

The Diagnostic Value of Color Doppler Ultrasound Examination for Gallstones and the Characteristic Analysis

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Abstract

Objective: The diagnostic value and characteristics of color Doppler ultrasound examination for gallstones were analyzed. **Methods:** 40 patients diagnosed (confirmed by pathological review) between March 2023 and March 2024 were studied by color Doppler ultrasound. The accuracy of gallstone classification and the detection rate of gallstone diameter were analyzed. **Results:** 40 patients were examined by color Doppler ultrasound. A total of 37 cases were detected. The examination accuracy rate was 92.50%. Color Doppler ultrasound was 90.91%. The coincidence rate of gallbladder neck stones was 100.00%, the agreement rate for the diagnosis of filled stones was 90.00%, and the coincidence rate of diagnosed sediment-like stones was 85.71%. The detection rate of color Doppler ultrasound was 50.00% for stones <0.5cm, the detection rate of stones diameter of 0.5-1.0cm was 92.59%, and the detection rate of stones diameter > 1.0cm was 100.00%. **Conclusion:** The color Doppler ultrasound examination has high accuracy and the detection rate of gallstone classification and stone diameter.

Keywords

Color Doppler ultrasound; Gallstone; Diagnostic value; Characteristics

As a common digestive disease, gallstones are gaining increasing attention from clinicians. This disease is mainly caused by the bile in the gallbladder containing excessive cholesterol or the biliary bile excretion is blocked, and has the characteristics of high incidence and recurrence [1]. As the gallstone disease progresses, patients may be at risk of gallbladder perforation, cholecystitis, and even gallbladder cancer [2]. As the main color Doppler ultrasound, in current clinical diagnosis, plays an important role in the diagnosis of gallstones with its characteristics of non-invasiveness, safety, high accuracy, and good reproducibility [3]. Through ultrasound and color Doppler technology, this technology can not only clearly show whether there are stones in the gallbladder and biliary tract, but also accurately judge the size, morphology, location, and number of stones, which can provide an important basis for subsequent treatment and management [4]. This paper aims to explore the diagnostic value and characteristics of color Doppler ultrasound examination on gallstones, in order to provide clinicians with a more accurate and reliable diagnostic basis, so as to help patients choose the most appropriate treatment plan and reduce the deterioration and recurrence of the disease. The report is as follows.

1. Data and methods

1.1 General information

Forty patients admitted with gallstones and diagnosed (confirmed by pathological examination) between March 2023 and March 2024 were included in the study. Patients were aged between 29 to 62 years, mean (46.75 ± 3.29) years; body mass index 20.54-24.87kg/m², mean (22.46 ± 1.27) kg/m²; 22 male patients and 18 female patients. Inclusion

criteria: gallstone confirmed by pathological examination; complete clinical data; the patient or family members signed informed consent; received cholecystectomy. Exclusion criteria: patients with incomplete heart, liver, kidney, and other organs; patients with mental diseases and dementia; systemic immune diseases and abnormal coagulation function; and patients with malignant tumors.

1.2 Methods

Color Doppler ultrasound examination method. Patients should follow preparation procedures before undergoing color Doppler ultrasound, including fasting and water abstinence for at least 8 hours, and be placed in the left lateral decubitus position for easy examination. The inspection uses Philips Epiq 5 type ultrasonic diagnostic equipment, equipped with a high-precision probe of 3.5 MHz. The examination process started below the costal margin of the right upper abdomen, and the probe was initially scanned in the spine at 45 angle. Adjust the position and angle of the probe flexibly according to the natural direction of the biliary system. During this process, the patient was instructed to cooperate with multiple deep breaths to promote the full display of the gallbladder. For detected stones, various characteristics including size (diameter or volume), number, morphology (e. g. round, oval, or irregular), and exact location (e.g., neck, body, or bottom of the gallbladder) were recorded.

1.3 Observing indicators

(1) Statistical accuracy of color Doppler ultrasound examination. (2) Statistics of the coincidence rate of color Doppler ultrasound examination to diagnose different types of gallstones. It mainly includes simple stones, gallbladder and neck stones, filled stones, and sediment stones. (3) Statistics of the detection rate of color Doppler ultrasound examination for diagnostones with different diameters.

1.4 Statistical treatment

The statistical software SPSS 26.0 is used to analyze the data in the text, and the counting index is represented by cases/percentage (n/%), for the χ^2 test; the measurement index is represented by mean \pm standard deviation ($\bar{x} \pm s$), the measurement index conforms to the normal distribution with the t-test; $P < 0.05$ is statistically significant.

2. Results

2.1 Statistical accuracy of color Doppler ultrasound examination

A total of 37 patients were detected with an accuracy of 92.50% (37/40).

2.2 Statistics of the coincidence rate of color Doppler ultrasound examination for the diagnosis of different types of gallstones

The coincidence rate of pure stone was 90.91%. The coincidence rate of gallbladder neck stones was 100.00%. The agreement rate for the diagnosis of filled stone was 90.00%. The coincidence rate of diagnosed sediment-like stones was 85.71% (Table 1).

Table 1. The coincidence rate of color Doppler ultrasound examination to diagnose different types of gallstones (n, %)

Inspection Method	n	Simple stone	Gallbladder neck stone	Full of stone
Surgical pathology (n)	40	11	12	10
Color Doppler ultrasound (n)	37	10	12	9
Coincidence (%)	-	90.91	100.00	90.00

2.3 Statistics of the detection rate of color Doppler ultrasound examination for diagnosed stones of different diameters

The detection rate of stone diameter < 0.5 cm was 50.00%. The detection rate of stone diameter 0.5~1.0cm was 92.59%. The detection rate of stone diameter > 1.0 cm was 100.00% (Table 2).

Table 2. The detection rate of color Doppler ultrasound to diagnose stones of different diameters (n, %)

Inspection Method	n	Stone diameter < 0.5cm	Stone diameter 0.5~1.0cm	Stone diameter > 1.0cm
Surgical pathology (n)	40	2	27	11
Color Doppler ultrasound (n)	37	1	25	11
Coincidence (%)	-	50.00	92.59	100.00

2.4 Characteristics of color Doppler ultrasound

(1) Simple stone. On color Doppler ultrasound, simple gallstones usually present as a single or multiple strong echogenicities in the gallbladder cavity, often posterior with an acoustic shadow. The morphology of stones is round, oval, or other irregular shapes, and their size and number vary due to individual differences. When changing the position, the stone can move in the gallbladder. (2) Gallbladder and neck stones. When the stone is not embedded immediately, the stone is easy to detect due to the surrounding bile, which is manifested by a strong echo. When the stone is embedded immediately, there is no bile foil, and the strong echo of the stone is not clear. Ultrasound showed only the strong echogenic masses of the gallbladder neck or thickening of the gallbladder neck, along with indirect signs of increased gallbladder size and gallbladder wall thickening. (3) Fully filled stones. The characteristics of filled gallstones in color Doppler ultrasound examination are mainly the anechogenic area in the gallbladder, that is, the bile is completely occupied by the stones. The ones may be massive or scattered and fill the entire gallbladder cavity. The gallbladder wall may be thickened due to the long-term compression of the stone, and gallbladder wall calcification may even occur. Fully filled gallstones may also be accompanied by gallbladder atrophy. (4) Sediment-like stones. Fine punctate or patchy strong echo in the gallbladder cavity, posterior with acoustic shadow, strong echo point or patch may move with positioning. Sediment-like stones may be deposited in the posterior wall or base of the gallbladder, and ultrasound may show a strong echo band in the posterior wall or base of the gallbladder with acoustic shadow.

3. Discussion

A gallstone refers to the solid crystalline material formed in the gallbladder, often causing cholecystitis and gallbladder pain. The presence of gallstones can not only cause abdominal pain, nausea, vomiting, and other uncomfortable symptoms, but also may cause serious complications such as cholecystitis, cholangitis, and pancreatitis. Color Doppler ultrasound is a method that uses high-frequency sound waves (ultrasound) to penetrate the skin and uses sound waves reflected back from tissues and organs to form an image to show the morphology, size, position, and function of organs or tissues. They usually appear as strong echogenicity on color Doppler ultrasound images with an acoustic shadow at the rear. When changing the position, the stone moves in the direction of gravity. This study [5] pointed out that color Doppler ultrasound can provide guidance for the formulation of a treatment plan.

The results of this study showed that the accuracy of color Doppler ultrasound diagnosis was 92.50%. Consistent with the findings of Ying Wang's [6] study. Color Doppler ultrasound equipment has high resolution and strong penetration, which can clearly show the gallbladder and its internal structure, thus making an accurate diagnosis. Cai Huizhen et al. [7] said that in the diagnosis of gallstones, the use of color Doppler ultrasound examination combined with a variety of flexible posture changes can significantly improve the diagnostic effect. The results of this study showed that the coincidence rate of color Doppler ultrasound was 90.91%, 100.00%, 90.00%, and 85.71%. Because simple stones usually appear as a single or more isolated strong echo mass in the gallbladder, with an acoustic shadow in the rear, regular stone morphology, and a clear boundary [8]. When the gallbladder neck stone is located in the neck of the gallbladder, the gallbladder neck can be observed on the ultrasound images, which may be accompanied by increased gallbladder volume and cervical acoustic shadow. The filled stone is the whole gallbladder filled with stones. On the ultrasound image, the gallbladder cavity is filled with a strong echogenic mass. The contour of the gallbladder may not be obvious, which only shows the thickening of the gallbladder wall and a strong echogenic light band. Sediment stones show small and dense strong echo points in the gallbladder, the posterior acoustic shadow is not obvious, and the stones move with the change of body position. Sometimes, the stones can be observed in the posterior wall of the gallbladder to form an acoustic shadow. The results of this study showed that the detection rate of stone diameter <0.5cm was 50.00%, 92.59% for 0.5~1.0cm, and 100.00% for stone diameter > 1.0cm. Consistent with the findings of Lingling Chen's [9] study. During the examination, by adjusting the position and Angle of the probe and allowing the patient to change the position, the size and morphology of the stone in different directions can be observed, which can help to accurately measure the diameter of the stone and reduce the measurement error.

Because color Doppler ultrasound examination is easy to operate, without complicated preparation, patients need not bear additional pain or discomfort, and are able to monitor the systolic function of the gallbladder and dynamic changes of stones in real time [10]. Therefore, the value of color Doppler ultrasound in the diagnosis of gallstones is relatively high.

In conclusion, color Doppler ultrasound has a high accuracy in the diagnosis of gallstones, and a high detection rate of gallstone classification and stone diameter.

References

- [1] Lu J, Zhang X, Zeng C, et al. Clinical Analysis of Laparoscopic Common Bile Duct Primary Suture and T-Tube Drainage in the Treatment of Common Bile Duct Stones. *J Laparoendosc Adv Surg Tech A*. 2023;33(7):622-5.
- [2] Unalp-Arida A, Ruhl CE. Increasing gallstone disease prevalence and associations with gallbladder and biliary tract mortality in the US. *Hepatology*. 2023;77(6):1882-95.
- [3] Li X, Cheng L, Xie C. Value of color Doppler ultrasound in the examination of gallstones complicated with cholecystitis. *J Med Imaging*. 2023;33(9):1694-6.
- [4] Huang W, Fei S, Ouyang Z, et al. NLR combined with color Doppler ultrasound imaging score to assess the severity and clinical value of calculous cholecystitis. *Prog Clin Med*. 2023;13(8):13766-71.
- [5] Wu G, Yu Y, Li B. Clinical value of color Doppler ultrasound in the diagnosis of cholecyolithiasis. *Mod Med Imaging*. 2024;33(3):569-72.
- [6] Wang Y. The clinical value of color Doppler ultrasound in the diagnosis of gallstone. *Chin Women's Health Res*. 2023;(16):178-9,198.
- [7] Cai H. The value of color Doppler ultrasound. *Chin Med Device Info*. 2023;29(22):125-7.
- [8] Lv Q. Analysis of the clinical value of gallstone complicated with gallbladder cancer diagnosed by ultrasound. *Imaging Res Med Appl*. 2023;7(16):172-4.
- [9] Chen L. Diagnostic efficacy of color Doppler ultrasound in the diagnosis of gallstones. *Mod Diagn Treat*. 2022;33(3):427-30.
- [10] Zadeh NE, Sadeghi-Bojd S, Ansari-Moghaddam A, et al. Color Doppler Ultrasound's Utility in Detecting Vesicoureteral Reflux Using the Ureteral Jet Angle. *J Ultrasound Med*. 2023;42(3):723-8.