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Comparison between CT Net enhancement and PET/CT SUV for N staging of gastric cancer: A case series

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HIGHLIGHTS

- Gastric cancer N staging represents a diagnostic challenge for patient management.
- CT and PET-TC play a crucial role in this field.
- CT has a high sensitivity and a low specificity.
- Disease over-staging causes ineffective care when patient categorized as palliative is excluded from curative treatment.
- The proposed new 3D CT software with quantitative data for N staging improves CT specificity.

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ABSTRACT

Background: The therapeutic approach of gastric cancer strictly depends on TNM staging mainly provided by CT and PET/CT. However, the lymph node size criterion as detected by MDCT causes a poor differential diagnosis between reactive and metastatic enlarged lymph nodes with low specificity values. Our study aims to compare 320-row CT Net enhancement and fluorine-18 fluoro-2-deoxy-D-glucose positron emission tomography/computed tomography (F-FDG PET/CT) SUV for N staging of gastric cancer.

Materials and methods: 45 patients with histologically proven gastric cancer underwent CT and F-FDG PET/CT. Two radiologists in consensus evaluated all images and calculated the CT Net enhancement and F-FDG PET/CT SUV for N staging, having the histological findings as the reference standard. CT and F-FDG PET/CT sensitivity, specificity, diagnostic accuracy, positive and negative predictive values (PPV and NPV) were evaluated and compared by using the Mc Nemar test.

Results: The histological examination revealed nodal metastases in 29/45 cases (64%). CT Net enhancement obtained sensitivity, specificity, accuracy, PPV and NPV of 90%, 81%, 87%, 90% and 81%, respectively. F-FDG PET/CT SUV obtained sensitivity, specificity, accuracy, PPV and NPV of 66%, 88%, 73%, 90% and 58%, respectively. No statistically significant difference between the two imaging modalities was found ($p = 0.1$).

Conclusion: CT Net enhancement represents an accurate tool for N staging of gastric cancer and could be considered as the CT corresponding quantitative parameter of F-FDG PET/CT SUV. It could be applied in the clinical practice for differentiating reactive lymph nodes from metastatic ones improving accuracy and specificity of CT.

1. Introduction

Gastric cancer represents one of the most common cancer in the world and a major cause of morbidity and mortality [1–3]. The diagnosis of gastric cancer is provided by endoscopy associated

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with biopsy [2]. The therapeutic approach mainly bases on cancer staging which provides crucial information in terms of tumor resectability and patient prognosis. Cancer staging includes primary tumor local extension, lymph node involvement and distant metastases assessment [3–5]. The most widely used diagnostic technique for preoperative staging of gastric cancer is represented by multi-detector computed tomography (MDCT) [3,5–10]. An overall MDCT diagnostic accuracy of 94% for T staging has been reported applying specific software of image reconstructions with values of 96%, 96%, 98% and 100%, respectively for T1, T2, T3 and T4 stages [3]. Despite the recent advances in the field of pre-operative CT imaging of gastric cancer, N staging still remains controversial with lower accuracy value as compared with T staging [5,6,11]. As regard with gastric cancer M staging, PET and MDCT show overall accuracies respectively of 88 and 82% for detecting distant metastases [11].

The debated role of MDCT for N staging of gastric cancer is mainly related to the high frequency of microscopic tumor involvement in small-sized lymph nodes and the poor differential diagnosis between reactive and metastatic enlarged lymph nodes with low specificity values [12–14]. The recent use of metabolic information provided by fluorine-18 fluoro-2-deoxy-D-glucose positron emission tomography/computed tomography (18F-FDG PET/CT) has improved the role of imaging in the field of cancer diagnosis, staging, therapeutic response and recurrence as suggested by the National Comprehensive Cancer Network and The European Society for Medical Oncology. However, also the role of 18F-FDG PET/CT in the staging of gastric cancer is still controversial because of its relatively low sensitivity [12–14].

The aim of our study is to compare the diagnostic accuracy of quantitative and qualitative parameters respectively provided by net enhancement (NE) value and by vessel probe (VP)/3D analysis reconstructions on 320- row CT for N staging of gastric cancer and to compare the obtained results with 18F-FDG PET –CT quantitative parameters.

2. Patients

Between September 2013 and March 2015, forty-five consecutive patients (18 women and 27 men; mean age: 58.6 y; age range: 35–80 y) with endoscopic and histological diagnosis of gastric cancer, underwent 320-row MDCT examination within 8 days after conventional endoscopy.

In all cases 18F-FDG-PET/CT scan was performed within 18 days after CT and before any treatment. Written informed consent was obtained from all patients for the diagnostic procedures. Pathological staging was established according to the 7th edition of the American Joint Committee on Cancer Staging guidelines, and histologic types were classified according to the World Health Organization classifications [15]. Surgery was performed within 15 days after imaging (mean interval time of 8 days). 39 out of 45 patients underwent radical surgical treatment (total or partial gastrectomy), while in the remaining 6 patients palliative gastrectomy was performed. No patient underwent preoperative chemotherapy or radiotherapy. CT and 18F-FDG PET/CT results were compared with operative and pathological data, having the latest as reference standard.

3. CT protocol

CT scans were performed with patients in the supine position from the lung apices to the pubic symphysis, before and after intravenous injection of 1.5 mL/kg of iopamidol (Iomeron 400; Bracco, Milan; Italy) at 3 mL/s through the antecubital vein with an automatic power injector.

Before CT examination, gastric wall distension was obtained by the intramuscular injection of 20 mg of scopolamine-N-butyl bromide (Buscopan, Boehringer Ingelheim Japan, Tokyo, Japan) and by ingestion of 400–600 ml of water, after 12 h of fasting.

A 320-row CT scanner (Aquilion One, Toshiba, Nasu, Japan) was used with the following protocol: detector collimation 320 × 0.5 mm, rotation time 0.5 s, mean kV/mAs: 120/200; in all cases, the volumetric acquisition was performed during the venous phase 55 s after contrast material injection. Radiation dose to patients was modulated for each study by means of the volume CT dose index, which was calculated by the CT scanner.

4. 18F-FDG PET/CT protocol

Images were acquired by using a Discovery LSA PET/CT device (GE Healthcare, Waukesha, WI) combining a PET (advance nI) with 16-slice CT scanner (light speed plus). All patients had a capillary blood glucose of <160 mg/mL and fasted for at least 8 h before 18F-FDG injection. Gastric distension was obtained by drinking 500 mL of water before images acquisition. The image acquisition was performed 50 min after intravenous injection of 4.6 MBq/kg of 18F-FDG. The CT scan was carried out without contrast material injection from the neck to the pubic symphysis with the following CT protocol: mean kV/mAs:120 kV/340 mA; slice thickness: 3.75 mm, tube rotation time: 0.8 ms, collimation field of view: 50 cm. The CT data were used for the attenuation correction of PET scanning, performed immediately after CT scans.

The PET acquisition was obtained in caudal-cranial direction; PET was reconstructed with a matrix of 128128, ordered subset expectation maximum iterative reconstruction algorithm (2 iterations, 28 subsets), 8 mm Gaussian filter, and 50 cm field of view.

5. Image analysis

All CT data were transferred to a workstation (HP XW8600, Minnetonka, US) equipped with a dedicated software for image reconstructions (Vitrea Fx, Vital Images, Minneapolis, Minnesota, US). Two radiologists with more than 10 years' experience in the field of CT imaging and blinded to the histological results of perigastric lymph nodes evaluated CT images in consensus using a threshold net enhancement value of 40 HU for differentiating reactive lymph nodes from metastatic ones.

CT images were evaluated by applying the Vessel Probe (VP) in MPR reconstructions and the automatic 3D analysis software which respectively provided peri-gastric lymph nodes qualitative and quantitative data [3,16].

Multi-Planar-Reformatting (MPR) and Vessel Probe (VP) in MPR mode programs were used for the qualitative analysis of perigastric lymph nodes including shape (round, oval or irregular) and edges (regular or irregular). By clicking on the lymph node site in simple transverse images, VP in MPR mode automatically generates a reference line along the major axis of lymph node and displays the best views in multiple curved planes [3,16].

Automatic 3D analysis software was used for the quantitative analysis of peri-gastric lymphonodes. It was applied for measuring lymph node diameters and density by selecting a region of interest (ROI) on the whole lymph node. Lymph node density values were calculated before and after contrast material injection and then Net enhancement (NE) was calculated by subtracting pre-contrast density from the density obtained by post-contrast values, as already reported in other experiences with regard to other anatomical districts [17]. The overall image analysis was performed within 15 min for patient.

Two nuclear physicians with more than 8 years' experience in the field of PET-CT imaging and blinded to the histological results of