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G Funds Collection

The utility of low-dose hydro-CT using SAFIRE for the diagnosis of gastric cancer

Użyteczność niskodawkowej hydro-TK z wykorzystaniem SAFIRE do diagnostyki raka żołądka

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Summary

Objective: The aim of this retrospective study was to evaluate the application of hydro-CT using sinogram-affirmed iterative reconstruction (SAFIRE) in the diagnosis of gastric cancer.

Material/Methods: Low-dose hydro-CT was performed on 30 patients with suspicion of gastric cancer in gastroscopy. The raw data were reconstructed with SAFIRE. Images were retrospectively analyzed by two experienced radiologists in tandem who were blinded to the gastroscopy results. The results of the gastric biopsy were treated as a standard of reference. We compared the diagnostic accuracy of hydro-CT and endoscopy for the diagnosis of gastric cancer using the chi-square test with Yates' correction. A P value of less than 0.05 was considered statistically significant.

Results: The diagnosis of gastric cancer was confirmed in a histopathological examination in 25 (83.3%) patients, while in the remaining 5 cases (16.7%) benign gastric ulceration or gastritis was diagnosed. In 23 cases (92%) a correct diagnosis of gastric cancer was made in hydro-CT. The accuracy of endoscopy was at the level of 83.3%. There was no significant difference in the correctness of the diagnosis of gastric cancer in endoscopy and hydro-CT ($p>0.05$). For the diagnosis of gastric cancer with hydro-CT, sensitivity of 100%, specificity of 80%, a positive predictive value of 95.8%, and a negative predictive value of 100% were calculated.

Conclusions: Low-dose hydro-CT using SAFIRE may be considered as a valuable diagnostic method for the diagnosis of gastric cancer, especially for patients who have contraindications to endoscopy or gastric biopsy.

Keywords: **gastric cancer • low-dose CT • SAFIRE • optical endoscopy**

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INTRODUCTION

The most common gastric neoplasm, gastric cancer (adenocarcinoma), occurs in approximately 95% of cases [5]. Gastric cancer represents an aggressive tumor with five years survival depending on tumor stage [8]. The superficial form of gastric cancer usually called "early gastric cancer" has a better prognosis with a five-year survival rate of more than 90%, but this form can be difficult to diagnose [8]. An advanced form of gastric cancer reaches the muscularis propria and can have a variable extent [8]. The gold standard for the diagnosis of gastric cancer is endoscopically directed biopsy [10]. Multidetector computed tomography (MDCT) is a widely used diagnostic method mainly for preoperative, post-therapeutic control or follow-up evaluation of gastric cancer according to the tumor-node-metastasis (TNM) system [3, 5, 8]. In hydro-CT, we use water as an oral contrast agent for optimal distension of gastric walls to identify the small tumor and to better distinguish normal-appearing gastric walls from the tumor mass or adjacent structures in scanning performed after the administration of venous contrast agent [6]. The development of the MDCT techniques including x-ray tube current modulation and tube voltage modification depending on patient size has allowed the radiation dose during CT examination to be reduced [6]. Introduction of iterative image reconstruction algorithms by the CT manufacturers allowed implementation of lower dose CT techniques without sacrificing image quality. This iterative reconstruction algorithm enabled image noise to be reduced and spatial resolution to be improved in comparison to the standard reconstruction algorithm – filtered back projection (FBP) [6]. Importantly, iterative reconstruction algorithms may provide an improvement of the diagnostic accuracy of MDCT. For patients with some contraindications to gastroscopy (non-cooperating patients) or gastric biopsy (in the case of actively bleeding ulcers, coagulopathy, or patient instability), low-dose hydro-CT using iterative image reconstruction may be an alternative diagnostic method to endoscopy in the diagnosis of gastric cancer. Therefore, the purpose of this retrospective study was to evaluate the utility of low-dose hydro-CT using sinogram-affirmed iterative reconstruction (SAFIRE) in the diagnosis of gastric cancer.

MATERIAL AND METHODS

Patients

Low-dose hydro-CT was performed in 30 consecutive patients (21 men, 9 women, mean age 61.4 years) with a suspicion of gastric cancer in gastroscopy. All endoscopies were performed by three different and experienced gastric surgeons (over six years) in gastroscopy in our institution. In all cases, during endoscopy, multiple gastric biopsies (5-10 per procedure) were performed. Next, after gastroscopy, all patients had hydro-CT for preoperative cancer staging. Written informed consent was obtained from all patients.

CT protocol and image analysis

Images were obtained with patients in the supine position using a 64-detector CT scanner (Somatom Definition AS +, Siemens Healthcare). The CT parameters were tube potential of 120 kV, tube current modulation (Care Dose4D), collimation of 128 × 0.6 mm, a pitch of 0.8, and a gantry rotation time of 0.5 seconds. Raw data were reconstructed with a sinogram-affirmed iterative reconstruction algorithm (SAFIRE, Siemens Healthcare) and a strength setting of 3 using a high-spatial-resolution kernel (I30). Before CT scanning to distend the stomach wall all patients ingested water orally in a volume of 0.75-1.0 l (within 10 minutes before starting the scanning), and next 0.25 l (immediately before scanning) and they were given intravenously a dose of 20 mg of butylscopolamine (10 minutes before the study) to reduce gastric motility. The ionic contrast medium (Ultravist 370; Bayer Healthcare, Germany) was administered intravenously at a dose of 1.5 ml/kg of body weight at a rate of 3.0 ml/s. Then dynamic enhanced phases were performed with scan delay time of 25 and 50 seconds. Obtained images were retrospectively interpreted by two experienced radiologists, who were blinded to the gastroscopy results, in tandem (over five years). They used a diagnostic workstation (Syngo.via, Siemens Healthcare) and maximum intensity projection (MIP) reconstructions or multiplanar reconstructions (MPR) for coronal, sagittal and axial images. In the present study, the diagnostic criteria for gastric cancer were based on

Table 1. TNM criteria of gastric cancer in hydro-CT [1, 3]

Stage	Description
T1	nontransmural focal stomach enhancement with thickening of the wall, or a significant enhancement while maintaining a layered structure
T2	transmural focal wall enhancement with thickening of the wall, affecting the muscle layer, with occupation of the gastric serosa
T3	transmural enhancement of the stomach wall with blurring of its three-layer structure, a slight thickening of the outer wall, or small linear bands of soft tissue extending into the adipose tissue (desmoplastic reaction)
T4	reticular or irregular thickening of the outer stomach wall or blurring of the adiposetissue around the observed change, and/or obliteration of adipose tissue between gastric cancer and adjacent organs that may be accompanied by further invasion of adjacent organs
N	lymph nodes larger than 1.0 cm in short axis
M	distant metastases

Table 2. Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) in diagnosis of gastric cancer for hydro-CT. Histopathology was used as the reference standard

Measure	Hydro-CT
Sensitivity	100%
Specificity	80%
PPV	95.8%
NPV	100%

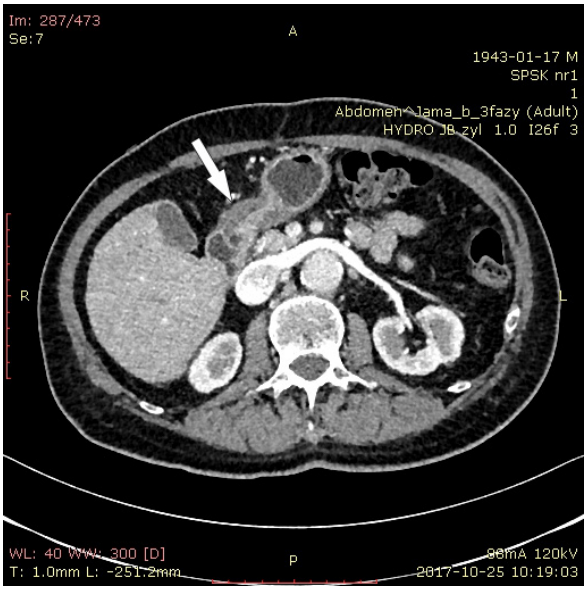

Fig. 1. The hydro-CT image in the axial projection shows the cancer of the pyloric antrum of the stomach affecting the muscle layer (lower density) (arrow)

the study by Ba-Ssamalah et al.: focal wall thickness, diffused infiltration (linitis plastica), disintegrated or ulcerated tumor mass, intramural, exophytic or mixed change, altered local adipose tissue and desmoplastic reaction [1]. Diagnosed gastric cancers were evaluated according to TNM criteria which are summarized in Table 1.

STATISTICAL ANALYSIS

The results of the gastric biopsy were treated as a standard of reference. Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) in the diagnosis of gastric cancer were calculated for hydro-CT. Additionally, we compared the diagnostic accuracy of hydro-CT and gastroscopy for the diagnosis of gastric cancer using the chi-square test with Yates' correction. A P value of less than 0.05 was considered statistically significant. The radiation dose was estimated by the volume CT dose index (CTDIvol). Calculations and statistical analysis of the results were performed using Microsoft Excel 2010 and STATISTICA v.10.

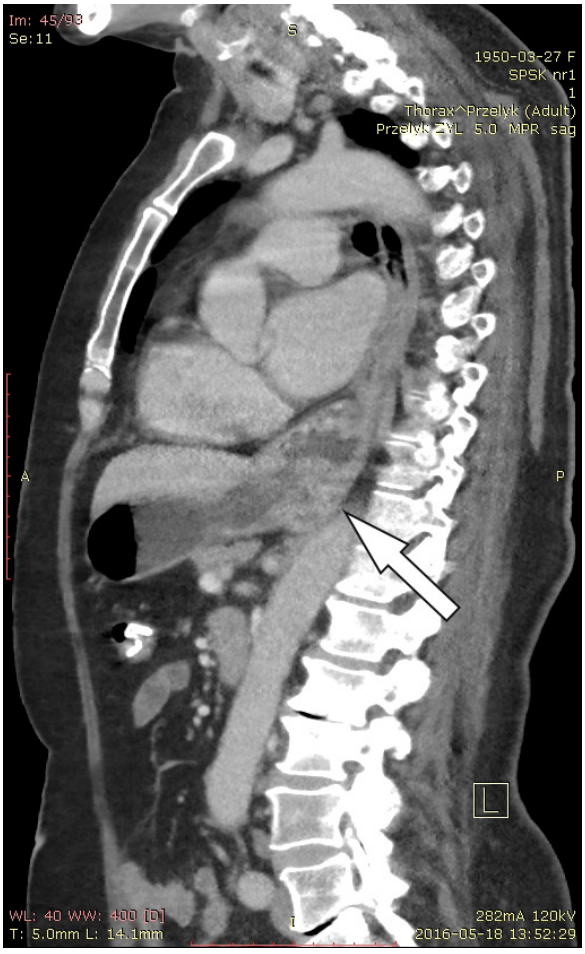

Fig. 2. The hydro-CT image in the saggital projection shows the gastritis of the gastro-oesophageal junction of the stomach and gastric cardia. There is visible transmural focal wall enhancement with thickening of the wall and gastric folds during of the hernia hiatus oesophagi (arrow)

RESULTS

The diagnosis of gastric cancer was confirmed in a histopathological examination in 25 (83.3%) patients. In the remaining 5 cases (16.7%) benign gastric ulceration or gastritis was diagnosed. In 23 cases (92%) correct diagnosis of gastric cancer was made in hydro-CT. The accuracy of the endoscopy was at the level of 83.3%. There was no significant difference in the correctness of the diagnosis of gastric cancer in endoscopy and hydro-CT ($p>0.05$). For the diagnosis of gastric cancer with hydro-CT, sensitivity of 100%, specificity of 80%, a positive predictive value of 95.8%, and a negative predictive value of 100% were calculated (Table 2). The percentage of neoplasms in stage T1-T2 in the hydro-CT study was 28% and in stage T3-T4 it was 72%. Fifteen (50%) patients had enlarged lymph nodes, and 4 (13.34%) patients had distant metastases. The $CTDI_{vol}$ was in the range of 3.65-8.8 mGy per scan.

Fig. 3. The hydro-CT image in the coronal projection shows the ulcerated form of gastric cancer (arrow)

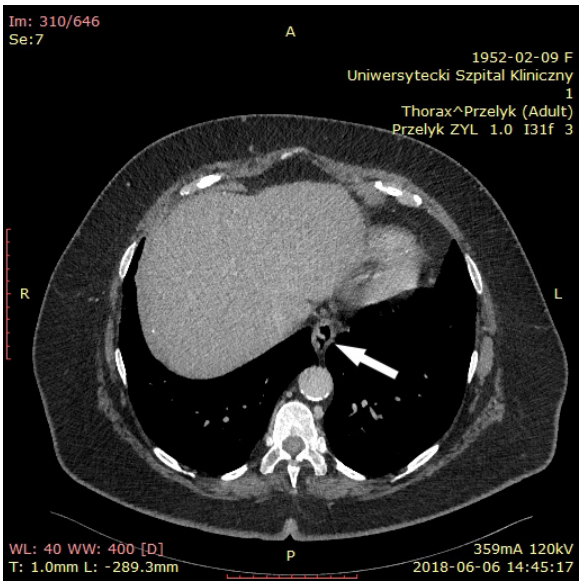

Fig. 4. The hydro-CT image in the axial projection shows the exophytic form of gastric cancer in stage T1 localized in the gastric cardia (arrow)

DISCUSSION

The main indication to perform the hydro-CT examination is the preoperative evaluation of gastric cancer according to the TNM system [4]. In these cases, the diagnostic accuracy of the hydro-CT may be comparable to endoscopic ultrasound (EUS) [4]. In this study, diagnosed gastric cancers were also evaluated according to the TNM system. Hydro-CT may be an alternative diagnostic method for EUS due to the high cost of this method. In the present study, we assessed the application of low-dose hydro-CT using SAFIRE in the diagnosis of gastric cancer. Chen et al. and Mosheta et al. reported that virtual CT gastroscopy may be a useful diagnostic method in differentiation between malignant and benign gastric ulcers with high diagnostic value [2, 7]. In our study, the sensitivity and specificity of differentiating benign from malignant lesions (Fig. 1, 2, 3) was 100% and 80% respectively. The diagnostic accuracy of hydro-CT in the diagnosis of gastric cancer was at the level of 92%. Some authors have suggested that hydro-CT has low diagnostic value in the diagnosis of "early gastric cancer" [9]. They reported that the size of the tumor and depth of neoplastic infiltration are factors which significantly affect the visibility of gastric cancer [9]. It should be noted that most of the gastric cancers diagnosed in our study fulfilled the criteria for an advanced stage because in our conditions the screening of gastric cancer is not conducted. Importantly, stage T1 of gastric cancer should be differentiated from benign ulcerations or gastritis so endoscopy with biopsy should be performed in each patient (Fig. 4). However, in the present study we used a 128-slice CT scanner and modified low-dose scanning protocol, and the raw data were reconstructed using a sinogram-affirmed iterative algorithm, so that may improve the diagnostic accuracy of hydro-CT in the diagnosis of gastric cancer in stage T1. In addition, the use of the low-dose technique reduced the negative effects of exposure to ionizing radiation according to ALARA (as low as reasonably achievable) principles. The next limitation of our study was the small group of patients. However, only patients with a suspicion of gastric cancer in endoscopy were enrolled in the study.

In our opinion, low-dose hydro-CT using SAFIRE may be considered as a valuable diagnostic method in the diagnosis of gastric cancer, especially for patients with a contraindication to endoscopy or gastric biopsy. Conducting studies on a larger group of patients using the latest low-dose techniques and iterative algorithms (third generation CT scanners) may contribute to the wider use of the hydro-CT method in the diagnosis of gastric cancer in the future.

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The authors have no potential conflicts of interest to declare.