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Article

The Clinical Application Value Assessment of Enhanced CT in the Diagnosis of Gastrointestinal Stromal Tumors

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Abstract: Objective: To evaluate the clinical application value of enhanced CT in the diagnosis of gastrointestinal stromal tumors (GISTs). Methods: This study selected clinical and CT scan data from 62 patients with gastrointestinal stromal tumors between January 2023 and May 2024. The detection efficacy of different diagnostic methods was compared, and the CT imaging characteristics based on risk classification and tumor location were analyzed. Patients were divided into two groups: gastric GIST and small intestine GIST, and the CT features and CT values were analyzed. Results: Enhanced CT scanning was superior to conventional CT in detecting gastrointestinal stromal tumors ($p < 0.05$). There were significant differences in tumor risk, morphology, calcification, necrosis, boundaries, vascularity, and size ($p < 0.05$), but no significant differences in calcification, necrosis, and tumor internal features between the two groups ($p > 0.05$). Significant differences were observed in tumor morphology and growth characteristics between the gastric GIST group and the small intestine GIST group ($p < 0.05$), and the CT values in the gastric GIST group were consistently lower than those in the small intestine GIST group ($p < 0.05$). Conclusion: Enhanced CT scanning improves the detection rate of gastrointestinal stromal tumors, reduces the risk of missed diagnoses and misdiagnoses, helps determine pathological grade and tumor nature, and shows differences in malignancy between tumors in different locations, providing a reliable basis for clinical decision-making.

Keywords: gastrointestinal stromal tumors; diagnosis; application value; enhanced CT

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1. Introduction

Gastrointestinal stromal tumors (GISTs) are a type of non-specifically differentiated mesenchymal tumor of the digestive system, with the potential for malignant development. Due to the limitations of past pathological techniques, these tumors were often misclassified as neurogenic or smooth muscle tumors. With the advancement and application of immunohistochemistry in China, researchers now believe that GISTs are most likely to originate from interstitial cells of Cajal, which are mesodermal in origin. These tumors often do not exhibit structural proteins, and actin reactions are typically negative or only positive in very small areas. Furthermore, under electron microscopy, myofilament structures are rarely observed, making it inappropriate to classify these tumors as true smooth muscle tumors [1]. GISTs most commonly occur in the stomach, accounting for approximately 70% of cases, followed by the small intestine. Although determining the tumor location is usually straightforward, due to the potential for malignancy, distinguishing between benign and malignant properties of gastrointestinal stromal tumors, and improving the accuracy, specificity, and sensitivity of diagnosis, holds significant clinical value [2]. Currently, CT imaging technology is the primary method for diagnosing GISTs. With the advancement of CT technology, particularly the application of enhanced CT, the accuracy of GIST detection has been significantly improved [3]. This CT technique utilizes multi-row wide detectors, enabling the acquisition of multi-layer image information in a single scan, thereby producing higher-quality three-dimensional imaging [4]. Since abdominal anatomical layers are often difficult to distinguish in routine scans, enhanced CT imaging can detect and differentiate lesions. As a result, it has been widely used in various medical fields such as three-dimensional imaging, angiography, cardiac imaging, brain perfusion imaging, and tumor diagnosis [5,6].

2. Materials and Methods

2.1. General Information

This study selected 62 patients with gastrointestinal stromal tumors (GISTs) who underwent surgical treatment and were confirmed by pathology at our hospital between January 2023 and May 2024. Among them, 35 were male and 27 were female; the patients' ages ranged from 46 to 68 years, with a mean age of (54.28 ± 6.34) years. The duration of the disease ranged from 2 to 9 months, with an average duration of (5.64 ± 1.78) months.

Inclusion Criteria: Complete clinical data; good treatment compliance; presence of gastrointestinal masses; patients and their families were fully informed about the study and agreed to participate.

Exclusion Criteria: Patients with other gastrointestinal diseases; those with mental illness or cognitive disorders; females who are pregnant or breastfeeding; patients with severe heart, liver, or kidney failure.

2.2. Methods

Prior to surgery, all patients underwent both enhanced multi-slice spiral CT scans and conventional CT scans [7]. Patients were required to fast for at least 4 hours before the examination. Twenty minutes before the scan, patients were instructed to drink 1000 mL of warm water to fill the stomach. For colon examinations, bowel preparation was required. To reduce radiation exposure, key areas were covered with lead protective clothing. The scans were performed using either a GE 16-slice spiral CT Optima 520 or a Siemens SOMATOM AS + 64-slice CT, both for routine and enhanced scanning. Patients were positioned supine, and the scanning range covered from the diaphragm to the iliac crest, with the scanning range adjusted to the pelvic area as needed depending on the lesion location. The scanning parameters were set as follows: slice thickness and spacing of 5 mm, pitch of 1.375, current of 350 mA, voltage of 120 kV, scanning cycle of 0.85 seconds, and bed speed of 27.5 mm/s. During the scan, patients were required to hold their breath to reduce the impact of diaphragm movement. After the routine CT scan, 75-100 mL of contrast agent was injected into the elbow vein at a speed of 4 mL/s. Enhanced scans were performed at 30 seconds, 75 seconds, and 300 seconds post-injection. The scan data were then transmitted to an image processing workstation for multiplanar reconstruction and volumetric reconstruction. Two experienced physicians reviewed and discussed the images to make the final diagnosis [8,9].

In the conventional CT scan images, malignant indicators for gastrointestinal stromal tumors are typically characterized by a tumor diameter greater than 5 cm, an irregular surface, uneven density distribution, cystic changes or necrotic areas, unclear boundaries, and invasion of surrounding tissues or distant metastasis [10]. Tumors exhibiting these features are usually classified as malignant; if these characteristics are absent, the tumor is classified as benign. Enhanced multi-slice spiral CT scanning reveals moderate to uneven enhancement of the tumor, particularly in necrotic or cystic areas where significant enhancement occurs, which also suggests malignancy. If a nodular or lace-like enhancement pattern is observed around the tumor, along with a cluster-like or linear vascular distribution within the tumor and its borders, these are considered typical features of malignant gastric GISTs.

2.3. Observation Indicators

(1) To analyze the imaging features and parameters of gastric and small intestine GIST patients in multi-slice spiral CT scans, such as tumor location, shape, and calcification.

(2) To assess the efficiency of conventional CT and multi-slice spiral CT in detecting gastrointestinal stromal tumors and explore the CT imaging features of patients with different risk classifications, including tumor size, calcification, necrosis, shape, tumor blood supply, and enhancement degree.

2.4. Statistical Methods

Statistical analysis was performed using SPSS 26.0. Measurement data were presented as mean ± standard deviation (±s) and analyzed using the t-test. Count data were expressed as percentages and analyzed using the chi-square (χ^2) test. A *p*-value of less than 0.05 was considered statistically significant.

3. Results

3.1. Comparison of CT Features in Patients with Different Tumor Locations

Surgical pathology results showed 39 cases of gastric GISTs and 23 cases of small intestine GISTs. No significant differences were observed between the two groups in terms of tumor necrosis, calcification, and internal solid type ($p > 0.05$). However, gastric GISTs exhibited a higher degree of shape regularity compared to small intestine GISTs, while showing lower degrees of lobulation, wall-in/wall-out growth, and transmural growth, with significant differences ($p < 0.05$). See Table 1.

Table 1. Comparison of CT Features in Patients with Different Tumor Locations [Cases (%)].

CT Feature		Gastric GIST Group (39 cases)	Small Intestine GIST Group (23 cases)	χ^2/Z Value	*p* Value
Calcification	Yes	11 (28.21)	7 (30.43)	0.030	0.862
	No	28 (71.79)	16 (69.57)		
Necrosis	Yes	13 (33.33)	8 (34.78)	0.011	0.918
	No	26 (66.67)	15 (65.22)		
Internal Features	Homogeneous Solid	24 (61.54)	12 (52.17)	0.900	0.638
	Heterogeneous Solid	9 (23.08)	7 (30.44)		
	Cystic Solid	6 (15.38)	4 (17.39)		
Growth Pattern	Wall-In	16 (41.02)	2 (8.70)	29.097	0.000
	Wall-Out	14 (35.90)	2 (8.70)		
	Transmural	9 (23.08)	19 (82.60)		
Shape	Well-defined	29 (74.36)	11 (47.83)	5.670	0.017
	Lobulated	10 (25.64)	12 (52.17)		

3.2. Comparison of Detection Rates for GISTs Using Different Examination Methods

Enhanced multi-slice spiral CT scanning showed better diagnostic accuracy for gastrointestinal stromal tumors than conventional CT, with this difference being statistically significant ($p < 0.05$). See Table 2.

Table 2. Comparison of Detection Rates for Gastrointestinal Stromal Tumors Using Different Examination Methods.

Examination Method	Number of Cases	Detected (Cases)	Missed/Incorrect Diagnosis (Cases)	Detection Rate (%)
Conventional CT Examination	62	55	7	88.71
Multislice Spiral CT Examination	62	60	2	96.77
χ^2 Value				4.792
p Value				0.029

3.3. Comparison of CT Values in Patients with Different Tumor Locations

In all scanning phases, the CT values of the gastric GIST group were lower than those of the small intestine GIST group, and this difference was statistically significant ($p < 0.05$). See Table 3.

Table 3. Comparison of CT Values in Patients with Different Primary Sites ($\bar{x} \pm s$).

Group	Number of Cases	Pre-Scan	Arterial Phase	Venous Phase	Delayed Phase
Gastric GIST Group	39	36.97 ± 7.54	67.44 ± 12.76	73.33 ± 16.52	80.45 ± 15.25
Small Intestine GIST Group	23	41.25 ± 7.42	113.81 ± 34.22	98.31 ± 24.33	89.22 ± 16.34
t Value		2.426	8.485	5.361	2.387
p Value		0.018	0.000	0.000	0.020

3.4. Comparison of CT Features in Patients with Different Risk Levels

There were no significant differences in tumor enhancement and growth patterns between patients with different risk levels ($p > 0.05$). However, significant differences were observed in tumor morphology, calcification, necrosis, boundaries, blood vessels, and size among patients with different risk levels ($p < 0.05$). See Table 4.

Table 4. Comparison of CT Features in Patients with Different Risk Levels [Cases (%)].

CT Feature		Very Low + Low Risk (26 cases)	Moderate Risk (23 cases)	High Risk (13 cases)	χ^2/Z Value	p Value
Calcification	Yes	2 (7.69)	7 (30.43)	9 (69.23)	8.563	0.024
	No	24 (92.31)	16 (69.57)	4 (30.77)		
Necrosis	Yes	2 (7.69)	7 (30.43)	8 (61.54)	6.738	0.029
	No	24 (92.31)	16 (69.57)	5 (38.46)		
Degree of Enhancement	Mild	6 (23.08)	4 (17.39)	2 (15.38)	0.941	0.625
	Moderate	4 (15.38)	7 (30.44)	3 (23.08)		
	Severe	16 (61.54)	12 (52.17)	8 (61.54)		
Growth Pattern	Intramural	2 (7.69)	2 (8.70)	0 (0.00)	0.843	0.742
	Extramural	8 (36.77)	4 (17.39)	4 (30.77)		
	Transmural	16 (61.54)	17 (73.91)	9 (69.23)		
Shape	Regular-shaped	24 (92.31)	12 (52.17)	2 (15.38)	12.348	0.001

	Irregular-shaped	2 (7.69)	11 (47.83)	11 (84.62)		
Boundary	Clear	25 (96.15)	16 (69.57)	3 (23.08)	15.346	0.000
	Fuzzy	1 (3.85)	7 (30.43)	10 (76.92)		
Tumor Vessels	Yes	2 (7.69)	9 (39.13)	11 (84.62)	12.241	0.001
	No	24 (92.31)	14 (60.87)	2 (15.38)		
Tumor Size	<5cm	25 (96.15)	18 (78.26)	0 (0.00)	54.494	0.000
	5~10cm	1 (3.85)	4 (17.39)	6 (46.15)		
	>10cm	0 (0.00)	1 (4.35)	7 (53.85)		

4. Discussion and Conclusion

Gastrointestinal stromal tumors (GISTs) are more commonly found in the stomach than in the esophagus or small intestine. These tumors are typically seen in elderly individuals, particularly those aged 50 to 60, and pose a significant health threat to patients. Therefore, early diagnosis and appropriate treatment are crucial for improving patient survival rates. Clinical treatment is mainly surgical, but the choice of treatment and prognosis improvement are influenced by the malignancy of the tumor. Due to the complex histological and immunohistochemical characteristics of GISTs, distinguishing between benign and malignant cases is difficult. In recent years, combining imaging technologies to differentiate between benign and malignant tumors and assess their malignancy has become a focus of clinical research.

In the diagnosis of GISTs, common imaging techniques include ultrasound, X-ray barium meal, CT scans, and magnetic resonance imaging (MRI). Ultrasound imaging is often hindered by interference from gases in the intestines, making it difficult to clearly visualize images of hollow organs, which increases the risk of misdiagnosis and missed diagnoses. Although X-ray barium meal can provide information about the shape and size of a mass, it has limitations in assessing the anatomical relationship between the gastrointestinal tract and the tumor. MRI is renowned for its high spatial resolution, allowing clear visualization of the relationship between the gastric mucosa and the lesion, as well as the density and internal vascular distribution of the tumor. However, its high cost and lower patient acceptance limit its use. In contrast, multi-slice spiral CT (MSCT) with contrast-enhanced scanning has advantages such as fast examination time, simple operation, 3D imaging capability, and a wide scanning range. It is a useful method for observing lesions from multiple angles. Furthermore, through post-processing techniques, MSCT can more clearly display the internal structure of the lesion and its relationship with surrounding tissues and organs.

In this study, compared to conventional CT, multi-slice spiral CT demonstrated a higher detection rate for GISTs, indicating its superior diagnostic accuracy. This advantage stems from MSCT's ability to assess tumor blood supply and surrounding vascular invasion during enhanced scanning, as well as precise lesion localization achieved through multi-planar thin-layer reconstruction and image reconstitution. MSCT's ability to effectively identify both intramural and extramural tumors and reveal their internal structures in relation to adjacent tissues is essential for further assessing metastasis. Studies have shown significant differences in tumor characteristics among patients with different risk levels. Enhanced CT not only aids in diagnosing GISTs but also helps assess their risk levels. The characteristics observed on CT scans are helpful for clinical assessment of tumor malignancy and provide guidance for distinguishing benign and malignant tumors. Tumor diameter is a key factor in risk assessment; tumor enlargement typically correlates with increased risk. MSCT can accurately measure tumor diameter, with low-risk tumors usually measuring less than 5 cm, while medium- and high-risk tumors are often 5 cm or larger. Thus, tumor diameter measured by MSCT can serve as a crucial indicator for assessing patient risk.

Further analysis shows significant differences in the shape and borders of benign and malignant tumors. MSCT scans reveal that low-risk tumors are typically well-formed with clear boundaries, while medium- and high-risk tumors tend to have irregular shapes and unclear boundaries with surrounding tissues. High-risk tumors exhibit rapid growth, lobulated shapes, and complex vascular structures. Enhanced MSCT scanning can reveal both intratumoral and surrounding vascular conditions, which are key in assessing tumor malignancy. High-risk tumors often show enhanced vascularity, whereas low-risk tumors show no significant enhancement. Additionally, the study found that gastric GISTs were more likely to exhibit regular shapes compared to small intestinal GISTs, which tended to show more lobulated, intramural/extramural, and transwall growth patterns, with significant differences in the biological behavior and morphological characteristics of these tumors, which could be differentiated through CT imaging. This has important clinical implications for treatment planning.

Gastric and small intestinal GISTs are the two primary types of GISTs in the gastrointestinal tract. MSCT imaging revealed that gastric GISTs typically present as inward or outward protrusions, with round or near-circular shapes and clear boundaries. In contrast, small intestinal GISTs tend to penetrate the bowel wall and spread outward, showing transwall growth and irregular shapes, often with lobulated structures. The lobulated or irregular shape of the tumor is closely related to its aggressiveness, indicating that small intestinal GISTs grow rapidly and have significant invasive characteristics, which should be carefully monitored for potential deterioration.

In this study, small intestinal GISTs showed higher CT values across different scanning phases, suggesting a richer vascular distribution compared to gastric GISTs. This phenomenon is likely due to capillary neovascularization caused by the rapid growth of small intestinal GISTs. Using MSCT's three-phase enhanced scanning, the gradual enhancement pattern of gastric GISTs and the peak-then-decline enhancement pattern of small intestinal GISTs could be distinguished.

In summary, multi-slice spiral CT enhanced scanning improves the detection rate of GISTs, reduces the risk of missed and misdiagnosed cases, aids in determining the pathological grade and tumor nature, and reveals differences in the malignancy degree of tumors at different sites, thus providing a reliable basis for clinical decision-making.

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