Computed Tomographic Features of Adenocarcinoma Compared to Malignant Lymphoma of the Stomach

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Objective: *To compare the CT findings of adenocarcinoma and malignant lymphoma of the stomach.*
Material and Method: *The authors retrospectively reviewed the computed tomographic images of 21 patients who received a definite pathologic diagnosis of adenocarcinoma or malignant lymphoma of the stomach. The images were taken at Srinagarind Hospital between January 2006 and February 2009. Seventeen patients with gastric adenocarcinoma and four with malignant gastric lymphoma were included in the present study. The pattern of involvement, the location of lesion, the perigastric fat plane, the perigastric lymphadenopathy and the extension of disease on CT images were evaluated and analyzed by Chi-square and Fisher exact tests.*
Results: *There was a statistically significant difference between gastric adenocarcinoma and malignant gastric lymphoma in the pattern of involvement of disease ($p = 0.010$), the perigastric fat plane ($p = 0.002$) and the location of disease ($p = 0.008$). By contrast, there was no respective statistically significant difference in the perigastric lymphadenopathy ($p = 0.950$) and the extension of disease ($p = 0.175$) in between gastric adenocarcinoma and malignant gastric lymphoma.*
Conclusion: *The CT findings helpful for differentiating gastric adenocarcinoma from malignant gastric lymphoma are the pattern of involvement, the perigastric fat plane, and the location of lesion. Localized involvement of the lesion, abnormal perigastric fat plane and location involving one region of the stomach tend to indicate gastric adenocarcinoma; while diffused involvement of the lesion, preserved perigastric fat plane and location involving more than one region of the stomach tend to indicate malignant gastric lymphoma.*

Keywords: *Computed tomography, Stomach, Adenocarcinoma, Lymphoma*

J Med Assoc Thai 2011; 94 (11): 1387-93
Full text. e-Journal: *http://www.mat.or.th/journal*

Recent advances in computed tomography (CT) and three-dimensional (3D) imaging software have renewed interest in using CT to evaluate gastric disease. Multi-detector row CT scanners allow thinner collimation, which improves the visualization of subtle tumors as well as the quality of the 3D data sets. When water is used as an oral contrast agent, subtle disease is easier to visualize, especially when a rapid contrast material bolus is intravenously administered[1]. Adenocarcinoma is the most common gastric malignancy and typically appears as focal or segmental wall-thickening or a discrete mass. Gastric lymphoma can have a CT appearance similar to that of adenocarcinoma. Both gastric adenocarcinoma and lymphoma may be associated with adenopathy.

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Adenocarcinoma is the most common gastric malignancy, representing over 95% of malignant tumors of the stomach. It is an aggressive tumor with a 5-year survival rate < 20%[1]. Prognosis correlates with the stage of the tumor at presentation. Therefore, accurate staging of gastric cancer is essential because surgical resection is the treatment for localized disease. CT is currently the staging modality of choice because it can help identify the primary tumor, assess for local spread, and detect nodal involvement and distant metastases.

Lymphoma – the stomach is the most frequent site of gastrointestinal tract involvement by non-Hodgkin lymphoma. With CT, gastric lymphoma typically appears as segmental or diffuse wall thickening[1-3]. In contrast to gastric adenocarcinoma, lymphoma typically involves more than one region of the stomach. Perigastric adenopathy is common in patients with gastric lymphoma as well as in those with gastric adenocarcinoma. However, adenopathy that

extends below the renal hilar favors gastric lymphoma over adenocarcinoma as a diagnosis. In additional to helping detect gastric involvement by lymphoma, CT is useful in detecting complication such as perforation, extragastric extension, or fistulization.

The purpose of the present study was to compare the CT findings of adenocarcinoma and malignant lymphoma of the stomach.

Material and Method

Data collection

The authors retrospectively reviewed the CT images, radiological records, and medical records of 21 patients having a definite pathological diagnosis of adenocarcinoma or malignant lymphoma of the stomach. The patients were seen at Srinagarind Hospital between January 2006 and February 2009. The present study was approved by the Institutional Review Board of Srinagarind Hospital, Faculty of Medicine, Khon Kaen University, Thailand.

The present study population in the gastric adenocarcinoma group included 10 males (58.8%) and 7 females (41.2%) while the malignant gastric lymphoma group included 3 males (75%) and 1 female (25%) (Table 1). The age range of the gastric adenocarcinoma group was from 34 to 77 years (mean 57 years) while it was 36 to 66 years (mean 54 years) for the malignant gastric lymphoma group. The authors excluded any patients having a definite pathological diagnosis of adenocarcinoma or malignant lymphoma of the stomach who had received any previous treatment by surgery and/or chemotherapy.

Imaging technique

An optimum CT technique requires high spatial resolution, proper gastric distention, and proper timing of contrast media injection in order to detect subtle changes in the gastric wall and to accurately stage tumors.

For dedicated imaging of the stomach, adequate distention is essential. The authors prefer to use water as an oral contrast agent in patients with suspected gastric disease because it is inexpensive (usually free), well-tolerated, distends the stomach well, allows good visualization of the enhancing wall, and does not interfere with the manipulation of the 3D data sets. When CT is performed specifically to evaluate the stomach, the patient is given about 750-1000 mL of water approximately 15 minutes before scanning.

Gastric imaging has been improved by the introduction of multi-detector row CT scanners. The authors currently used a four-detector row CT scanner with a 0.5-second tube rotation (Somatom Volume Zoom; Siemens, Forchheim, Germany) in all 21 patients of the present study. The scan included the whole abdomen from the diaphragm to the iliac crest with 0.75-1.25 mm section collimation, at a pitch of > 1.0 with a 1.0-1.5 mm reconstruction. The scanning parameters were 120 kV, but 140 kV was used for optimal image quality in very obese patients.

In additional to an oral contrast agent, which allows good gastric distention, an intravenous contrast material is essential for complete evaluation of any neoplastic and inflammatory disease of the stomach. The authors routinely administer 100 mL of nonionic contrast material at a rate of 3 mL/sec. A 30-second and 70-second delay after initiation of the contrast material injection was used for the arterial and portovenous phases of the abdominal images with soft-tissue window (window width 300 HU; window level 40 HU).

Image evaluation

The CT images of both adenocarcinoma and malignant lymphoma of the stomach were evaluated in a blinded retrospective manner by two staff radiologists. If there was any disagreement, the final interpretation was reached through consensus. Locations of lesions were classified as fundus, body, and antrum. The involvement of the gastric wall was classified as either localized or diffuse. The thickness of the lesion was measured in centimeters. CT attenuation of a thickened gastric wall was classified as either an inhomogeneous hyperdensity or a homogenous hypodensity. Additional attenuation of a thickened gastric wall was measured in Housfield Unit (HU). The perigastric fat plane was classified as abnormal or preserved. The

Table 1. The number and age of the patients with adenocarcinoma and malignant lymphoma of stomach

	No. of patients	Mean age (range), yrs
Adenocarcinoma		
Total	17	57 (34-77)
Male	10	
Female	7	
Malignant lymphoma		
Total	4	54 (36-66)
Male	3	
Female	1	

perigastric lymphadenopathy was classified as whether extending above or below the renal pedicle. Extensions of disease were classified as adjacent organ and/or distant organ. Others items identified were gallstones, ascites, and pleural effusion.

The demographic data were expressed as the mean and range. The findings of adenocarcinoma and malignant lymphoma of the stomach groups were compared and analyzed by Chi-square and Fisher exact tests. A p-value of less than 0.05 was considered as statistically significant.

Results

The pattern of involvement of gastric adenocarcinoma was usually localized (70.6%, 12 in 17 patients) over against diffuse (29.4%, 5 in 17 patients) (Fig. 1, 2, Table 2). The pattern of involvement of malignant gastric lymphoma was always diffuse (100%, 4 in 4 patients). There was a statistically significant difference in the pattern of infiltration of disease between both groups (p = 0.010 and 95% CI; 1.003, 3.229).

The perigastric fat plane of gastric adenocarcinoma was mostly abnormal perigastric fat plane (94.1%, 16 in 17 patients) over against a preserved perigastric fat plane (5.9%, 1 in 17 patients). The perigastric fat plane of malignant gastric lymphoma was usually a preserved perigastric fat plane (75%, 3 in 4 patients) over against abnormal perigastric fat plane (25%1 in 4 patients). There was a statistically significant difference in the perigastric fat plane of disease between both groups (p = 0.002 and 95% CI; 0.001, 0.433).

The location of gastric adenocarcinoma was at the fundus 11.8% (2 in 17 patients), the body 47.1% (8 in 17 patients), the antrum 29.4% (5 in 17 patients), the fundus with body 5.9% (1 in 17 patients), and the E-G junction 5.9% (1 in 17 patients). The location of malignant gastric lymphoma was at the whole fundus, body, antrum 75% (3 in 4 patients) and antrum only 25% (1 in 4 patients) There was a statistically significant difference in location of disease between both groups (p = 0.008 and 95% CI; 0.0, 0.1).

Perigastric lymphadenopathy was common in gastric adenocarcinoma (76.5%, 13 in 17 patients) and in malignant gastric lymphoma (75%, 3 in 4 patients). Infrarenal lymphadenopathy in gastric adenocarcinoma was 23.5% (4 in 17 patients) and in malignant gastric lymphoma was 25% (1 in 4 patients). There was no statistically significant difference in the presentation of infra-renal lymphadenopathy between both groups (p = 0.950).

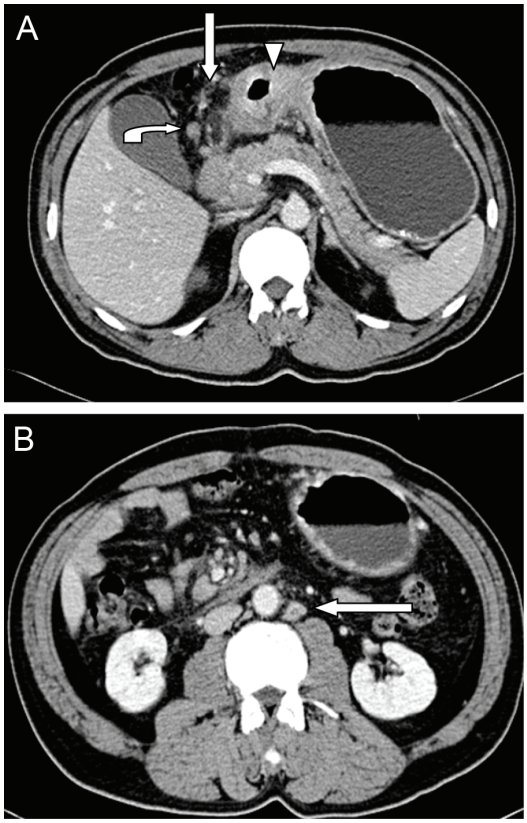

Fig 1. A 60 years old man with gastric adenocarcinoma (A) CT image shows circumferential mass at gastric antrum (arrowhead), perigastric fat plane involvement (straight arrow) and enlargement of perigastric node (curved white arrow)
(B) CT image at below level shows enlargement of lymph node at infrarenal region (straight arrow)

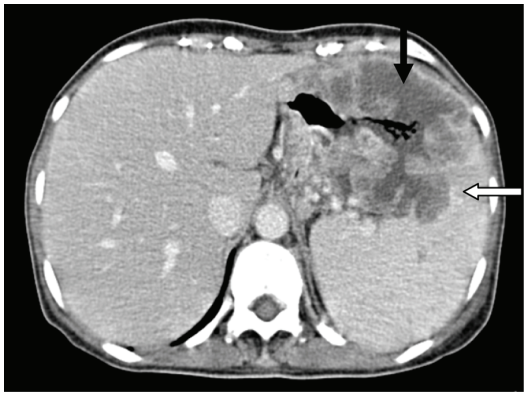

Fig 2. A 42 years old woman with gastric adenocarcinoma at gastric fundus (black arrow), inhomogeneous enhancement of the tumor and evidence of splenic invasion (white arrow)

Table 2. Comparison between the CT findings in adenocarcinoma and malignant lymphoma of stomach

Findings	Adenocarcinoma (n = 17)		Lymphoma (n = 4)		p-value
	No.	%	No.	%	
Pattern of involvement					
Localized	12	70.6	0	0	0.010
Diffuse	5	29.4	4	100	
Perigastric fat plane					
Abnormal	16	94.1	1	25	0.002
Preserve	1	5.9	3	75	
Location					
Body	8	47.1	0	0	0.008
Antrum	5	29.4	1	25	
Fundus	2	11.8	0	0	
Fundus, body	1	5.9	0	0	
E-G junction	1	5.9	0	0	
Fundus, body, antrum	0	0	3	75	
Perigastric LN					
No infrarenal	13	76.5	3	75	0.950
Infrarenal	4	23.5	1	25	
Extension					
Adjacent organ	3	17.6	2	50	0.175
Distant organ	8	47.1	0	0	
No extension	6	35.3	2	50	

Enhancement of the thickened gastric wall in gastric adenocarcinoma was inhomogeneous enhancement 76.5% (13 in 17 patients) and homogeneous enhancement 23.5% (4 in 17 patients). Enhancement of thickened gastric wall of malignant gastric lymphoma was homogeneous enhancement 75% (3 in 4 patients) and inhomogeneous enhancement 25% (1 in 4 patients) (Fig. 2, 3). There was a statistically significant difference in enhancement of the thickened gastric wall between both groups (p = 0.049; and 95% CI; 0.0, 0.2).

The extension of disease in gastric adenocarcinoma was to distant organs 47.1% (8 in 17 patients), adjacent organs 17.6% (3 in 17 patients) and no extension 35.3% (6 in 17 patients). In malignant gastric lymphoma, the extension was to adjacent organs 50% (2 in 4 patients) and no extension 50% (2 in 4 patients). There was no statistically significant difference in extension of disease between both groups (p = 0.175).

The thickness of gastric wall in gastric adenocarcinoma had a range of thickness from 1.1 to 4.0 cm and mean of thickness was 1.92 cm. The thickness of the gastric wall in malignant gastric lymphoma had a range of thickness from 1.0 to 3.7 cm and mean of thickness was 2.5 cm.

The range of CT attenuation of gastric adenocarcinoma was 28 to 58 HU (mean 38 HU) in precontrast study and was 80 to 130 HU (mean 108 HU) in postcontrast study. The range of CT attenuation of malignant gastric lymphoma was 33 to 42 HU (mean 38 HU) in precontrast study and was 70 to 100 HU (mean 86 HU) in postcontrast study.

Gastric adenocarcinoma had other CT findings such as ascites 29.4% (5 in 17 patients), pleural effusion 11.8% (2 in 17 patients) and gall stones 23.5% (4 in 17 patients) while malignant gastric lymphoma had no such CT findings.

Discussion

Numerous studies[4-10] over the years have independently discussed the computed tomographic features of gastric neoplasm and malignant gastric lymphoma, while only a few[1-3] have compared the computed tomographic findings between gastric adenocarcinoma and malignant gastric lymphoma.

In the literature[2] it revealed the CT features of gastric adenocarcinoma include: (1) a focal area of wall-thickening; (2) diffuse infiltration (linitis plastica); (3) a bulky or ulcerated mass; (4) intraluminal, exophytic or mixed disease; (5) abnormal perigastric fat; (6) local

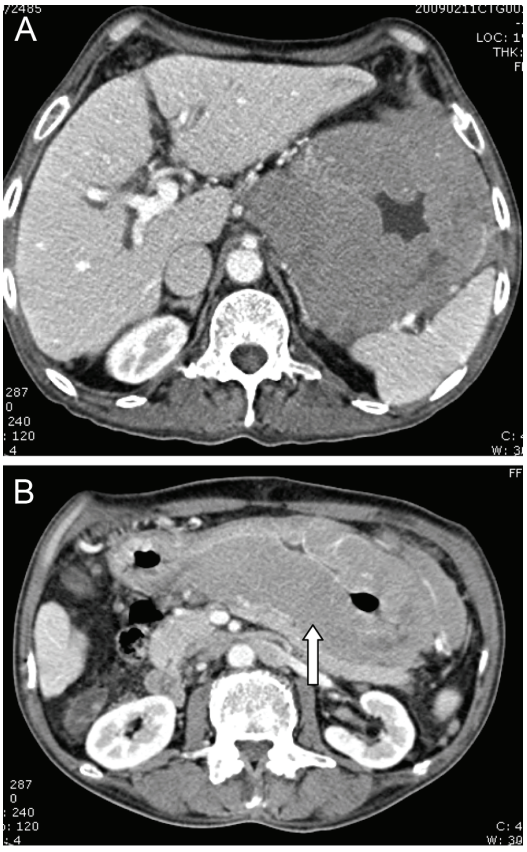

Fig. 3 A 66 years old man with malignant gastric lymphoma
(A) CT image shows diffuse thickening of gastric wall (gastric fundus and body)
(B) There is almost homogeneously enhancement of gastric mass (straight arrow)

lymphadenopathy; (7) seeding along the peritoneal ligaments; and, (8) metastases. In the same literature[2] also presented the CT features of gastric lymphoma, which included: (1) wall thickening > 1 cm; (2) diffuse infiltration > 50% of the wall; (3) circumferential involvement of most of the stomach; (4) segmental infiltration of the stomach; (5) homogeneous wall-thickening with preservation of the overlying rugae; (6) localized polypoid lesions with ulcers or perforation; and, (7) presence of lymph nodes on either side of the mesenteric vessels. Despite the differences, the authors[2] said that the CT appearance of gastric lymphoma and gastric carcinoma might be very similar. Therefore, it was the challenge for the present study to compared computed tomographic features between gastric adenocarcinoma and malignant gastric lymphoma.

The difference in the pattern of involvement between gastric adenocarcinoma and malignant gastric lymphoma was significantly different ($p = 0.010$). Gastric adenocarcinoma usually had localized involvement whereas malignant gastric lymphoma had diffuse involvement. These findings are similar to previous studies[1-3]. Ba-Ssalamah et al[2] reported that gastric adenocarcinoma had focal areas of wall-thickening while gastric lymphoma had diffuse infiltration > 50% of the wall. Horton and Fishman[1] confirmed that gastric adenocarcinoma typically appears as focal or segmental wall-thickening while gastric lymphoma typically appears as diffuse wall-thickening. Stetter et al[3] reported that gastric adenocarcinoma had focal wall-thickening and malignant gastric lymphoma had diffuse wall-thickening. For the perigastric fat plane, the statistically significant difference between gastric adenocarcinoma and malignant gastric lymphoma was shown ($p = 0.002$). The perigastric fat plane of gastric adenocarcinoma was abnormal whereas for malignant gastric lymphoma it was preserved, which agrees with previous reports[1,4,5]. Ba-Ssalamah et al[2] reported that gastric adenocarcinoma had an abnormal perigastric fat plane whereas malignant gastric lymphoma was preserved. The review by Balfe et al[4] showed that gastric adenocarcinoma had obliteration of the posterior fat plane between the stomach and pancreas. Buy and Moss[5] found that CT features that were highly suggestive of gastric lymphoma were complete preservation of perigastric fat plane.

As for the location of disease, there was a statistically significant difference between gastric adenocarcinoma and malignant gastric lymphoma ($p = 0.008$). In the present study, the gastric adeno-carcinoma was located at the body (47.1%), the antrum (29.4%), the fundus (11.8%), the fundus with the body (5.9%), and the E-G junction (5.9%). By comparison, the malignant gastric lymphoma was located at the whole fundus, the body and the antrum (75%) and at the antrum only (25%), which were resembled to the previous study[2]. Ba-Ssalamah et al[2] found that gastric adenocarcinoma was located at the antrum (30%), the body (30%), the fundus or cardia (30%) and diffuse entire stomach (10%); whereas most cases of malignant gastric lymphoma involved the antrum and body, although the entire stomach can be involved.

The present study revealed that perigastric lymphadenopathy in gastric adenocarcinoma was 76.5% and in malignant gastric lymphoma was 75%, which was similar to previous a study [1,5]. Buy and Moss[5] found that perigastric lymphadenopathy

occurred about 50 to 60% of patients with gastric lymphoma and gastric adenocarcinoma. Similarly, Horton and Fishman[1] showed that perigastric adenopathy is common in patients with gastric lymphoma as well as in those with gastric adenocarcinoma.

In the present study, infrarenal lymphadenopathy in gastric adenocarcinoma was 23.5% and in malignant gastric lymphoma was 25%. There was no statistically significant difference in infrarenal lymphadenopathy between gastric adenocarcinoma and malignant gastric lymphoma ($p = 0.950$). Buy and Moss[5] reported that lymphadenopathy in gastric adenocarcinoma is usually localized above the renal pedicle whereas in gastric lymphoma is usually metastatic lymph node below the renal pedicle and associated with perigastric adenopathy. The review by Horton and Fishman[1] showed that however, adenopathy that extends below the renal hilar favors gastric lymphoma over adenocarcinoma as a diagnosis.

The difference in extension of the disease between gastric adenocarcinoma and malignant gastric lymphoma was not statistically significant ($p = 0.175$) in the present study. The review by Buy and Moss[5] showed that direct spread into other organs was present 42% in gastric lymphoma and 73% in gastric adenocarcinoma. Thus, adjacent organ can occur in both groups of patients while it is more often encountered in patients with gastric carcinoma. Ba-Ssalamah et al[2] reported that gastric adenocarcinoma was metastases and seeding along peritoneal ligaments.

In the present study, the thickness of the gastric wall in gastric adenocarcinoma ranged from 1.1 to 4.0 cm (mean 1.92 cm). Balfe et al[4] reported that gastric adenocarcinoma ranged from 1.2 to 4.0 cm but no described meaning of thickness in gastric adenocarcinoma.

In the present study, the thickness of the gastric wall in malignant gastric lymphoma ranged from 1.0 to 3.7 cm (mean 2.5 cm). Buy and Moss[5] showed that thickened gastric wall was always greater than 1 cm (range 1.2-7.7 cm; mean 4.0 cm). Ba-Ssalamah et al[2] also found that gastric lymphoma had wall-thickening > 1 cm. The review by Ba-Ssalamah et al[2] showed that early gastric lymphoma had an average size of only 3.5 cm at diagnosis while advanced gastric lymphoma had an average size of 10 cm.

Although retrospective data collection and small sample size are limitations of the present study, the significant findings in the present study may give clues to confidentially distinguishing gastric adenocarcinoma from malignant gastric lymphoma on CT imaging.

Conclusion

The CT findings that are helpful for differentiating gastric adenocarcinoma from malignant gastric lymphoma are pattern of infiltration, perigastric fat plane, and location of lesion. Localized involvement of the lesion, abnormal perigastric fat plane, and location involving one region of the stomach such as at fundus, body, or antrum tend to be gastric adenocarcinoma. Diffused infiltration of the lesion, preserved perigastric fat plane, and location involving more than one region of the stomach or involving entire stomach tend to be malignant gastric lymphoma.

Acknowledgement

The authors wish to thank the Faculty of Medicine, Khon Kaen University, for its support and Mr. Bryan Roderick Hamman for assistance with the English-language presentation of the manuscript.

Potential conflict of interest

None.

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ลักษณะภาพเอกซเรย์คอมพิวเตอร์ของมะเร็งกระเพาะอาหารชนิด adenocarcinoma เปรียบเทียบกับ malignant lymphoma

นิตยา ฉมาดล, จิตราภรณ์ วงศ์วิวัฒน์ไชย, ธารินี วชิรโกวิทย์, ชวลิต ไพโรจน์กุล

วัตถุประสงค์: *เพื่อศึกษาเปรียบเทียบลักษณะภาพเอกซเรย์คอมพิวเตอร์ระหว่างมะเร็งกระเพาะอาหารชนิด adenocarcinoma และ malignant lymphoma*

วัสดุและวิธีการ: *เป็นการศึกษาลักษณะภาพเอกซเรย์คอมพิวเตอร์ย้อนหลังตั้งแต่ มกราคม พ.ศ. 2549 ถึง กุมภาพันธ์ พ.ศ. 2552 รวมทั้งหมด 21 ราย (adenocarcinoma 17 ราย, malignant lymphoma 4 ราย) ซึ่งได้ทำการศึกษาเปรียบเทียบ ลักษณะรูปแบบรอยโรค ตำแหน่งรอยโรค ลักษณะการเปลี่ยนแปลงรอบกระเพาะอาหาร ต่อมน้ำเหลือง และการแพร่กระจายของตัวโรค โดยใช้สถิติ Chi-square และ Fisher exact test*

ผลการศึกษา: *ลักษณะภาพเอกซเรย์คอมพิวเตอร์ที่มีความแตกต่างกันอย่างมีนัยสำคัญทางสถิติได้แก่ ลักษณะรูปแบบรอยโรค (p = 0.010) ตำแหน่งรอยโรค (p = 0.002) ลักษณะการเปลี่ยนแปลงรอบกระเพาะอาหาร (p = 0.008) ส่วนลักษณะภาพเอกซเรย์คอมพิวเตอร์ที่ไม่มีความแตกต่างกันอย่างมีนัยสำคัญทางสถิติคือต่อมน้ำเหลือง (p = 0.950) และการแพร่กระจายของตัวโรค (p = 0.175)*

สรุป: *ลักษณะภาพเอกซเรย์คอมพิวเตอร์สามารถช่วยวินิจฉัยแยกโรคระหว่างมะเร็งกระเพาะอาหารทั้งสองกลุ่มได้ โดย adenocarcinoma จะให้ลักษณะรูปแบบเป็นแบบเฉพาะที่ ตำแหน่งรอยโรคมักพบตำแหน่งเดียวในกระเพาะอาหาร และมีลักษณะเปลี่ยนแปลงไขมันรอบกระเพาะอาหาร ส่วน malignant lymphoma จะให้ลักษณะรูปแบบเป็นแบบกระจายตำแหน่งรอยโรคมักพบมากกว่าหนึ่งตำแหน่ง และไม่พบความผิดปกติของไขมันรอบกระเพาะอาหาร*