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Diagnostic performance of using effervescent powder for detection and grading of esophageal varices by multi-detector computed tomography

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ABSTRACT

Purpose: To investigate the effect of using effervescent powder (EP) on the efficacy of multi-detector computed tomography (MDCT) in detection and grading of esophageal varices in cirrhotic patients by considering endoscopy as the gold standard.
Materials and methods: Ninety-two cirrhotic patients undergoing biphasic liver MDCT followed by upper gastrointestinal endoscopy within 4 weeks of MDCT were prospectively evaluated. The patients were divided into two groups before MDCT. The first group ($n = 50$) received effervescent powder (EP) before and during MDCT procedure and the second group did not receive ($n = 42$). The presence, size and grade of the esophageal varices were evaluated. MDCT findings were compared with endoscopic results. The sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and accuracy of MDCT with EP and without EP were calculated and compared. Correlations between the grades of the varices for each group based on MDCT imaging and endoscopic grading were also evaluated.
Results: The sensitivity, specificity, accuracy, PPV, and NPV of MDCT were 100%, 88%, 96%, 94%, and 100%, respectively, in the EP group, whereas they were 76%, 67%, 74%, 89%, and 43%, respectively, in the non-EP group. Correlations between the grades of the esophageal varices on MDCT and endoscopy were significant in both groups ($r = 0.94$, $p < 0.001$ for EP group and $r = 0.70$, $p < 0.001$ for non-EP group).
Conclusion: During periodic CT scanning of cirrhotic patients, use of EP increases the success rate of MDCT for detection and grading of esophageal varices.

1. Introduction

Cirrhosis, the final common pathway of variety of liver diseases causing damage to the normal liver tissue, is chronic irreversible disease that poses an important socioeconomic burden. This global public health concern, has also been reported to be still one of the leading causes of death and serious morbidity in European Union [1]. The most common causes of cirrhosis are alcohol abuse and viral hepatitis, the others are biliary, cryptogenic and metabolic [1]. High morbidity and mortality of this disease are related to the complications rather than hepatic dysfunction [2]. Complications of cirrhosis include portal hypertension, esophagus varices, ascites, hepatic encephalopathy, spontaneous bacterial peritonitis, hepatorenal syndrome, hepatopulmonary syndrome and hepatocellular carcinoma [1,3].

Periodic evaluations by endoscopic and scanning methods are necessary for early diagnosis and prevention of complications in cirrhotic patients. An important preventive measure in cirrhotic patients is the screening of esophageal varices [3]. It has been demonstrated that esophagus and/or gastric varices develop in all cirrhotic patients in the long term. While annual development rate for new varices is reported to be 5–10%, transformation rate of small varices into large varices is reported to be 5–30% [4]. Esophageal/gastric variceal bleeding is the most important complication of cirrhosis since it indicates that cirrhosis has progressed to the decompensated phase. Although the rate of death due to bleeding episodes has been significantly reduced along with advances in treatment in the last few decades, a mortality rate up to 20% is still in question [5]. Thus, identification and periodic screening of the patients with bleeding risk is of great importance to apply prophylactic treatment.

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Endoscopic imaging of upper gastrointestinal system is the most effective method in detecting esophageal varices. However, being invasive and expensive are the disadvantages of endoscopic method. Multi-detector computed tomography (MDCT) of the liver can successfully demonstrate distal esophageal varices [6,7]. Advantages of computed tomography include capability of visualizing extra mucosal varices, detecting other complications of cirrhosis, and being cheaper and less invasive than endoscopy [6,7]. However, the facts that esophagus is an organ showing poor distention and its lumen is easily collapsed with peristalsis are the most important disadvantages in detecting submucosal pathologies via computed tomography. To the best of our knowledge, there are few studies in the literature investigated the efficacy of effervescent powder (EP) use for distention of esophagus lumen [8,9]. These studies have evaluated extra-varicose pathologies [8,9]. The aim of the present study was to investigate the effect of EP use, which was expected to dilate esophagus lumen, on the efficacy of MDCT in detecting and grading varices in cirrhotic patients by considering the endoscopy as a gold standard.

2. Materials and methods

2.1. Patient population and reference standard

The present study was approved by the local ethical committee and informed consents of the patients were obtained. This prospective study was performed between May 2009 and June 2012 in a university hospital setting. MDCT was planned to perform in two groups of cirrhotic patients involving a group with EP and another group without EP administration. Power analysis revealed necessity of at least 45 and 40 patients for EP and non-EP groups, respectively, for a 95% confidence interval (CI) and 80% power (Power and Precision V4 program). And, one hundred and six consecutive cirrhotic patients who underwent biphasic liver MDCT for screening of hepatocellular carcinoma followed by upper gastrointestinal endoscopy within 4 weeks of MDCT. Of the patients, 14 were excluded from the study due to endoscopic variceal ligation ($n = 6$), use of beta-blockers ($n = 6$), hiatal hernia ($n = 1$), and nasogastric tube ($n = 1$). Therefore, the remaining 92 patients were included in the study. The diagnosis of liver cirrhosis was based on histopathology ($n = 27$) or the combination of typical clinical findings (symptoms and stigmata of cirrhosis), laboratory results (viral markers, hypoalbuminemia, hyperbilirubinemia, coagulopathy, and cytopenia), and imaging findings (liver segmental hypertrophy/atrophy, contour irregularity, splenomegaly, ascites, and collateral vessels) ($n = 65$). Disease severity was graded according to Child-Pugh scoring system [10]. The first group ($n = 50$) received EP before and during MDCT procedure to dilate the esophagus lumen, whereas MDCT was performed without EP administration in the second group ($n = 42$).

Endoscopy was performed by one of three experienced gastroenterologists. Esophageal varices were graded according to the classification proposed by Beppu et al. [11]. In consistent with the purpose of the present study, absence of esophageal varices was added as F0 to this classification and grading was grouped into four grades as follows: F0, no esophageal varices, F1, small and straight, F2, moderately sized, tortuous, and occupying less than one third of the lumen, and F3, large, coiled, and occupying one third or more of the lumen.

2.2. Computed tomography technique

Computed tomography was performed on a 16-MDCT scanner (Somatom Sensation, Siemens, Erlangen, Germany). A 130 mL nonionic contrast material (Ultravist [Iopromide], 300 mg I/mL, Bayer Schering Pharma AG, Berlin, Germany) was injected at a rate of 3 mL/s using an automatic injector system (Medrad Vistron computed tomography, Pittsburg, PA, USA) through a 20-gauge needle in an antecubital vein. Computed tomography images were obtained during the arterial phase (start delay, 30 s) and portal venous phase (start delay, 70 s). The patients in the EP group received a pack of EP (ENHOS fruit salt, sodium bicarbonate, tartaric acid, 100 g/pack) in 100 mL water both just prior to intravenous contrast agent administration and immediately after obtaining the arterial phase. The second pack was orally administered through a straw while the patients were lying. Twenty five patients (12 in EP group and 13 in non-EP group) received 750–1000 mL of concentrated barium sulphate suspension (E-Z CAT barium sulfate suspension concentrate, EZ-EM, NY, USA) as oral contrast agent by the request of the clinician. The remaining 67 patients received 750–1000 mL drinking water as a negative contrast agent before scanning. The scan protocol was as follows: slice collimation = 16 mm × 1.5 mm, table speed = 18.0 mm, rotation time = 0.5 s, kV = 120, and effective mAs = 160. Images were reconstructed at a workstation (Wizard, Siemens, Germany) with a slice thickness of 2 mm at every 1.5 mm reconstruction interval from the raw data sets for multiplanar reformate images. Images were obtained from the dome of the diaphragm to the lower pole of the right kidney during a single breath-hold.

2.3. Image analysis

All MDCT images were evaluated in consensus on a workstation (Wizard, Siemens, Germany) by two experienced abdominal radiologists who were blinded to clinical features, laboratory results, endoscopic findings, and the group of the patients. Axial portal venous phase images were evaluated to determine the presence and size of esophageal varices. Enhancing nodular lesions abutting the luminal surface of the esophageal wall or protruding into the lumen were accepted as a positive finding for the presence of esophageal varices. Arterial phase images were assessed when a suspicious finding was present at portal venous phase images. Ill-defined enhancing lesions and the patients using oral contrast agents were evaluated by a combination of arterial and portal venous phases. In the patients with positive findings, the radiologists measured the short-axis diameter of the largest esophageal varix with electronic calipers.

The same radiologists further assessed the grade of esophageal varices at coronal multiplanar reformate images. The grading system had similar classification used at endoscopy. The grades were as follows: Grade 0, no esophageal varices, Grade 1, small and straight, Grade 2, moderately sized, tortuous, and occupying less than one third of the lumen, and Grade 3, large, coiled, and occupying one third or more of the lumen.

Additionally, extraesophageal abnormalities were evaluated on both arterial and portal venous phases. The presence of extraesophageal varices and hepatocellular carcinoma was also recorded.

2.4. Statistical analysis

ROC analysis was performed in order to evaluate the diagnostic performance of EP on MDCT for the detection of esophageal varices. The sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and accuracy of MDCT were calculated for the EP and non-EP groups and compared. The ROC analysis was performed using Medcalc (version 9.6.4.0, Medcalc Software, Turkey).

Correlation between the grades of varices of each group based on MDCT imaging and endoscopic grading was performed by weighted Kappa statistics and the Spearman rank correlation test. A kappa value ≤ 0.20 was considered slight agreement, between 0.21 and