Application of 64-slice spiral CT and its reconstruction technique in preoperative diagnosis of gastric stromal tumours

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Purpose

1. Gastrointestinal stromal tumors (GISTs) are the most common mesenchymal neoplasms of the gastrointestinal tract.\textsuperscript{1} GISTs occur most frequently in the stomach (60%) which account for 1%~3% of gastric neoplasms.\textsuperscript{2,3} GISTs smaller than 2 cm are generally considered benign with a very low risk of recurrence. However, no GIST can truly be labeled benign.\textsuperscript{4}

2. A definitive preoperative diagnosis is particularly important because unresectable and metastatic GIST can now be treated with the new tyrosine kinase inhibitor imatinib with a remarkable response\textsuperscript{5} and a prolonged survival.\textsuperscript{6,7} For localized primary GISTs, surgical resection is the mainstay of therapy.\textsuperscript{4} The increasing recognition of GISTs and the prolonged survival have made imaging increasingly important, not only for diagnosing and staging the tumors, but also for monitoring the effects of treatment and detecting tumor progression. Computed tomography is the imaging modality of choice for these purposes.

3. 64-slice CT can identify smaller tumors(#1cm), detect small vascular lesions and assess local spread or distant metastases. Although many investigations regarding CT findings of gastric GISTs have been reported in recent years, criteria for distinguishing a benign from a malignant GIST by CT features still exist controversy,\textsuperscript{8-13} therefore, further study is needed.

4. The purposes of this study are to investigate the features of GSTs (morphology, location, size, pattern of enhancement and metastatic), analyse the relationship between CT features and staging of these tumor, and evaluate the contribution of 64-slice spiral CT to preoperative assessment.
Methods and Materials

Patients

Patients were selected from January 2007 to December 2009. Of the 48 patients aged 12~72 (53 in average), 26 were men and 22 were women. According to clinical manifestations, there were 11 cases of abdominal mass, 9 cases had a feeling of abdominal expansion and nausea, 18 cases of upper gastrointestinal bleeding or unexplained anemia, 10 cases were asymptomatic.

CT examinations

After 6~8 h of fasting, patients took 800~1000 ml of warm boiled water and received GE 64 Light speed CT scanning with scan thickness of 64 × 0.625 mm, reconstruction interval of 1.25mm and pith value of 1:1.5. 80~100 ml of enhanced CT scanning contrast agent Ultravist (300 mgI / ml) was infused through cubital vein at 3.5 ml/s. Plain and three phase enhanced scanning (arterial, venous, and equilibrium phase) plus multi-planar reconstruction was performed for all cases.

Imaging criteria

Three radiologists reviewed the CT scan images retrospectively, and final interpretations were reached by consensus. CT scan images were reviewed to determine the size, location, contour, growth pattern, boundary, pattern of enhancement, and necrosis of the tumors. The presence of calcification within the lesions was also recorded.

The pathology records of each patient were reviewed to establish mitotic activity and immunoreactivity with CD117, CD34, SMA and S-100. The histopathologic findings in surgical specimens were retrospectively reviewed by an experienced pathologist.

Statistical analysis

We evaluated the correlation between each CT feature and patients' pathological characteristics, and lesion location were also assessed. Statistical analyses were performed using software from SPSS for Windows 17.0. The statistical methods used included #2 test for categorical variables and Mann-Whitney U test for continuous variables. \( P < 0.05 \) was taken to indicate statistical significance.
Results

Characteristics of tumors

According to the consensus classification 2002,\textsuperscript{14} 21 cases were grouped as benign GSTs (very low risk, 8 cases; low risk, 13 cases) and 27 cases as malignant GSTs (intermediate risk, 12 cases; high risk, 15 cases). All tumors in this group were single tumors, the size of the lesions ranged from 1.1 to 26 cm, and the mean largest dimension of benign tumors was greater than that of malignant tumors. The tumors tended to be located in the body of the stomach, In our series of 48 GSTs, 15 (31\%) of our cases were confined to the cardia and fundus of the stomach, 29 (60\%) were located in the body, and four (9\%) were in the antrum, eight (17\%) tumors presented in the anterior wall (AW), 13 (27\%) in the posterior wall (PW), 18 (38\%) in the lesser curvature (LC) and 9 (18\%) in the greater curvature (GC) of the stomach. In addition, GST mostly grew along the vertical plane of gastric wall, with a large size but local attachment, and had three growth patterns: endophytic(Fig.1), exophytic(Fig.2), and endo-exophytic(Fig.3).

The tumor size was less than 5 cm in diameter in 20 cases. Of them, 16 cases had a regular shap, 16 cases showed homogeneous enhancement(Fig.4), and 8 cases exhibited central necrosis, 9 cases showed intra-luminal growth and 7 tumors showed extra-luminal growth, while the other 4 cases involved both intra and extra luminal. Twenty-eight cases had tumors larger than 5 cm in diameter. Of them, 24 cases had irregular shap(Fig.5), 26 cases showed inhomogeneous enhancement(Fig.3), 19 cases had central necrosis, 2 tumors showed intra-luminal growth and 14 tumors showed extra-luminal growth, while 12 cases involved both intra and extra luminal. The relationships between CT features and tumor size were listed in Table 1. We concluded that extralumina lesions had larger size than endoluminal lesions ($P < 0.001$); lesions with lobulated appearance had larger size than those with round appearance ($P < 0.01$); the greater the necrosis of a tumor, the more it presented with larger size ($P < 0.01$); and the features that larger than 5 cm, remarkable lobules, necrosis and cystic change, and heterogeneous enhancement were present statistically significant in the malignant tumors ($P < 0.05$) (Table 2).

A peripheral enhancement patterns was present in the majority (82.14\%) of our 28 malignant cases on intravenous contrast-enhanced CT images. Central areas of low attenuation(Fig.3) correspond to hemorrhage, necrosis, or cyst formation. Homogeneous enhancement was present in a minority (17.86\%) of cases. Lesions with extensive hemorrhage or necrosis may form large cystic spaces or cavities(Fig.5), substantial part of tumor showed heterogeneous and moderate to significant enhancement with large and distorted vascular shadow inside the tumors in arterial phase, while in venous phase and delayed phase, continuous enhancement was observed with parenchyma density higher than that of arterial phase. Five cases showed septal enhancement, 4 tumors exhibited marked enhancement in arterial phase with up to 60HU. Calcification was an unusual
feature of GISTs, seen in only 3 (6.25%) of our gastric cases. It may occur in a mottled pattern or be small punctuate calcified foci (Fig. 6). Punctate calcification was seen in one low-grade tumors and in two high-grade tumors, which was not statistically significant.

**Tumor aggression to nearby tissues and metastasis**

Of the 23 cases in which unclear edges were shown on CT, 19 were surgically found to have nearby tissue invasion, while 4 had no invasion, and all were emaciated patients, and of the 25 cases with clear edges on CT imaging, nearby tissue invasion was confirmed in 5 cases during the surgery. In our cases, the most common site for GIST metastasis was the liver in 9 cases, followed by the peritoneum in 7 cases, and 2 cases with lymph nodes enlargement detected on MSCT were pathologically confirmed to be mild reactive of hyperplasia and chronic inflammatory changes (Fig. 7). Metastases to bone was distinctly uncommon, as only one case in our patients (Fig. 8). In addition, one case with spleen metastasis (Fig. 9). Liver metastasis appeared isointense or hypointense to normal liver parenchyma on noncontrast images and usually had a lesser degree of enhancement than normal liver parenchyma on portal phase contrast images. Like the primary lesions, liver metastases can show calcification or central areas of necrosis or hemorrhage, It can also exhibited cystic-like change, with attenuation measuring 20-30 HU, slightly greater than a true cyst (Fig. 10).
Fig. 0: 74-year-old male with a 1.1cm × 0.6cm mass arising from the wall of the fundus of the stomach, with regular surface and homogeneous enhancement. Coronal volume-rendered image shows the tumor (arrow) and its location.

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Fig. 0: 46-year-old woman with a tumour in antrum of the stomach, Computed tomography scan shows an exophytic tumor (arrow) with central areas of low attenuation.

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**Fig. 0:** 50-year-old man with endo-exophytic malignant gastric GIST, contrast-enhanced CT scan shows a large heterogeneous mass (arrows) with central fluid attenuation.

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**Fig. 0**: 42-year-old man with a benign gastric GIST, transverse CT scan image of upper abdomen shows an exophytic mass (arrow) with regular surface, homogeneous enhancement, and isoattenuating with the enhanced liver parenchyma.

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**Fig. 0:** 47-year-old woman with an endophytic gastric GIST, and a large ulcer on its surface. Contrast-enhanced CT scan shows multiple tumor vessels (arrow) within the mass.

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Fig. 0: 55-year-old male with a pathologically proven malignant gastric stromal tumor, transverse CT scan image of upper abdomen shows a endophytic tumor with mottled pattern or punctuate calcification (arrow).

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Fig. 0: 46-year-old woman with a tumour in antrum of the stomach (same to figure 2), transverse CT scan shows two lymph nodes (arrow) were seen near the lesion, pathologically confirmed to be mild reactive of hyperplasia and chronic inflammatory changes.

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**Fig. 0:** 55-year-old male with a pathologically proven malignant gastric stromal tumor (same to figure 6), transverse CT scan shows multiple bone metastases in the vertebra (arrow).

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**Fig. 0:** 57-year-old man with a heterogeneous exophytic gastric stromal tumour, transverse enhanced CT scan shows a mesenteric mass in the spleen (arrow).

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**Fig. 0:** A liver metastasis exhibited cystic-like change (arrow), with attenuation enhancement, different from a true cyst.

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Conclusion

1. High frequency of malignancy in GISTs located in the gastric fundus and gastroesophageal junction-cardia region compared with antrum. Most malignant tumours were exogastric, whereas most benign tumours were endogastric, and location on one of the curvatures of the stomach was more likely to be associated with malignant disease, whereas most benign tumours were located on either the posterior or anterior gastric walls.\(^{20}\)

2. The size of GSTs is quite variable (1.1~26cm), larger tumors had a tendency to grow exophyticly and show lobulated contour, whereas smaller ones tended to grow endoluminally and show round contour, and the bigger tumor was, the more remarkable necrosis or cystic change was. Tumors with features that larger than 5cm, remarkable lobules, necrosis and cystic change, and heterogeneous enhancement were present statistically significant in the malignant tumors.

3. Most tumors are hypervascularized and supplied by branches from the gastroduodenal or left gastric arteries. In the arterial phase, moderate to significant enhancement was observed in parenchyma with large and distorted vascular shadow, while in venous phase and delayed phase,

4. In the case of gastric GIST, 64-slice spiral CT provide earlier detection, better road maps to evidence-based treatment selection, precise non-invasive treatment follow-up. In addition, it is helpful in differentiating benign with magligant gastric GISTs. Therefore, 64-slice spiral CT has the potential to serve as a comprehensive imaging test for the preoperative evaluation of gastric GISTs.
References


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