Original article

Routine chest CT for staging of gastric cancer

A.-H. Chen[1], W.-H. Chan[1], Y.-H. Lee[1], J.-H. Tseng[1], T.-S. Yeh[2], C.-T. Chiu[3], J.-S. Chen[4] and C.-M. Chen[1]

Departments of [1]Medical Imaging and Intervention, [2]Surgery and [3]Gastroenterology and Hepatology, and [4]Division of Haematology–Oncology, Department of Internal Medicine, Chang Gung Memorial Hospital at Linkou and Chang Gung University College of Medicine, Taoyuan, Taiwan
Correspondence to: Dr C.-M. Chen, Department of Medical Imaging and Intervention, Chang Gung Memorial Hospital, 199 DunHua North Road, Taipei, Taiwan (e-mail: dr.cmchen@gmail.com)

Background: **International guidelines on clinical staging of gastric cancer recommend the use of chest CT for the detection of pulmonary metastases. This study assessed the clinical value of routine chest CT in the staging of gastric cancer.**

Methods: **This retrospective study included patients identified from the gastric cancer registry of Chang Gung Memorial Hospital, Linkou, Taiwan. All patients who underwent clinical staging between 2008 and 2014 were included. The pattern, site and number of metastases at initial presentation and after surgery with curative intent were evaluated. Pulmonary metastases were defined as multiple small round pulmonary nodules with a random distribution or of variable size.**

Results: **Some 1669 patients were included, of whom 478 (28·6 per cent) had metastatic disease at clinical presentation. The majority of metastases were to the peritoneum (75·7 per cent of patients) or liver (30·5 per cent), and only 27 patients (5·6 per cent) had pulmonary metastases at presentation, none of which were isolated to the lung. Of these 27 patients, 11 had primary lesions located at the cardia/fundus. In 19 patients the lung metastases were also detected on the staging chest X-ray. After surgery there were 196 cancer recurrences. Some 15 patients (7·6 per cent) had lung metastasis and this was not the only site of metastases in any patient. The prevalence of lung metastasis at presentation of the disease and after surgery was 1·6 and 1·5 per cent respectively.**

Conclusion: **This study does not support the routine use of chest CT for staging of gastric cancer as isolated pulmonary metastasis in the absence of other metastatic sites could not be detected.**

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Introduction

International guidelines[1–5] on gastric cancer staging recommend the use of CT of the chest, abdomen and pelvis. The American College of Radiology Appropriateness Criteria®[6] suggest that chest CT for the screening of pulmonary metastasis is required only when there is evidence of suspicious abnormalities on chest X-rays. In the absence of radiographic findings, chest CT is suggested for tumours with a high propensity for pulmonary metastasis, such as breast tumours, melanoma, renal cell, colonic and bladder carcinoma.

The most common sites of metastases from gastric cancer are the liver and peritoneum[7]. Pulmonary metastases are relatively uncommon[8]. The majority of pulmonary metastases are concurrent with other metastases, and isolated pulmonary metastases are rare. Chong and colleagues[9] from Singapore carried out a retrospective review of 808 patients and concluded that chest CT has only limited value owing to the rarity of isolated pulmonary metastasis (0·4 per cent) in patients with gastric cancer.

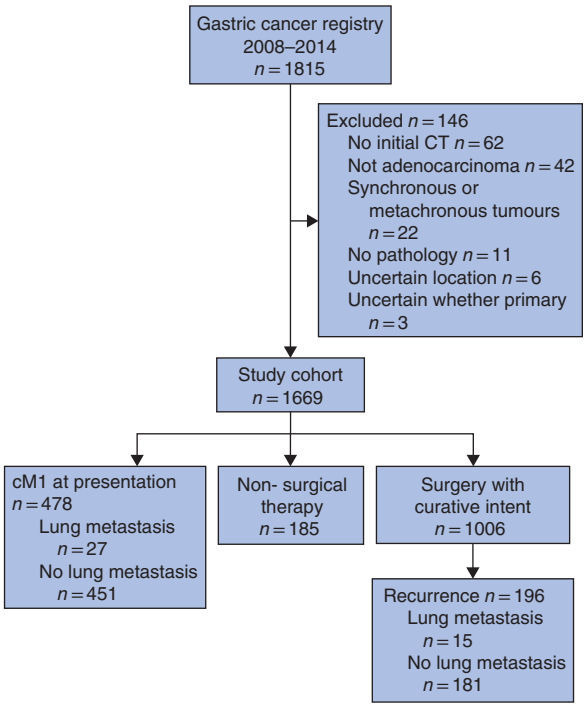
In colorectal cancer staging, chest CT has a low specificity for the detection of pulmonary metastasis and indeterminate findings are often reported[10–12]. Hence, routine chest CT is not recommended for colorectal cancer staging[13]. Pulmonary metastasectomy may lead to improved outcomes for patients with colorectal cancer[14,15], whereas the benefit of metastasectomy in gastric cancer is not clear and has been reported only in case series of highly selected patients[16,17].

The aim of this study was to evaluate the clinical value of routine chest CT for the clinical staging of gastric cancer.

Methods

This was a retrospective review of the gastric cancer registry at Chang Gung Memorial Hospital, Linkou,

Fig. 1 Study flow chart



Taiwan. This registry includes all patients diagnosed or referred for the treatment of gastric cancer. The present study included all patients treated between 2008 and 2014. Excluded were patients with no initial CT image on the hospital picture archiving and communication system, non-adenocarcinoma histopathology, synchronous or metachronous gastric tumours, absence of a histopathology report and uncertainty about the site of origin of the cancer. Staging was performed using the sixth (2008–2009)[18] and seventh (2010 onwards)[2] editions of the AJCC/IUCC staging system. The pattern of metastases at initial presentation and during follow-up after surgery with curative intent was evaluated. The hospital institutional review board approved the study and informed consent was waived.

CT staging protocol

As this is a large tertiary referral hospital, there was some variability in imaging protocols. Based on the institutional guideline for gastric cancer, complete imaging evaluation before surgery for gastric cancer consisted of chest X-ray and abdominopelvic CT. Gastric distension was achieved before imaging with ingestion of up to 1000 ml purified water. This was followed by contrast-enhanced imaging of the upper abdomen covering the stomach during the arterial phase, and the abdomen to the pelvis during the venous phase. Although not part of the standard protocol, referring physicians could request inclusion of the chest during CT staging. Images obtained from other hospitals were reviewed by radiologists from the multidisciplinary team and, if the images were adequate for evaluation, CT was not repeated before surgery.

Table 1 Patient and tumour characteristics

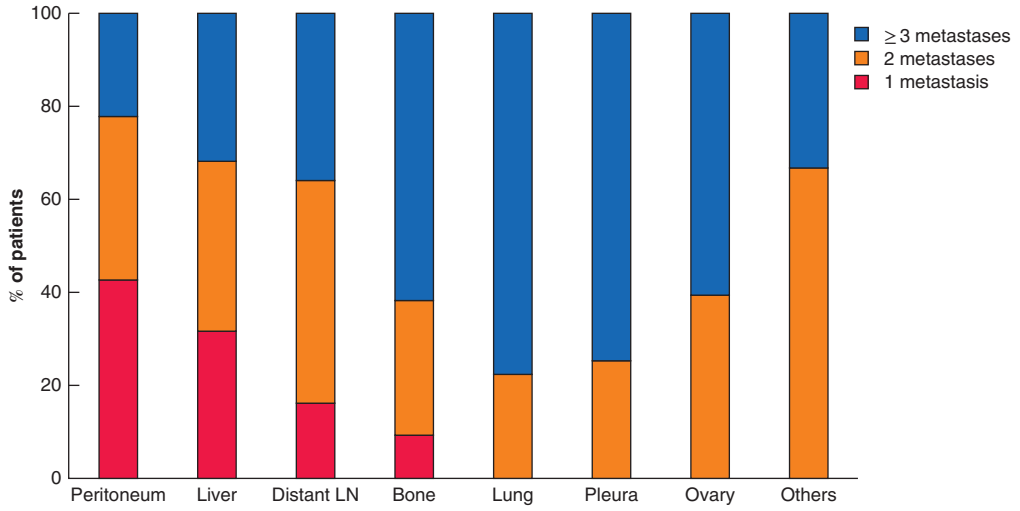
	No. of patients (*n* = 1669)
Age (years)*	67 (55–76)
Sex ratio (M : F)	1049 : 620
Primary tumour location	
Cardia/fundus	216 (12·9)
Body	534 (32·0)
Antrum	731 (43·8)
Diffuse (> 2 regions)	92 (5·5)
Gastric stump	96 (5·8)
Laurén classification	
Intestinal	502 (30·1)
Diffuse	430 (25·8)
Mixed	204 (12·2)
Unknown	533 (31·9)
Staging CT included chest	379 (22·7)
Clinical stage	
I	492 (29·5)
II	315 (18·9)
III	358 (21·4)
IV	488 (29·2)
0/unknown	16 (1·0)
Clinical T category	
cT2	456 (27·3)
cT3	503 (30·1)
cT4	424 (25·4)
cT1/unknown	286 (17·1)
Clinical M category	
cM0	1191 (71·4)
cM1	478 (28·6)

Values in parentheses are percentages unless indicated otherwise; *values are median (i.q.r.).

Image evaluation

All images were reviewed by radiologists participating in the multidisciplinary tumour board. Pulmonary metastases were considered to be present when there were multiple small round pulmonary nodules with a random distribution or of variable size, and when interlobular, septal or fissural thickening with multiple tiny centrilobular nodules was seen suggesting lymphangitis carcinomatosis.

Fig. 2 Distribution of patients with metastases by number of lesions at each site at clinical staging



No. of patients								
≥3 metastases	80	47	73	21	21	15	22	2
2 metastases	127	53	97	10	6	5	14	4
1 metastasis	155	46	32	3	0	0	0	0

LN, lymph node.

Malignant pleural effusion was diagnosed on the basis of a positive cytology aspirate. Bone metastases were diagnosed based on a positive bone scan, bone marrow aspirate or a gross morphological osteolytic lesion. Metastases to the liver, ovaries and other organs were diagnosed based on the presence of abnormal solid nodules at these sites, whereas peritoneal metastases were diagnosed when non-cirrhotic ascites or omental fat stranding or clustered subcentimetre omental nodules were present. Lymph nodes at distant and regional sites as defined by the AJCC were deemed positive for metastasis when they were clustered (3 or more, but smaller than 1 cm) or enlarged (1 cm or larger). Recurrence of tumour at the operative site after surgery was defined as local recurrence.

Data collection

Patient demographics, tumour location (cardia/fundus, body, antrum, diffuse if more than 2 regions involved, or gastric stump arising from previous gastrectomy), site of metastases (liver, peritoneum, distant lymph node, bone, lung, pleura, ovary and other sites), clinical stage, clinical T and M category, and whether chest CT was performed at staging were noted. Where tumour recurrence occurred after surgery with curative intent (all D2 gastrectomy), the site of metastases (local, peritoneum, liver, regional and distant lymph node, bone, lung, pleura and other sites), pathological stage and pT category were noted. The Laurén histological classification[19] was recorded when available.

Table 2 Pulmonary metastases at clinical staging and after surgery

	Clinical staging (*n* = 27)	Recurrence after surgery (*n* = 15)
Primary tumour location		
Cardia/fundus	11	5
Body	5	1
Antrum	8	8
Diffuse (> 2 regions)	3	1
Pulmonary metastases concomitant with other sites of metastasis		
2 sites	6	5
≥ 3 sites	21	10
Staging CT included chest		
Yes	16	2
No	11	13
Pulmonary nodules identified at staging chest X-ray		
Yes	19	0
No	8	15

Table 3 Demographic and tumour characteristics of patients with recurrent cancer after surgery with curative intent

	No. of patients ($n = 196$)
Age (years)*	65 (55–76)
Sex ratio (M : F)	132 : 64
Primary tumour location	
Cardia/fundus	25 (12·8)
Body	49 (25·0)
Antrum	103 (52·6)
Diffuse (> 2 regions)	6 (3·1)
Gastric stump	13 (6·6)
Laurén classification	
Intestinal	71 (36·2)
Diffuse	82 (41·8)
Mixed	35 (17·9)
Unknown	8 (4·1)
Surveillance CT included chest	39 (19·9)
Pathological tumour stage	
I	16 (8·2)
II	40 (20·4)
III	123 (62·8)
IV	17 (8·7)
Pathological T category	
pT1	15 (7·7)
pT2	35 (17·9)
pT3	84 (42·9)
pT4	62 (31·6)

Values in parentheses are percentages unless indicated otherwise; *values are median (i.q.r.).

Statistical analysis

Data on age are presented as median (i.q.r.). Tumour characteristics are summarized as counts with percentages. For patients with metastases, the number at each site was classified as one, two, or three or more. Data analysis was performed using R version 3.4.3 (R Foundation for Statistical Computing, Vienna, Austria).

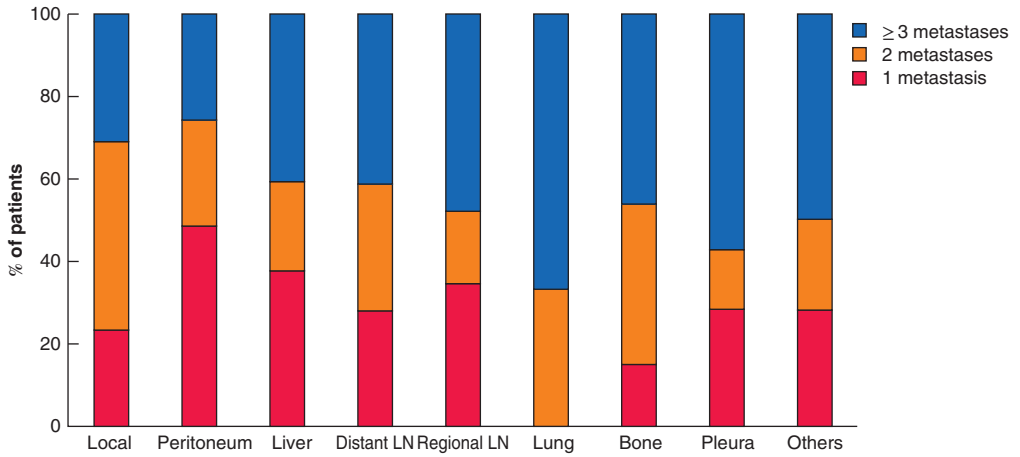
Results

In total, 1815 patient records were reviewed and the study group consisted of 1669 patients (*Fig. 1*). Excluded were patients with no initial CT image on the hospital picture archiving and communication system (62), non-adenocarcinoma histopathology (42), synchronous or metachronous tumours (22), no histopathology on record (11), and those in whom it was uncertain whether the gastric lesion was a primary tumour (3). In the final cohort, 503 patients were staged according to the sixth edition of the AJCC and 1166 according to the seventh edition. Patient and tumour characteristics are summarized in *Table 1*.

Metastases

Fig. 2 shows the number of patients with metastases at each site on clinical staging. Metastasis occurred at a single site in 236 of 478 patients (49·4 per cent), two sites in

Fig. 3 Distribution of patients with metastases by number of lesions at each site after surgery with curative intent



No. of patients	Local	Peritoneum	Liver	Distant LN	Regional LN	Lung	Bone	Pleura	Others
≥ 3 metastases	30	21	15	19	11	10	6	4	7
2 metastases	44	21	8	14	4	5	5	1	3
1 metastasis	23	40	14	13	8	0	2	2	4

LN, lymph node.

158 patients (33·1 per cent) and at three or more sites in 84 patients (17·6 per cent). The most common sites of metastases were the peritoneum (75·7 per cent, 362 of 478) and liver (30·5 per cent, 146 of 478). The incidence of pulmonary metastases was 1·6 per cent (27 of 1669 patients). There were no isolated lung metastases (*Table 2*). In 21 of 27 patients with lung metastases there were three or more sites of metastases. Multiple nodules could be identified in the lower lung fields in all 27 patients with lung metastases. Some 16 of 27 patients with pulmonary metastases had chest CT at clinical staging.

Tumour recurrence after surgery

Demographic and tumour characteristics of patients with recurrence after surgery are shown in *Table 3*, and numbers of patients with recurrence at each site by number of metastases in *Fig. 3*. Metastasis occurred at a single site in 106 of 196 patients (54·1 per cent), two sites in 53 patients (27·0 per cent) and at three or more sites in 37 patients (18·9 per cent). The incidence of pulmonary metastases at recurrence was 1·5 per cent (15 of 1006 patients). There were no isolated lung metastases. Pulmonary metastases were found in 15 of 196 patients (7·7 per cent), and all occurred concomitantly with spread at two or more other sites (*Table 2*). The majority of patients with pulmonary metastases had no staging chest CT (13 of 15), although no nodules were identified at staging chest X-ray. Isolated metastasis to the pleura in two patients was presumed to be gastric cancer; these patients died shortly after diagnosis and no further imaging was performed to identify other potential sites of metastasis.

Discussion

In this study, 27 of 478 patients (5·6 per cent) had pulmonary metastases at clinical presentation, which represents an incidence of 1·6 per cent for the detection of pulmonary metastasis. Pulmonary metastasis rates of 0·5 per cent (7 of 1314 patients)[20], 0·7 per cent (22 of 3076)[21], 1·0 per cent (193 of 20 187)[8] and 2·1 per cent (17 of 808)[9] have been reported previously in Asian populations. In the Swedish gastric cancer registry[7], pulmonary metastasis accounted for 15 per cent of all patients with stage IV disease. The Swedish database had more patients with a cancer located at the cardia than the antrum compared with the present cohort. However, in the Swedish study, 31 per cent of patients had an unknown primary tumour location.

In the present study, the incidence of pulmonary metastasis after surgery with curative intent was very low (1·5 per cent); recurrent disease involved the lung in 15 of 196 patients (7·7 per cent). Of these 15 patients, 13 did not have chest CT at staging, although none had lung nodules detected on staging chest X-ray. In a small study[22] of 159 patients from Singapore, of 84 patients with metastases, 12 had lung metastases, and those with cardia cancers were the most likely to have lung metastases. Similarly, a series from the MD Anderson Cancer Center[23] reported pulmonary metastases in 10 per cent of patients with gastric cancer, with a higher risk among those with cardia cancers.

In the present study, there was no isolated pulmonary metastasis at initial presentation or during follow-up after surgery. All pulmonary metastases were concomitant with two or more sites of metastatic spread. Chong and colleagues[9] reported that one of 238 patients had isolated pulmonary metastasis. In contrast, Kong *et al.*[8] noted that 40 of 193 patients (20·7 per cent) had pulmonary metastasis, although they included pleural effusion without other visible disease (such as pneumonia or heart failure) on imaging as pulmonary metastasis, without cytological confirmation.

Pulmonary metastases occur through haematogenous spread[7,8]. Lung metastases are characterized by a random distribution and nodules of variable size. As the distribution is random, nodules can often be identified in the lower lung fields, which are routinely covered by standard abdominopelvic CT, as was the case in the present study. In one study[24], just over 8 cm (craniocaudal) of lung parenchyma was included in abdominal CT, in which 95 of 243 patients (39·1 per cent) had lung nodules identified.

Despite additional radiation exposure (usually less than an additional 10 mSv[25]), inclusion of chest CT (typically requiring an additional 10 s imaging time) in an abdominopelvic CT protocol can readily be achieved with modern CT scanners, without affecting patient throughput. The American Association of Physicists in Medicine[26], however, has stated that the risk from exposure to an effective radiation dose of less than 50 mSv is 'too low to be detectable and may be non-existent'. With typical reading times for abdominal and chest CT of around 17 and 11 min respectively[27], in a high-volume radiology department, turnaround times may be adversely affected and misinterpretations increased (9 per cent[28] and 14 per cent[29] rate of clinically important changes at report review for chest and abdomen respectively). In the present cohort, chest CT would have to be undertaken at staging in 63 patients (1/0·016) to identify one patient with pulmonary metastasis, whereas 505 and 808 such scans would have to be performed to identify one patient with isolated pulmonary metastasis based on the series by Kong and co-workers[8] and Chong *et al.*[9] respectively.

Oesophagogastric junctional or cardia cancers are more common in Western countries[30] and chest CT at preoperative staging is recommended owing to a tendency for pulmonary metastasis at this site[31]. Although the AJCC guideline represents the current consensus on tumour staging, modifications based on ethnicity and geographical regions should be considered owing to epidemiological differences in disease pattern. Current treatment for metastatic gastric cancer is still limited and, owing to the rarity of pulmonary metastasis, inclusion of chest CT does not influence treatment options[31,32].

There were limitations to this study. Staging CT protocols varied because this institution is a large referral centre for cancer treatment. Nonetheless, specialized radiologists reviewed all the images and ensured adequate clinical staging. Chest CT is not part of the standard staging protocol and small nodules on chest X-rays may have been missed. However, no isolated metastasis to the lung developed in patients who had surgery. Finally, no biopsies of suspicious lung lesions were obtained. As the present cohort did not have isolated pulmonary metastasis, further pathological confirmation would not have altered the staging given the concomitant metastases. In current practice, indeterminate lung lesions in a patient with otherwise resectable gastric cancer are followed closely rather than biopsied. Definitive surgery is not delayed for a lung biopsy. Notwithstanding these shortcomings, this study does not support the routine inclusion of chest CT in gastric cancer staging because of the rarity of pulmonary metastases in patients with gastric cancer and the absence of isolated pulmonary metastases.

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Snapshot quiz

Snapshot quiz 19/13

Answer: The image shows the patient in the prone jackknife position, with the head towards the top. An incision has been made in the intergluteal fold between the anus (lower portion of displayed surgical field) and the coccyx. A retrorectal epidermoid cyst measuring 10 × 8 × 8 cm is being removed through this incision. Epidermoid cysts in this location are rare congenital malformations derived from the ectoderm. Transrectal ultrasound, nuclear magnetic resonance and/or CT are the most useful preoperative imaging studies. Surgical removal and histopathological examination of the specimen is required for definitive diagnosis[1].

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