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Differentiation of large (≥5 cm) gastrointestinal stromal tumors from benign subepithelial tumors in the stomach: Radiologists' performance using CT

Ye Ra Choi [a], Se Hyung Kim [a,b,*], Sun-Ah Kim [a], Cheong-il Shin [a,b], Hyung Jin Kim [a], Seong Ho Kim [a], Joon Koo Han [a,b], Byung Ihn Choi [a,b]

[a] Department of Radiology, Seoul National University Hospital, Republic of Korea
[b] The Institute of Radiation Medicine, Seoul National University Hospital, Republic of Korea

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ABSTRACT

Purpose: To identify significant CT findings for the differentiation of large (≥5 cm) gastric gastrointestinal stromal tumors (GIST) from benign subepithelial tumors and to assess whether radiologists' performance in differentiation is improved with knowledge of significant CT criteria.
Materials and methods: One-hundred twenty patients with pathologically proven large (≥5 cm) GISTs (n = 99), schwannomas (n = 16), and leiomyomas (n = 5) who underwent CT were enrolled. Two radiologists (A and B) retrospectively reviewed their CT images in consensus for the location, size, degree and pattern of enhancement, contour, growth pattern and the presence of calcification, necrosis, surface ulceration, or enlarged lymph nodes. CT findings considered significant for differentiation were determined using uni- and multivariate statistical analyses. Thereafter, two successive review sessions for the differentiation of GIST from non-GIST were independently performed by two other reviewers (C and D) with different expertise of 2 and 9 years using a 5-point confidence scale. At the first session, reviewers interpreted CT images without knowledge of significant CT findings. At the second session, the results of statistical analyses were provided to the reviewers. To assess improvement in radiologists' performance, a pairwise comparison of receiver operating curves (ROC) was performed.
Results: Heterogeneous enhancement, presence of necrosis, absence of lymph nodes, and mean size of ≥6 cm were found to be significant for differentiating GIST from schwannoma (P < 0.05). Non-cardial location, heterogeneous enhancement, and presence of necrosis were differential CT features of GIST from leiomyoma (P < 0.05). Multivariate analyses indicated that absence of enlarged LNs was the only statistically significant variable for GIST differentiating from schwannoma. The area under the curve of both reviewers obtained using ROC significantly increased from 0.682 and 0.613 to 0.903 and 0.904, respectively, with information of the significant CT findings differentiating GISTs from non-GISTs (P < 0.001).
Conclusion: Non-cardial location, heterogeneous enhancement, presence of necrosis, larger lesion size, and absence of lymphadenopathy are highly suggestive CT findings for large GISTs in differentiation from schwannomas or leiomyomas. Regardless of radiologists' expertise, diagnostic performance in differentiation can be significantly improved with knowledge of these CT findings.

1. Introduction

Like many other organs, the stomach is not only the origin of epithelial tumors and lymphomas, but also a wide range of mesenchymal tumors. Approximately 3% of all gastric tumors belong to the latter group [1]. Gastric mesenchymal tumors can be divided into four main categories; true smooth muscle tumors (leiomyomas, glomus tumors, leiomyosarcomas), neurogenic tumors (schwannomas, neurofibromas, ganglioneuromas, paragangliomas), fibroblastic tumors (desmoid, inflammatory myofibroblastic tumors), and gastrointestinal stromal tumors (GISTs). Gastric mesenchymal tumors typically manifest as a subepithelial lesion on both imaging and pathologic examinations. Except in very rare leiomyosarcomas, all gastric mesenchymal tumors other than GISTs are almost always benign. GISTs, on the other hand, even when they are small, are potentially malignant [2–4]. Therefore, accurate differentiation of GISTs from other benign subepithelial tumors is crucial for planning management options

* Corresponding author at: Department of Radiology, Seoul National University Hospital, 101, Daehangno, Jongno-gu, Seoul 110-744, Republic of Korea.
Tel.: +82 22072 2057; fax: +82 2743 6385.
E-mail address: shkim7071@gmail.com (S.H. Kim).

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and predicting patients' prognosis. Differentiation between GISTs and non-GISTs may be especially more critical in larger (≥5 cm) tumors as the risk of malignant behavior is higher in GISTs of this size category.

Although there have been numerous reports describing the imaging features of gastric GISTs and other subepithelial tumors [5–13], investigation regarding the imaging differentiation of GISTs from non-GISTs using CT is lacking. Recently, Choi et al. attempted to identify useful CT features helping to differentiate small (<5 cm) gastric GISTs from schwannoma [14]. They found that several CT features such as exophytic or mixed growth patterns, homogenous enhancements, peri-tumoral lymph nodes as well as slower doubling times can be suggestive of gastric schwannomas rather than GISTs. However, considering the low or very low risk of aggressive behavior in small GISTs, the impact of their results on clinical practice may be limited. In addition, they only considered schwannomas as a non-GIST tumor although there are several kinds of other mesenchymal tumors which occur in the stomach as listed above. Furthermore, whether knowledge of these CT findings truly influenced radiologists' diagnostic performance in differentiating GISTs from non-GISTs has not been analyzed.

Therefore, in this study, we attempted to determine whether there are characteristic CT features which may help differentiate GISTs from non-GISTs in patients with large (≥5 cm) gastric subepithelial tumors. Additionally, we assessed whether radiologists' performance in differentiation can be improved with knowledge of these CT criteria.

2. Materials and methods

2.1. Patients

This retrospective study was approved by our institutional review board and the requirement for informed consent was waived. A search of our pathology database from January 1999 to October 2012 for subepithelial lesions in the stomach revealed 420 patients with GISTs, 115 patients with leiomyomas, 49 patients with schwannomas, 5 patients with glomus tumors, and 21 patients with ectopic pancreas. All lesions were confirmed through histopathologic analysis of surgical or biopsy specimens. To make a study group of suitable cases for comparing CT findings of large subepithelial tumors, we used the following inclusion criteria: (a) pathologic diagnosis of GIST, schwannoma, leiomyoma, glomus tumor, or ectopic pancreas of the stomach; (b) available contrast-enhanced CT images; (c) lesions greater than or equal to 5 cm in maximum diameter on gross pathologic specimen or CT.

Of the total 610 subepithelial tumors, 300 GISTs, 110 leiomyomas, 33 schwannomas, and other remaining types of subepithelial tumors were excluded due to their small size of less than 5 cm. Ten patients with GISTs were additionally excluded as there were no available CT images. We also excluded four patients with metastatic GISTs and two patients with ruptured GISTs, as the presence of metastasis or peritoneal rupture is exclusively found in GISTs. Furthermore, five patients who had received preoperative molecular-targeted treatment with imatinib (Gleevec®, Novatis, USA) were excluded as targeted treatment for GISTs may alter the CT findings of the tumor [15]. Finally, 120 patients with ≥5 cm gastric subepithelial tumors were enrolled in our study: 99 patients with GIST (57 men, 42 women; mean age, 60.4 ± 12.9 (standard deviation (SD)) years; range, 25–85 years), 16 patients with schwannoma (7 men, 9 women; mean age, 58.9 ± 12.4 (SD) years; range, 37–83 years), and 5 patients with leiomyoma (3 men, 2 women; mean age, 42.4 ± 13.2 (SD) years; range, 27–63 years).

2.2. CT acquisition

Most CT scans (91/120, 75.8%) were obtained using one of the following MDCT scanners: 64-channel MDCT (Brilliance 64; Philips Medical Systems, Cleveland, Ohio (n = 27), Discovery 750 HD; GE Medical Systems, Milwaukee, WI (n = 6), and Ingenuity; Philips Medical Systems, Cleveland, Ohio (n = 4)) in 37 patients, 16-channel (Sensation 16; Siemens Medical Systems, Forchheim, Germany) in 21, 8-channel (LightSpeed Ultra; GE Healthcare, Milwaukee, WI) in 24, 4-channel (Mx8000; Philips Medical Systems, Cleveland, Ohio) in 8, and 320-channel (Aquilion ONE; Toshiba Medical Systems, Otawara, Tochigi, Japan) in 1. The remaining 29 CT examinations were performed using one of two single-detector CT scanners (Somatom Plus 4; Siemens Medical Systems, Forchheim, Germany (n = 20), HiSpeed Advantage; GE Healthcare, Milwaukee, WI (n = 9)). For MDCT examinations, the scanning parameters were as follows: detector configuration, 0.625–1 mm; pitch, 0.891–1.35; rotation time, 0.5–0.75 seconds; 120 kVp; 150–250 mAs. For single-detector CT, acquisition parameters were slice thickness/reconstruction interval of 5 mm/5 mm, pitch of 1, rotation time of 1 s, 120 kVp, and 200 mAs.

Prior to CT scanning, 76 patients (63.3%) were asked to ingest two packs of an effervescent agent (n = 57) or more than 1000 mL of water (n = 19) to attain adequate gastric distention. For 70 patients, CT scanning was performed in two positions; left posterior oblique and right decubitus (n = 53), supine and right decubitus (n = 10), or prone and right decubitus (n = 7). For the remaining 50 patients, CT scanning was done in either the supine (n = 48) or prone (n = 2) position. Relationship between patients' position and gastric distention was illustrated in Fig. 1. For the left posterior oblique position, patients were first positioned in the left lateral decubitus position to shift gastric contents from the lower two thirds to the fundus of the stomach. They were then immediately placed on the scanning table in a 30° left posterior oblique position by placement of a pillow under their back. The left posterior oblique position was used to better distend the lower half of the stomach [16] (Fig. 1).

For contrast enhancement, 1.5 mL/kg of a 370 mgI/mL iodinated contrast agent (Ultravist 370, Bayer Schering Pharma, Berlin, Germany) was administered at a rate of 3–5 mL/s with an automatic power injector. Multiphase dynamic CT images were obtained in 93 of 120 patients; arterial and portal venous phases (n = 17); arterial, portal, and equilibrium phases (n = 30); and portal and equilibrium phases (n = 46). In the remaining 27 patients, only portal phase scanning was performed. For the arterial phase, a delay time of 13–17 s was used after the attenuation of the descending aorta reached 100 HU using the bolus tracking technique. Portal phase scanning was performed 60–75 s after contrast administration. Equilibrium phase CT images were obtained immediately after changing positions from the first position.

2.3. Image analysis

CT images were reviewed in three different reading sessions. First, two radiologists interpreted the CT images in consensus to determine significant CT features in the differentiation of GISTs from schwannoma and leiomyoma. The next two sessions were performed for independent review of the CT images by two other radiologists without and thereafter with information of significant CT features determined at the consensus reading session.

For the first consensus reading session, two radiologists (Kim SH and Choi YR of 15 and 3 years of experience, respectively) who were blinded to the histopathologic results and clinical information reviewed the CT images. All CT images were reviewed