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Clinical Trials Study

Computed Tomography Combined with Gastroscope Application in Pancreatic Segmental Portal Hypertension

CT Combined with Gastroscope Application in PSPH

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Abstract

BACKGROUND

Pancreatic segmental portal hypertension (PSPH) is the only type of portal hypertension that can be completely cured. However, it can easily cause varicose veins in the esophagus and stomach and hemorrhage in the digestive tract.

AIM

To explore the application of computed tomography (CT) to examine the characteristics of pancreatic segmental portal hypertension and assess the risk level.

METHODS

This was a retrospective analysis of our center's CT images of 22 patients diagnosed with pancreatic segmental portal hypertension. Spearman correlation analysis was performed using the range of esophageal and gastric varices (measured by the vertical gastric wall), the ratio of the width of the splenic portal vein to the compression site (S/C ratio), the degree of splenomegaly, and the staging under gastroscopy. The study recorded whether patients had gastrointestinal bleeding within two weeks and combined CT and gastroscopy to explore the connection between bleeding and CT imaging.

RESULTS

The range of esophageal and gastric varices had the best correlation in the diagnosis of PSPH ($P<0.001$), and the S/C ratio ($P = 0.007$) was correlated with the degree of splenomegaly ($P = 0.021$) and PSPH ($P<0.05$). The study revealed that male patients were more likely than females to progress to G2 or G3 staging as viewed under gastroscopy. The CT imaging demonstrated excellent performance, with an AUC of 0.879.

CONCLUSION

CT can effectively analyze the imaging signs of PSPH and combine it with a gastroscope to effectively predict the risk level of gastrointestinal bleeding.

Key Words: Computed tomography; Pancreatic segmental portal hypertension; esophageal and gastric varices; Gastrointestinal bleeding; Curable portal hypertension

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Core Tip: 1. This is a detailed clinical imaging study (Computed tomography, CT) of Pancreatic segmental portal hypertension (PSPH), the only curable portal hypertension. 2.CT is of great significance in the diagnosis and treatment of PSPH.

INTRODUCTION

Pancreatic segmental portal hypertension (PSPH) is rare regional, accounting for only 8% of extrahepatic portal hypertension cases (1). PSPH is usually caused by pancreatic tumors, pancreatitis, and IgG4 diseases that cause pancreatic vein compression. Clinically, it manifests as regional portal hypertension on the left side; usually, the right portal system is not significantly affected(2). At the same time, it is now the only curable portal hypertension. However, if PSPH is not detected early, continuous compression of the pancreatic veins will cause esophageal and gastric varices, which may lead to a hemorrhage of the gastrointestinal tract. In severe cases, hemorrhagic shock or death may occur. Therefore, it is essential to diagnose PSPH as soon as possible and assess whether there is a tendency for gastrointestinal bleeding(3).

Because other underlying diseases of the pancreas usually cause this type of disease, it can generally be cured by removing the underlying disease (4,5). This approach ignores the risk of gastrointestinal bleeding in this type of patient. Clinics usually only focus on

curing the underlying disease, and iatrogenic secondary injuries after tumor resection or pancreatitis treatment may also cause a continuous increase in the pressure of the originally narrowed pancreatic vein, leading to an increased risk of gastrointestinal bleeding bleeding(6-8). At the same time, splenomegaly or hypersplenism caused by PSPH can also cause increased destruction of blood cells and decreased resistance. Therefore, this disease is receiving increasing attention in clinical practice(9).

The diagnostic criteria for this type of the disease are as follows: ①A history of the primary pancreatic disease; ②No history of liver cirrhosis, blood system disease, or schistosomiasis disease and normal liver function; ③Splenomegaly or hypersplenism; ④Doppler ultrasound results showing that the portal vein is not wide (only the splenic vein is obstructed with or without widening of the splenic portal vein, and there are regional varicose veins on the left side [usually esophageal and gastric varices]); and ⑤ Varicose vascular masses observable under gastroscopy. PSPH can be diagnosed when three of the above five criteria are satisfied(10). Among the current diagnostic criteria, prerequisites ① and ② are met by almost all diagnosed patients. However, splenomegaly does not appear in all patients. Gastroscopy can only elucidate the varicose veins that have compressed the fundus esophagus. Pancreatic effusion or gas will also obscure the site analyzed by Doppler ultrasound. Therefore, the diagnosis of varicose veins combined with the clinical history under gastroscopy can usually diagnose the disease.

Due to the relatively rare nature of this type of disease, computed tomography (CT) imaging has not yet determined the clear signs of this type of disease. However, CT has apparent advantages over ultrasound and gastroscopy. It is not affected by gas and can reflect and measure deeper varicose veins. In addition, the CT-enhanced portal phase can also facilitate an excellent preliminary judgment regarding stenosis of the splenic vein and the splenic portal dilated vein. It can also evaluate enlargement of the spleen. Moreover, CT is more convenient than digital subtraction angiography (DSA) and can

reflect the initial vascular condition(11). In this study, CT signs were combined with the manifestations of gastric fundal and esophageal varices to explore the appearance of PSPH under CT and the risk of gastrointestinal bleeding.

MATERIALS AND METHODS

Computed Tomography Scanning Solution

All patients' data were examined using 32-section CT system (Siemens Healthcare Sector, Germany). Before the CT examination, the patient fasted for 4–6 h without intramuscular injection of antispasmodic drugs or oral contrast agents. The scan range was from the top of the diaphragm to the level of to the mid-abdominal. The scanning parameters used are as follows: the width of the collimator was 64×0.625 mm, the tube voltage was 100 kVp, automatic tube current control technology (85~150 mA) was adopted, and the X-ray tube rotation speed was 0.5 s/cycle. The reconstruction layer thickness was 2.0 mm, and the layer spacing was 0 mm. The enhanced scan used contrast agent intelligent tracking threshold trigger technology. The trigger point was set in the abdominal aortic lumen at the celiac trunk. The trigger threshold was 120 HU. The venous phase started to be collected 30 s after the end of the arterial phase scan. Iopramide (350 mg/mL iodine concentration) was used as the contrast agent at a dose of 1.2 mL/kg, and the injection rate was 3.0 mL/s.

Image analysis

Because the portal phase can better reflect the pancreatic veins, the enhanced portal phase of the CT images of the above PSPH patients was analyzed. Three senior doctors performed the image interpretation and measured the diameter of the splenic vein in the compressed area and the diameter of the splenic vein at the splenic hilum. The rib unit was measured on the largest level of the spleen, and the largest side of the varicose vein was measured. The vertical distance from the outermost edge to the stomach wall was taken as the range of varicose veins (Figure 1, patient 1). To reduce differences between men and women and individual patients, we did not directly measure the

splenic meridian but instead used the number of rib units. For the splenic portal dilated splenic vein and the compressed splenic vein, the ratio of the two values (S/C) is used to respond to the degree of vascular stenosis.

At the same time, we combined the findings from the abovementioned analyses with the gastroscopy report of the Department of Gastroscopy to classify these PSPH patients with esophageal varices under gastroscopy as follows: Grade 1 (G1): The varicose veins are straight or slightly tortuous, and there is no "red sign"; Grade 2 (G2): The veins are straight or somewhat tortuous with the red sign or exhibit a snake-like tortuousness without the red sign; Grade 3 (G3): The varicose veins are serpentine with the red sign or vascular abnormalities are beaded and nodular and exhibit a tumor-like bulge accompanied (or not accompanied by) the red sign. (The red symbol represents a high risk of bleeding in the digestive tract.)(12). Follow up with the patient and record whether there is bleeding within two weeks after the scan.

Statistical Analysis

We organized the above patient clinical information and imaging measurement information in Table 1. We used SPSS 19.0 (SPSS v. 19, Chicago, Illinois) for statistical analysis. Because the data did not conform to a normal distribution, we employed the Spearman test combined with the staging diagnosis under gastroscopy to compare and test various measurement parameters. $P<0.05$ indicated statistical significance. All statistical graphs were created using GraphPad Prism 7 (Prism 7, La Jolla, California).

According to whether the patient bleeds within two weeks, we divided patients into a bleeding group (n = 8) and a non-bleeding group (n = 14). The Mann-Whitney U test compares continuous variables between bleeding and non-bleeding. P-value < 0.05 was considered statistically significant. All patients' continuous and classification variables are represented as the mean ± standard deviation (SD) and n (%), respectively. ROC

analysis was used to evaluate the CT diagnostic capabilities, including calculating the AUC value and 95% confidence interval (CI).

RESULTS

The results of Spearman's test are shown in Table 2. The parameters with the strongest correlation coefficient from high to low were the range of varicose veins (correlation coefficient=0.873, P<0.001), S/C ratio (correlation coefficient=0.518, P = 0.007), and rib unit (correlation coefficient=0.436, P = 0.021). The range of varicose veins had the strongest correlation with the grade under gastroscopy. In addition to the main measurement parameters, the width of the compression site was also statistically significant (P = 0.031), and it was negatively correlated; that is, the narrower the width was, the higher the grade of esophageal varices. The Figure 2 box diagram shows the three main measurement values distribution under different gastroscope levels.

At the same time, we were surprised to find that the severity of esophageal varices in male patients with PSPH was usually higher than that in female patients, which was statistically significant (P<0.001). However, the patient's age was not statistically significant.

Predictive Value of CT for bleeding

The Mann-Whitney U test showed that S/C ratio, range of varicose veins, and gastroscopy grade were significant independent predictors of bleeding（Table.3）. The ROC showed excellent performance, with an AUC of 0.879 for the Varicose vein range, 0.844 for gastroscopy grade, and (Figure 3).

DISCUSSION

PSPH, as a rare type of portal hypertension, has vital clinical significance. Still, it is easy to ignore the existence of this disease because of the excessive emphasis on the original condition in diagnostic images(13). However, gastroscopy usually delays the diagnosis of such diseases when the imaging findings are ignored, for example, as occurred in the

patient (Figure 4), who had IgG4 pancreatitis. Gastroscopy was only used four days after admission, and the typical "red sign" had already appeared. The patient developed massive gastrointestinal bleeding within 24 h. Although he was rescued in time, the prognosis was poor. While paying attention to the primary disease, we also need to evaluate whether the patient has excessive portal hypertension and the degree of compression of the splenic vein in the pancreatic area(14).

This study found that the degree of varicose veins under gastroscopy correlated with the maximum vertical measurement of esophageal varices under CT. The S/C ratio was also positively associated with the size of the spleen. Initially, we had various ideas for measuring the meridian, such as the second graded measurement of varicose veins. In addition to calculating the vertical meridian of the largest plane, the judgment of the density of varicose vessels (through the number of cross-sections of the ship in this plane) is added. However, such measurement has certain drawbacks. In some patients, although the degree of varicosity is more significant, the blood vessel diameter is smaller; other patients have a more substantial degree of varicosity, but the diameter of the vessel is larger. This results in the inability to perform practical grading measurements on patients, and the clinical operation is more complicated, requiring much time for evaluation. This situation may be dangerous for emergency patients(15).

Compared with the measurement of the range of varicose vessels, the S/C ratio has a specific correlation. However, if the splenic vein is significantly compressed and interrupted, this measurement method will be difficult to perform. However, if the splenic vein can indicate the interruption point on the CT-enhanced portal phase image, targeted diagnosis and treatment are also necessary to relieve the compression of the lesion. Although the size of the spleen is related to a certain degree, it is greatly affected by time. The enlarged spleen can also resolve after relieved compression to avoid resection(16). The early stage of PSPH usually manifests as esophageal and gastric varices. At the same time, this study found that male patients have a higher grade of varicose veins than female patients. This may be related to men's alcohol consumption

and women's sensitivity to pain, which can thus be detected early. This view has been confirmed in a study of acute pancreatitis(17-19).

All patients in this study had underlying diseases of the pancreas. Such patients need to be highly vigilant about the occurrence of PSPH. Most of the studies regarding PSPH assessed on CT are published on rare cases, and there is no detailed research or consensus yet(20). In animal models, CT studies of Swan Specchi and Giovanna Bertolini show that esophageal variances often occur in the collateral circulation established by esophageal fundus veins such as the left gastric vein and the left gastroepiploic vein, which CT can better observe to show PSPH collateral circulation (21). We recommend that for patients with underlying pancreatic diseases, CT plain scans and enhanced scans should be used to make a preliminary judgment of the PSPH level of the patient. It is proposed to use the “banyan tree root” sign (Figure 5) to identify high-risk PSPH. When there is a banyan tree root-like change, clinicians should be highly vigilant about the risk of gastrointestinal bleeding. Such patients need urgent emergency gastroscopy to prevent a poor prognosis.

This study found that CT is a powerful supplement to gastroscopy. Although CT and gastroscope alone have excellent results when applied to PSPH bleeding, it is necessary to be alert to the occurrence of exceptional circumstances. For example, if the scope of gastric esophageal varices is enormous, but the gastroscope has not yet reached the G3 grade, we should be alert to gastrointestinal bleeding. In patients with abdominal pain after pancreatic disease, even conventional CT scans can initially determine whether there are esophageal varices in the fundus of the stomach. The enhanced CT scan can better assess the location and extent of the stenosis. At the same time, gastroscopy is an invasive examination, and CT examination can more conveniently judge the prognosis of pancreatic patients.

PSPH is relatively rare in clinical practice, and the number of patients included in this study is relatively small, so the related statistical analysis has been dramatically restricted. Although this study has reached a somewhat preliminary conclusion, it requires more cases to accumulate and explore the role of imaging in this type of disease to get a more accurate decision. The clinical judgment of PSPH is usually an exclusive diagnosis; that is, the regional portal hypertension of left-sided portal hypertension is caused only by compression of the pancreatic area(22). As the only portal hypertension that can be cured entirely, PSPH requires excellent attention in clinical and imaging studies so that patients can obtain better treatment and prognosis.

Limitations: 1. Since this study is a small sample study, it is greatly influenced by individuals. If there are more samples, the credibility of this study will be further improved. 2. With enough samples, we can establish a more reliable diagnostic model. And we can use a subset of patient data to plug into the model to verify that the model is reliable.

CONCLUSION

Measuring gastric esophageal varices on CT and assessing the degree of stenosis of the compressed spleen combined with gastroscopy can effectively predict bleeding in patients with pancreatic segmental portal hypertension. CT is of great significance in the diagnosis and treatment of PSPH.

ARTICLE HIGHLIGHTS

Research background

Pancreatic segmental portal hypertension (PSPH) is the only type of portal hypertension that can be completely cured.

Research motivation

PSPH can easily cause varicose veins in the esophagus and stomach and hemorrhage in the digestive tract.

Research objectives

To explore the application of computed tomography (CT) to examine the characteristics of pancreatic segmental portal hypertension and assess the risk level.

Research methods

This was a retrospective analysis of our center's CT images of 22 patients diagnosed with pancreatic segmental portal hypertension. Spearman correlation analysis was performed using the range of esophageal and gastric varices (measured by the vertical gastric wall), the ratio of the width of the splenic portal vein to the compression site (S/C ratio), the degree of splenomegaly, and the staging under gastroscopy. The study recorded whether patients had gastrointestinal bleeding within two weeks and combined CT and gastroscopy to explore the connection between bleeding and CT imaging.

Research results

The range of esophageal and gastric varices had the best correlation in the diagnosis of PSPH ($P<0.001$), and the S/C ratio ($P = 0.007$) was correlated with the degree of splenomegaly ($P = 0.021$) and PSPH ($P<0.05$). The study revealed that male patients were more likely than females to progress to G2 or G3 staging as viewed under gastroscopy. The CT imaging demonstrated excellent performance, with an AUC of 0.879.

Research conclusions

CT can effectively analyze the imaging signs of PSPH and combine it with a gastroscope to effectively predict the risk level of gastrointestinal bleeding.

Research perspectives

1. This is a detailed clinical imaging study (Computed tomography, CT) of Pancreatic segmental portal hypertension (PSPH), the only curable portal hypertension.
2. CT is of great significance in diagnosing and treating PSPH.

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