The Role of Spiral Computed Tomography in the Detection & Staging of Gastric Malignancy

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ABSTRACT

Background :

Accurate evaluation of local extent of gastric malignancy is fundamental in the choice of an optimal therapeutic strategy.

Objectives :

The aim of this study was to evaluate the accuracy of spiral CT in detecting & staging of gastric malignancy.

Patients & Methods:

During the period from Nov 2001 to May 2002, 50 patients (35males & 17females) ,with an age range of 23-85years, had an abdominal Spiral CT examination at Spiral CT units of the Medical City. The patients were referred from Baghdad Teaching & Nursing Home Hospitals. All patients had endoscopic biopsy prior to CT examination. Abdominal CT findings were correlated with the operative & histopathological results according to TNM criteria.

Results :

The accuracy & sensitivity of Spiral CT in the detection & diagnosis of gastric malignancy in general were 96% & 100% respectively. Two patients showed false positive results ,due to severe gastric wall thickening caused by chronic inflammation. Regarding gastric adenocarcinoma, the accuracy, sensitivity & specificity of CT diagnosis were 98%,100% & 88.9% respectively. The Overall agreement between CT diagnosis & final diagnosis of different types of gastric malignancy was 96% . The sensitivity, specificity & accuracy of CT in pre-operative staging of gastric tumor was 79%,50% & 77.8% respectively. CT showed higher accuracy in advanced cases. Spiral CT showed accuracy of 92% in detecting metastasis to the extra-perigastric lymph nodes compared to low accuracy (37.8%) for the detection of perigastric metastatic lymph nodes. CT accurately detected liver metastasis ,ascites & tumor extension to pancreas .

Conclusions:

This study showed that Spiral CT is an accurate imaging modality for evaluation of gastric wall lesions providing important pre-operative informations to the surgoen. Spiral CT showed high sensitivity & accuracy for the detection & diagnosis of gastric malignancy in general .It even could detect gastric tumors (showing submucosal process) which were not detected by endoscopic biopsy .CT is also of value in the staging of gastric tumors with higher accuracy for advanced cases..

Key words :
Gastric malignancy, spiral CT.

Original Artical

Introduction:

Gastric carcinoma is the second most common cancer in the world and accounts for 95% of primary malignancies arising in the stomach [lymphoma (4%), leiomyosarcoma (1%)].The incidence of gastric cancer varies greatly from country to country, with most cases occurring in Asia[(1)] .

The result of Iraqi cancer registry shows that the stomach cancer (3.2%) is the most common site in gastrointestinal tract, it always ranks within the commonest ten cancers, adenocarcinoma forms 80% of total cases [(2)] .

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Regarding the clinical presentation, gastric carcinoma typically produce no specific symptoms when it is superficial and surgically curable [3,4] .The disease is often locally advanced or metastasized at the time of clinical presentation weight loss and abdominal pain are most frequent initial symptoms. Anorexia and nausea are often quite common [5] .

The accurate evaluation of the local extent of gastric cancer is fundamental in the choice of an optimal therapeutic strategy. Detection of tumor invasion beyond the gastric wall has considerable clinical importance because prognosis of the disease is directly related to the depth of invasion of gastric wall and lymph node involvement [6,7] .

Endoscopy and double contrast barium examination of the stomach are still the basic investigation in the diagnosis work-up of gastric cancer patients, however they are limited by their inherent inability to evaluate the transmural and extraserosal extension of disease, and gastric carcinoma staging has been traditionally based on pathological finding, obtained from the surgical specimens.CT has been shown to be capable of accurately detecting and staging gastric cancers [8]

Initial reports in the late 1970s, and early 1980s, were optimistic that CT was a reliable tool for staging gastric carcinoma .Lee et al (1979) [9] found that CT was able to identify the primary tumor, area of the direct extension and distant metastasis in patients who had advanced gastric carcinoma.

In another study, Balfe et al (1980)[10] found that primary tumor appeared as focal wall thickening ranging from 1-2 cm to 4 cm, and also correctly diagnosed tumor extension to the pancreas when the fat plane normally separating the stomach from the pancreas was obliterated. They concluded that CT was valuable in determining the extent of tumor including involvement of the adjacent organs.

CT anatomy of the stomach:

The stomach must be fully distended before good diagnostic images of gastric wall can be obtained [11]. The thickness of the normal gastric wall should not exceed (10mm) as measured from serosal surface to the recesses between the gastric fold. Increased normal thickness of the gastric wall may however be observed in substantial number of patients in the region of esophago-gastric junction and in gastric antrum & pylorus [12,13].

The normal gastric wall shows two or three layer appearance. The inner layer enhance markedly and correspond to the mucosal layer, the intermediate layer of low attenuation correspond to the submucosal layer & the occasionally seen outer layer of slightly higher attenuation correspond to the muscular-serosal layer [14] .

The contrast filled gastric fundus lies superior and posterior adjacent to the diaphragm or spleen.The gastric body traverse obliquely across midline to lie anteriorly and consequently becomes well distended with contrast and air in supine position.The antrum begins anteriorly and curves posteriorly, on its ventral surface lies either the left hepatic lobe or the abdominal wall [14].

Patients and Methods:

During the period from November 2001 to May 2002, prospective series of 50 patients (33 males, 17 females) with age range 23- 85 years , were examined by spiral CT.

The patients were collected from Nursing Home & Baghdad Teaching hospitals . All cases had an endoscopic biopsy performed before CT.

Histopathological confirmation was provided to 43 patients (37 adenocarcinoma, 3 lymphoma, 3 leiomyosarcoma). The remaining 7 patients had negative endoscopic biopsy but still had suspicion of gastric malignancy.

Spiral CT study was performed with Somatom Plus 4 Seimens. 120 KV, 130 mA, matrix (512 x 512), scan thickness of 5-10 with 10 mm intervals.

The patients had been fasting for at least 5 hours prior to CT examinations.

Each patient was given 1500 ml of diluted contrast (2%) water- soluble contrast medium.

One liter taken by the patient in the hour preceding the examination, and the remaining 500 ml just prior to the examination, for optimal distension of the stomach.

The patients were positioned on the scan table in the supine position. A pre-contrast scan was performed as routine. In some patients ,additional scan was obtained with the patient positioned according to the location of the tumor seen at endoscopy (in patients with antral or pyloric tumors the patients were scanned in prone position). Post-contrast scan was also obtained after injection of non-ionic contrast medium [350 mg/ml Iohexol (Omnipaque)] as a bolus dose.

For purposes of strict comparison, CT findings were correlated with surgical and histopathological results according to TNM criteria [1,4,15].

Results:

The age and gender distribution of the sample is shown in table (1).The mean age of the total sample was 54.6 ± 16.5 years . The age group (50-69 years) was found to be highest in number of patients(19 patients, 38%).The sample included 17 females (34%), and 33 males (66%).

Table 1: Frequency distribution of the study sample by age and gender.

	N	%
Age in years		
<30	5	10
30-49	14	28
50-69	19	38
70+	12	24
Mean +/- SD= 54.6+/-16.5		
Gender		
Female	17	34
Male	33	66
Total	**50**	**100**

Upper abdominal pain, nausea, weight loss, anaemia and gastrointestinal bleeding were the most frequent presenting signs and symptoms as shown in table (2).

Table 2:Presenting sign and symptoms.

Presenting symptoms (n=50)	N	%
Abdominal pain	50	100
Weight loss	38	76
Anaemia	36	72
Nausea	21	42
Gastrointestinal bleeding	2	4

Of 50 patients, 12 did not undergo surgery because CT demonstrated multiple liver metastasis, with extensive peritoneal metastasis or para-aortic lymphadenopathy and pancreatic involvement.

The observed agreement between CT and final diagnosis in classifying the study sample into 4 possible stomach pathologies (adenocarcinoma, lymphoma, leiomyosarcoma, and chronic inflammation) was 96% (table 3). Adenocarcinoma was the final diagnosis in 41 pateints (82%), lymphoma in 4(8%) & leiomyosarcoma in 3(6%) (table 3).

Table 3: Agreement between CT and final diagnosis in classifying the study sample into 4 possible stomach pathologies.

	Final Diagnosis				
	Adenocar-cinoma	Lymphoma	Leiomyo-sarcoma	Chronic inflammation	Total
Diagnosis by spiral CT					
Adenocarcinoma	41			1	**42**
Lymphoma		4		1	**5**
Leiomyosarcoma			3		**3**
Chronic inflammation					**0**
Total	**41**	**4**	**3**	**2**	**50**

Observed agreement = 48/50 = 96%.

The lesions measured from 2cm to 15cm with an average of 6.78cm, the lesion were distributed in antrum 25(50%), the body 12(24%), the fundus 9(18%), and the prepyloric 4(8%) as shown in (table 4).

Most of adenocarcinoma & lymphoma cases were detected in the antrum, in 51.2 % & 75% respectively,while 66.7% of cases of leiomyosarcomas were detected at the body of the stomach (table 4).

Table 4: Common sites of tumor in the stomach.

	Site of tumor in stomach									
	Prepyloric		Fundus		Body		Antrum		Total	
	N	%	N	%	N	%	N	%	N	%
Final Diagnosis										
Adenocarcinoma	2	4.9	9	22	9	22	21	51.2	41	100
Lymphoma	1	25					3	75	4	100
Leiomyosarcoma					2	66.7	1	33.3	3	100
Chronic inflammation	1	50			1	50			2	100
Total	**4**	**8**	**9**	**18**	**12**	**24**	**25**	**50**	**50**	**100**

In all patients, spiral CT showed destruction of multilayered pattern with marked thickening of gastric wall. In 75.6% of cases of adenocarcinoma, obliteration of fat plane was detected, compared to 25%of lymphoma cases and 66.7% of leiomyosarcoma cases (table 5).

Table 5: The positivity rate of 2-CT features of malignancy by stomach pathology.

	Positive CT features					
	Wall thickening (> 1cm)		Obliteration of fat plane		Total	
	N	%	N	%	N	%
Final Diagnosis						
Adenocarcinoma	41	100	31	75.6	41	100
Lymphoma	4	100	1	25	4	100
Leiomyosarcoma	3	100	2	66.7	3	100
Chronic inflammation	2	100	0	0	2	100

In addition to evaluating gastric wall, spiral CT not only rely on thickening of gastric wall, also by enhancing pattern of tumor , there was marked degree of tumor enhancement in 45 patients, moderate degree in 2 patients & mild in 3 patients, so hyperdense tumor was detected relative to normal

enhancing gastric mucosa in 45 patients ,hypodense tumor in 3 patients & isodense in 2 patients ,this was helpful to improve detectability of tumor.

Spiral CT was found to be capable of accurately detecting gastric malignancy.All the 41 cases with final diagnosis of adenocarcinoma (true positive),were also diagnosed as carcinoma by CT,4 cases from those had false negative result by endoscopy.All 48cases with final diagnosis of gastric malignancy in general (true positive),were positive on CT and from those,5 cases (10.4%) were false negative by endoscopy.Regarding the two cases who were really negative for gastric malignancy on final diagnosis,both were also negative on endoscopy but were falsely positive by CT, as shown in table (6).

Table 6: Comparison of CT and endoscopic diagnosis of adenocarcinoma and gastric malignancy in general for true positive and true negative cases.

	CT diagnosis				
	Adenocarcinoma			Gastric malignancy	
Provisional diagnosis by endoscopy	**Negative**	**Positive**	**Total**	**Positive**	**Total**
True positive cases					
Negative	0	4	4	5	5
Positive	0	37	37	43	43
Total	0	41	41	48	48
True negative cases					
Negative	8	1	9	2	2
Total	8	1	9	2	2

The validity parameters of CT in the diagnosis of adenocarcinoma and malignancy of stomach in general is shown in table (7).

Table7: The validity parameters of CT in the diagnosis of adenocarcinoma and malignancy of stomach in general.

	Final Diagnosis				
Provisional diagnosis by CT	**Negative**	**Positive**	**Total**		
Adenocarcinoma				**Sensitivity**	=100
Negative	8	0	8	**Specificity**	=88.9
Positive	1	41	42	**PPV**	=97.6
Total	**9**	**41**	**50**	**NPV**	=100
				Accuracy	=98.0
				False -ve	=0.0
				False +ve	=11.1
Gastric malignancy #					
Negative	0	0	0	**Sensitivity**	=100
Positive	2	48	50	**PPV**	=96.0
Total	**2**	**48**	**50**	**Accuracy**	=96.0
				False -ve	=100

Note: Specificity, NPV and false positive proportions can not be calculated

The detection rate of lymph node metastasis was higher for extra-perigastric lymph nodes, corresponding to sensitivity 100%, the specificity and accuracy were 85% and 92.1% respectively while the detection rate for perigastric lymph nodes was low, with sensitivity, specificity, and accuracy of 33.3% , 75% , and 37.8% respectively (table 8).

The sensitivity, specificity, and accuracy of CT in evaluating invasion of pancreas were (91.7% , 96.2% , and 94.7%) respectively. The sensitivity, specificity, and accuracy of CT for liver metastasis were (100%). The sensitivity, specificity and accuracy of CT in evaluation for colonic invasion were (75% , 100% , and 100%) respectively. CT had limited sensitivity for peritoneal metastasis implantation (45.5%) but the specificity, and accuracy were quite high (100%) (table 8).

Table 8: Validity parameters of CT findings in predicting its counterpart at surgery.

		Extra-perigastric lymph nodes	pancreas	colon	liver	perigastric lymph nodes	peritoneum	Distant metastasis (in general)
Sensitivity	=	100	91.7	75.0	100	33.3	45.5	100
Specificity	=	85.0	96.2	100	100	75.0	100	82.4
PPV	=	85.7	91.7	100	100	91.7	100	87.5
NPV	=	100	96.2	97.1	100	12.0	81.8	100
Accuracy	=	92.1	94.7	97.4	100	37.8	84.2	92.1
False -ve	=	0.0	8.3	25.0	0.0	66.7	54.5	0.0
False +ve	=	15.0	3.8	0.0	0.0	25.0	0.0	17.6

Comparing the TNM staging by CT finding of 36 cases with result of surgery and histopathological examination, the observed agreement was 75% (table 9).

Table 9: Joint assessment of tumor stage by CT and surgery.

	Tumor stage at surgery				Total
	Stage-I	**Stage-II**	**Stage-III**	**Stage-IV**	
Tumor stage by CT					
Stage-I					
Stage-II	1		6	1	8
Stage-III		1	2		3
Stage-IV				25	25
Total	**1**	**1**	**8**	**26**	**36**

Observed agreement = 27/36 = 75%

Regarding the validity parameters of spiral CT scan in differentiating between advanced and early stage of malignancy were as follows; accuracy of 77.8% and sensitivity of 79.4%, and specificity 50% (table 10).

Table 10: Validity parameters of CT scan in differentiating between advanced and early stages of malignancy.

	Assessment at surgery				
Tumor stage III or higher	**Negative (stage I-II)**	**Positive stage (III-IV)**	**Total**		
CT assessment				**Sensitivity**	=79.4
Negative (stage I-II)	1	7	8	**Specificity**	=50.0
Positive (stage III-IV)	1	27	28	**PPV**	=96.4
Total	**2**	**34**	**36**	**NPV**	=12.5
				Accuracy	=77.8
				False -ve	=20.6
				False +ve	=50.0

Note: CT scan has a presumed 100% accuracy in the diagnosis of stage 4 cases. In the present series 12 cases were labeled as stage 4 based on CT findings only and were not operated upon.

Discussion:

Until recently the role of pre-operative staging of gastric cancer was limited and the choice of type and extent of surgery was determined by the finding at laparatomy, however, the availability of new imaging methods that are able to evaluate the extent of tumor spread before surgery can have a significant impact on the decision of therapy [(7)].

In this study, cases of gastric malignancy showed a male to female ratio of 2:1 & the most common age group affected was (50-69 years) (table 1),this is in agreement with what is reported by Elia et al (2000) [(7)].

Gastric cancer is difficult to diagnose at an early stage because there are no identifying signs and symptoms [(1,4)].This study have documented the most common signs and symptoms of gastric carcinoma (table 2),and included; abdominal pain 100%, weight loss 38% ,anaemia 36%, nausea 21%, and gastro- intestinal bleeding 2%. This is in agreement with findings of other studies [(3,16)].

Spiral CT diagnosed 41 cases of adenocarcinoma (figure 1), 4 cases of lymphoma (figure 2) and 3 cases of leiomyosarcoma (figure 3) with observed agreement of 48/50 = 96% (table 3).

The most common stomach region affected by tumor was the antrum (50%), followed by the body (24%), fundus (18%), and preopyloric region (8%)(table 4). Mann et al (1991) [(17)] gave approximately the same results.

Spiral CT detected a thickened or abnormally enhancing wall in 100% of cases with accuracy of 96% (table 7). The inaccuracies occurred due to the fact that the wall thickening was not specific for gastric tumor and occurred in other pathological lesion. In this study, 2 cases had final diagnosis of chronic inflammation diagnosed as adenocarcinoma and lymphoma by CT due to extensive wall thickening (table 3 & 5).These findings were comparable with other studies [(13,16,18)].

Many authors [(6,16,18)], reported that adenocarcinoma and leiomyosarcoma showed obliteration of fat plane especially in advanced stage, while lymphoma showed preserved fat plane. And because of the patients in this study were in a relatively advanced stage, 75.6% cases of adenocarcinoma showed obliteration of fat plane, compared to 66.7% of leiomyosarcoma and 25% of lymphoma cases(table 5).

Chapman (1998)[13] and Gossios (2000)[16] reported that occasionally gastric cancer will spread submucosally leaving the mucosa intact, also lymphoma can be originated as submucosal process, so an endoscopic biopsy returns negative.In this study, 5 cases with final diagnosis of adenocarcinoma (4 cases) and lymphoma (1 case),were diagnosed positive by CT and false negative by endoscopy (table 6).

The degree of contrast enhancement of tumor was classified into marked ,moderate & mild degrees relative to normal enhancing gastric mucosa ,with markedly enhancing tumor being the most common pattern of enhancement ,comparable results was reported by Kosling (1995) [19].

In the present study (table 10), the sensitivity, specificity and accuracy of spiral CT in staging gastric tumor were 79%, 50%, and 77.8% respectively, Takao et al (1998)[14] showed that the accuracy of spiral CT for tumor staging was 82% ,while Hundt et al (1999)[20] found CT staging had an accuracy of 79.4%.

Staging inaccuracy was either due to overstaging or understaging. Overstaging was reported in 2 patients, stage I tumor as stage II in 1 patient and stage II as stage III in another patient (table 9). Overstaging was reported as tumor spread to pancreas due to adherence of tumor to the pancreas, which showed no invasion at surgery. This finding was in consistent with findings of other studies done by Kelinhaus (1988)[18] and Sussman (1988) [21].

There were 7 cases understaged by preoperative CT (table 9).The understaging was due to missed perigastric nodal metastasis and small nodules in peritoneal cavity and omentum.

With reference to extension of the cancer into adjacent organs, the limitation of CT was evident in the inability of CT to identify tiny nodules of peritoneal dissemination particularly in the absence of ascites[6,8,20]. In this study the sensitivity for detecting the peritoneal metastasis was 45.5%, and accuracy 84.2% while specificity was very high 100% (table 8).

Regarding ascites, all cases (7) were correctly diagnosed by CT.This finding was in agreement with other studies [6,7,18].). In consistence with Dehn et al (1984) [22],this study showed high sensitivity, specificity, and accuracy 100% in detection of liver metastasis (table 8). Direct invasion of adjacent organs like the pancreas is predicated when there is focal obliteration of fat plane separating the stomach from the pancreas. However, peritumoral inflammation can mimic local invasion of pancreas [17,23].

Spiral CT correctly diagnosed the presence or absence of pancreatic metastasis in 11 out of 12 patients.The only false positive case (3.8%)(table 8) was due to obliteration of fat plane between the pancreas and stomach and the gastric tumor was adherent to the pancreas. This finding was in agreement with what reported by Manami et al (1992) [24].

The sensitivity of spiral CT for detection of metastasis to colon was 75% while specificity and accuracy were very high 100% (table 8). Similar results are found in other studies [17,23,25].

The diagnosis of lymph node abnormalities on CT scan has been based on size criteria. The size and location of lymph node were important factors in determining the sensitivity for detecting lymph node involvement.CT imaging is limited in the detection of cancer involvement of normal sized nodes, and to distinguish between reactive hyperplasia and metastatic enlargement, although there was a clear correlation between enlargement of lymph node and cancer involvement [7].

In this study, regarding to perigastric lymph node involvement, the sensitivity was 33% while the specificity and accuracy were 75% and 37.8% respectively, which approximated the results obtained by Davies et al (1994) [5] and lower than results reported by Fukuya et al (1997) [8]. The low sensitivity for detecting perigastric lymph node involvement was due to difficulty in evaluating the distance between the tumor edge and lymph node.

Regarding to extra-perigastric lymph node involvement,the sensitivity, specificity, and accuracy were 100%,85%,92% respectively.This was in agreement with results reported by Hundt et al (1999)[20].

The false positive value in extra-perigastric lymph node involvement was 15% and in perigastric lymph node was 25% (table 8).The false positive results were due to inability of CT in differentiating between reactive hyperplasia and metastatic involvement of lymph nodes larger than 1cm.

The presence of local adenopathy has significant prognostic implication, but for all practical purposes, recognition of perigastric adenopathy is not critical because these nodes are almost always removed at time of gastric surgery [11,13,15,25,26].

In consistent with what is reported by Elia et al (2000) [7], the detection rate of extra-perigastric lymph nodes was higher than the prigastric lymph nodes because extra-perigastric lymph nodes were better evaluated along the arteries of gastric region.

In conclusion , Spiral CT showed high sensitivity & accuracy in the detection of gastric malignancy. Spiral CT proved to be of value in the pre-operative staging of gastric malignancy esepcially in advanced cases. This diagnostic technique, therefore, may have a positive impact on therapeutic decision.

Spiral CT scan detects gastric tumor which could not be easily detected by endoscopic biopsy especially for few cases of adencarcinoma and lymphoma which tend to have submucosal process.

While spiral CT has low detection rate for the lymph node especially perigastric node adjacent to primary lesion, it correctly identified most cases with invasion of liver, pancreas, colon, and is of value in detecting peritoneal metastasis.

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