritoneal metastasis in 8/38, ascites in 1/38, and pleural metastasis in 1/38 of malignant GISTs. De Matteo et al[12] had 200 patients with malignant GISTs and 47% of them presented with metastatic disease. The liver was the most common

site of metastasis followed by peritoneum. Lung, bone, and lymph node metastases could be seen. The authors found invasion of adjacent organs in 62.5% (including 2 benign GISTs), ascites in 6.25%, and perilesional fat plane stranding in 93.75% (including all three benign GISTs), bilateral pleural effusion in 7.69%, intrabdominal lymphadenopathy in 25% (including 1 benign GIST), and liver metastasis in 8.75% (also including one benign GIST). The lesion that the authors found in one case of benign GIST could be co-incidental benign liver lesion. However, this lesion was not proven by the pathologist. The benign GISTs included in parenthesis are pathologic diagnosis.

There is no statistically significant difference ($p > 0.05$) in the imaging findings between benign and malignant group according to the comparison of CT findings in Table 3.

However, the present study is limited because of small sample size. The authors need a larger sample size and much more information from the pathologic and surgical reports in order to enhance of the authors' results.

In conclusion, the most common sites of GISTs were found in the stomach. The typical CT features are inhomogeneous enhancing heterogeneous extraluminal mass with well-defined or irregular border. The tumors may contain fluid, gas, or calcification. The CT findings cannot be used as a single tool for distinguishing the benign from the malignant GISTs.

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ลักษณะภาพเอกซเรย์คอมพิวเตอร์ของผู้ป่วย GIST

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วัตถุประสงค์: *เพื่อศึกษาและวิเคราะห์ลักษณะภาพเอกซเรย์คอมพิวเตอร์ ของผู้ป่วย GIST ในโรงพยาบาลศรีนครินทร์*

วัสดุและวิธีการ: *ภาพเอกซเรย์คอมพิวเตอร์ช่องท้องของผู้ป่วยทั้งหมด 16 คน(ผู้ชาย 12 คน, ผู้หญิง 4 คน, อายุเฉลี่ย 49 ± 17SD) ที่ได้รับการผ่าตัดและ ผลทางพยาธิวิทยาวินิจฉัยเป็น GIST ระหว่าง ปี พ.ศ. 2546-2549 ได้รับและวิเคราะห์แบบย้อนหลัง เพื่อศึกษาและวิเคราะห์ ขนาด ขอบนอก ลักษณะของก้อน ลักษณะของการเปลี่ยนแปลงหลังการฉีดสารทึบแสง และลักษณะที่เป็นเนื้อร้ายของ GIST ลักษณะดังกล่าวจะถูกเปรียบเทียบกันระหว่างก้อนเนื้อที่ไม่ร้ายแรงและร้ายแรง*

ผลการศึกษา: *จากผู้ป่วยทั้งหมด 16 คน พบว่าตำแหน่งที่พบ GIST มากที่สุดคือกระเพาะอาหารซึ่งพบ 56.25% ตำแหน่งอื่นที่พบคือ ลำไส้เล็ก 43.75% ก้อนส่วนมากมีขนาดใหญ่กว่า 5 เซนติเมตร พบขอบเขตเรียบ 50% ไม่เรียบผสมกับเรียบ 50% ก้อนทั้งหมดมีลักษณะค่าความหนาแน่นของเอกซเรย์คอมพิวเตอร์แบบไม่สม่ำเสมอ พบฟองอากาศในก้อน 43.75% ของเหลว 37.5% หินปูน 50% หลังจากฉีดสารทึบแสงพบการเปลี่ยนแปลงแบบไม่สม่ำเสมอในก้อนนั้นมีการลุกลามไปเนื้อเยื่อข้างเคียง 62.5% มีต่อมน้ำเหลืองโต 25% และมีการกระจายของโรคไปที่ตับหรือมีรอยโรคที่ตับ 18.75% มีน้ำในช่องท้อง 6.25% ค่าความหนาแน่นของเอกซเรย์คอมพิวเตอร์ในเนื้อเยื่อไขมันเพิ่มขึ้น 93.5% และพบน้ำในช่องเยื่อหุ้มปอด 6.25%*

สรุป: *ตำแหน่งที่พบ GIST ที่มากสุดคือ กระเพาะอาหาร ลักษณะเฉพาะที่พบคือ มีค่าของความหนาแน่นของเอกซเรย์คอมพิวเตอร์แบบไม่สม่ำเสมอ และขอบนอกอาจเรียบหรือไม่เรียบ เอกซเรย์คอมพิวเตอร์ไม่สามารถใช้เป็นเครื่องมือเพียงอย่างเดียวในการแยกลักษณะของ GIST แบบไม่ร้ายแรงและร้ายแรง*