The Value of Chest CT in Staging of Gastric Cancer

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Abstract

Aims: Gastric cancer (GC) is one of the most common malignant tumors in the world. However, the significance of chest computed tomography (CT) in staging of GC is uncertain and the relevant study is few. So this study aims to evaluate the value of chest CT in gastric cancer staging.

Methods: This study included 1158 cases of GC patients admitted to Shaoxing People's Hospital from 2015 to 2018. Chest, abdominal and pelvic CT scans were used to systematically evaluate the site of metastasis. All images were reviewed twice by two radiologists. Clinical data was statistically analyzed.

Results: The study finally included 846 patients, 672 cases (79.4%) received surgical treatment. Only 55 cases (6.5%) had lung metastases before or after surgery, and 20 cases (2.4%) had thoracic or supraclavicular lymph nodes (LN) metastases, of which 8 cases had double lung and thoracic LN metastases. The most common site of metastases is the peritoneum (265/390, 67.9%). Almost all lung or thoracic LN metastases accompanied with metastases to other sites, only one patient had a single thoracic LN metastases (1/846, 0.12%), while no single lung metastases was found. When tumor involved gastric fundus/cardia, compared to distal GC, there was a higher probability of lung metastases, and the difference was statistically significant (P=0.028).

Conclusions: This study shows that chest CT has a low application value in the routine staging of gastric cancer, but when the tumor is located in the fundus/cardia, due to the high proportion of lung metastases, chest CT has a certain existence value.

Background

Gastric cancer (GC) is one of the most common malignant tumors in the world. According to the 2019 World Health Organization (WHO) report, GC has become the fifth highest morbidity and third highest mortality cancer in the world[1]. As a country with a high incidence of GC, China officially released the second highest incidence of GC in 2015, with a mortality rate of 21.48 per 100,000, ranking second in the third[2]. Interestingly, there are significant regional differences in the incidence of GC. Distal gastric cancer is more common in Asia (including China), while proximal gastric cancer is more common in western countries[1,3].

Accurate clinical staging is the beginning of treatment for GC. According to National Comprehensive Cancer Network (NCCN) 2020 guidelines, chest, abdominal and pelvic computed tomography (CT) is used to routinely evaluate tumor staging and monitor tumor recurrence for newly diagnosed and follow-up patients with GC[4,5]. However, based on our clinical observation, the most common distant metastases sites of GC are peritoneal, distant lymph nodes (LN, including retroperitoneal, supraclavicular, mediastinal and other unresectable lymph nodes), liver or other sites of metastases[6–8], lung metastases is relatively rare[9,10].
In the staging treatment of colorectal cancer, it is often reported that the proportion of lung metastases is low and the clinical significance is uncertain. Therefore, chest CT is not recommended routinely in some literatures\[11\]. However, for the same digestive tract tumor, there are relatively few studies on the clinical significance of chest CT in GC, and the significance of chest CT in staging and treatment of GC is uncertain. In a retrospective study of 808 patients with GC, Chong\[12\] et al. found that the value of chest CT was limited due to the rarity of isolated lung metastases (0.4%) in patients with gastric cancer. While Chen AH\[13\] et al. conducted a study on 1669 patients with GC and found that only 5.6% of the patients with tumor recurrence included lung metastases, and all of the patients had multi-site metastases. Therefore, it is not recommended to routinely use chest CT for staging GC.

So this study aims to evaluate the value of chest CT in gastric cancer staging.

**Methods**

**Patient Data**

In this study, 1158 cases of GC patients admitted to Shaoxing People's Hospital from 2015 to 2018 were retrospectively studied. Among them, 312 cases were excluded due to incomplete chest and abdominal CT or clinicopathological data or incomplete follow-up data, and the remaining patients were followed up for at least 2 years. In this study, chest, abdominal and pelvic CT scans were used to systematically evaluate the site of metastases at initial diagnosis and at postoperative follow-up. TNM staging was performed using the seventh (2010) versions of the AJCC/IUCC staging system.

**Image evaluation**

The chest was evaluated by 16-slice plain CT, and the slice thickness was 2.5mm. The abdominal and pelvis were evaluated by 64-slice enhanced CT, the slice thickness was also 2.5mm. And 5 min before abdominal CT evaluation, the patient was instructed to drink 1000ml of water for contrast imaging. All images were reviewed twice by two radiologists with more than 5 years of working experience. If the CT was performed by another hospital, it was also reviewed by at least two radiologists and the image quality was qualified.

**Statistical analysis**

The clinical characteristics, pathological stages and follow-up data of all patients were provided by the clinical database, and patients with incomplete data needed to be excluded. The chi-square test was used for classification variables. Data analysis was performed using SPSS 19.0.

**Results**

This study included a total of 1158 patients with pathological diagnosis of GC, who treated in Shaoxing People's Hospital from 2015 to 2018, in which 56 cases with incomplete image information, 18 cases
with incomplete clinical pathological information, and 238 cases with incomplete 2 years follow-up information was ruled out. The study finally included 846 patients, male 533 cases (63.0%), female 313 cases (37.0%), average age 69 (36–97). Among them, 672 cases (79.4%) received surgical treatment, 420 cases (62.5%) were males and 252 cases (37.5%) were females. While the remaining 174 cases (20.6%) of the phase tumors, 113 cases (64.9%) were male. The specific clinical data are shown in Tables 1 and 2.
|                            | No. of patients (n = 672) |
|---------------------------|---------------------------|
| **Age (years)**           |                           |
| ≤ 60                      | 460 (68.4)                |
| ≤ 60                      | 212 (31.6)                |
| **Sex ratio (M : F)**     | 420 : 252                 |
| **Tumor location**        |                           |
| Fundus/cardia             | 134 (19.9)                |
| Body                      | 113 (16.8)                |
| Antrum                    | 352 (52.4)                |
| Diffuse (> 2 regions)     | 73 (10.9)                 |
| **Pathological staging**  |                           |
| T category                |                           |
| 4                         | 285 (42.4)                |
| 3                         | 96 (14.3)                 |
| 2                         | 139 (20.7)                |
| 1                         | 152 (22.6)                |
| N category                |                           |
| 3                         | 168 (25.0)                |
| 2                         | 96 (14.3)                 |
| 1                         | 132 (19.6)                |
| 0                         | 276 (41.1)                |
| **Vascular recidivism**   |                           |
| Positive                  | 140 (20.8)                |
| Negative                  | 532 (79.2)                |
| **Nerve recidivism**      |                           |
| Positive                  | 132 (19.6)                |
| Negative                  | 540 (80.4)                |
We analyzed the 174 cases of the phase II tumors, which has the highest percentage of peritoneal or transfer within the abdominal cavity, 71.8% (125/174), followed by abdominal LN metastases (77/174, 44.3%) or liver metastases (62/174, 35.6%). Only 19 cases (10.9%) of GC caused lung metastases, which all accompanied with metastases to other sites, while no single lung metastasis was found. And another 12 patients (6.9%) had thoracic or supraclavicular LN metastases, but most of them were secondary to abdominal LN metastases (7/12, 58.3%) or lung metastases (4/12, 33.3%), and only one patient had a single thoracic LN metastases, Fig. 1. In the 19 cases of lung metastases, although the difference was not statistically significant (P = 0.22, Table 3), we found that when the tumor involved gastric fundus/cardia, the proportion of lung metastases was higher (8/52, 15.4%), while when the tumor did not involve gastric fundus/cardia, the proportion of accompanied lung metastases was lower (11/122, 9.0%).

### Table 2
Clinical data of primary advanced cases

|                      | No. of patients (n = 174) |
|----------------------|---------------------------|
| Age (years)          | 70 (46–97)                |
| < 60                 | 131 (75.3)                |
| ≤ 60                 | 41 (24.7)                 |
| Sex ratio (M : F)    | 113 : 61                  |
| Tumor location       |                           |
| Fundus/cardia        | 32 (18.4)                 |
| Body                 | 31 (17.8)                 |
| Antrum               | 68 (39.1)                 |
| Diffuse (> 2 regions)| 43 (24.7)                 |

### Table 3
Proportion of lung metastases in primary advanced cases

|                      | Lung metastasis | No lung metastasis | Total | P values |
|----------------------|-----------------|--------------------|-------|----------|
| Involve fundus/cardia| 8               | 44                 | 52    | 0.218    |
| No involve fundus/cardia | 11            | 111                | 122   |          |
| Total                | 19              | 155                | 174   |          |

A total of 216 cases (32.1%) of GC after undergoing surgery relapsed, which has the highest percentage of peritoneal metastases (140/216, 64.8%), followed by abdominal LN metastases (111/216, 51.4%) or liver metastases (56/216, 25.9%). And there are 36 cases (16.7%) of lung metastases, which all
accompanied with metastases to other sites, and has the highest percentage of peritoneal metastases (24/36, 66.7%), among them, 20 cases (55.6%) accompanied with multiple systemic metastases. However, no single lung metastases was also found. Only 8 patients (8/216, 3.7%) had thoracic or supraclavicular LN metastases, but all of them were secondary to abdominal LN metastases (6/8, 75%) or lung metastases (3/8, 37.5%), Fig. 2. Similarly, in the 36 cases of lung metastases, although the proportion of lung metastases was higher when tumor involved gastric fundus/cardia (17/75, 22.7%), the difference was still not statistically significant (P = 0.084, Table 4). Interestingly, when we combined the cases of primary lung metastases and postoperative lung metastases to further increase the sample size, we were pleasantly surprised to find that when tumor involved gastric fundus/cardia, there was a higher probability of lung metastases, and the difference was statistically significant (P = 0.028, Table 5).

| Table 4 | Proportion of lung metastases in postoperative recurrence cases |
| --- | --- | --- | --- | --- |
| Lung metastasis | No lung metastasis | Total | P values |
| Involve fundus/cardia | 17 | 58 | 75 | 0.084 |
| No involve fundus/cardia | 19 | 122 | 141 | |
| Total | 36 | 180 | 216 | |

| Table 5 | Proportion of lung metastases in All metastatic cases |
| --- | --- | --- | --- | --- |
| Lung metastasis | No lung metastasis | Total | P values |
| Involve fundus/cardia | 25 | 102 | 127 | 0.028 |
| No involve fundus/cardia | 30 | 233 | 263 | |
| Total | 55 | 335 | 390 | |

**Discussion**

With the fast development of CT imaging technology, more and more countries and regions using CT to clinical stage and prognosis of malignant tumor[14]. GC as a cancer of high incidence in China, even in the world, according to NCCN guidelines, chest, abdominal and pelvic CT can be used as the diagnostic basis for preoperative staging and postoperative recurrence[14, 15]. However, combined with our actual clinical experience and existing literature reports, the incidence of lung metastases in GC is relatively low[9, 10]. This study found that in the 846 included cases, only 55 cases (19 + 36, 6.5%) had lung metastases before or after surgery, and 20 cases (12 + 8, 2.4%) had thoracic or supraclavicular LN metastases, of which 8 cases had double lung and thoracic LN metastases, and more importantly, only
one patient had a single thoracic LN metastases (1/846, 0.12%), while no single lung metastases was found. In addition, when lung or thoracic LN metastases occurs in GC cases, most of them are associated with intraperitoneal metastases. Therefore, when abdominal and pelvic CT indicates metastases, the clinical stage of the patients is all advanced, so whether lung metastases is present or not, it has no influence on the choice of treatment plan. So it is suggested that chest CT has limited value in the staging of GC, and frequent CT examination not only increases the economic burden of patients and medical insurance, but also increases the workload of radiologists, which will also cause more radiation damage to patients.

Although GC is one of the most common malignant tumors in the world, its incidence varies around the world. In East Asia, distal GC is more common, while in Western countries, although the overall incidence is low, the proportion of proximal GC is relatively high[1, 2]. In this study, it was found that compared with distal GC, when tumor involved gastric fundus/cardia, there would be a higher proportion of lung metastasis in primary advanced cases or postoperative recurrence cases, although the difference was not statistically significant, which was considered to be related to the small sample size. When we conducted an unified test for all metastatic cases, we found that, compared with distal GC, the incidence of lung metastases was significantly increased when the tumor involved gastric fundus/cardia, and the difference was statistically significant. It has been reported that lung metastases of GC is mainly realized through hematogenous dissemination[7, 16, 17]. When the tumor is in the distal of the stomach, the tumor cells can pass around the stomach arteriovenous access portal system or celiac trunk artery system, and then transferred to the liver, lungs or bones, while when the tumor is located in the fundus or cardia, tumor cells not only can transfer to the lungs by conventional path, also through the transport branches between the esophagus and stomach or the inferior phrenic artery. Compared with distal GC, the tumor metastasis pathways are more abundant and shorter, so the probability of lung metastases is higher.

Of course, this study has its limitations. First of all, due to the limitation of single-center study, the sample size is small, the follow-up period is insufficient, and the data of some cases is lost. We also hope that qualified units can carry out multi-center retrospective study, so as to further improve the reliability of the results on the basis of increasing the sample size. Secondly, according to the literature description, lung metastases in the chest CT images on the characteristics of the performance are often as random distribution, discrepancy size, uneven thickness of nodules[18], and although we study by two or more radiologists to double check, but failed to pathological diagnosis, there may be some error. Thirdly, compared with plain chest CT, enhanced CT can improve the detection rate of lung neoplasm. Despite these deficiencies, this study still shows that chest CT has a low application value in the routine staging of gastric cancer, but when the tumor is located in the fundus/cardia, due to the high proportion of lung metastases, chest CT has a certain existence value.

**Abbreviations**
Declarations

Ethics approval and consent

This article was approved by the Ethics Committee Review Board of Shaoxing People's Hospital (Ethical No. 2020-K-Y-147-01).

Consent for publication

We had obtained informed consent from the patient before the study began, and consent form was signed by the patient.

Availability of data and materials

All data and materials are available within the manuscript.

Competing interests

The authors declare that they have no conflict of interest to disclose. All authors have read this manuscript and considered for publication. None of the material related to this manuscript has been published or is under consideration for publication elsewhere, including the internet.

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Authors' contributions

SLYJ designed the experiment. LYQ and XGG collected clinical data. LYQ wrote the manuscript. SLYJ and LZX checked the chest CT.

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