

Color Doppler ultrasonographic assessment of the risk of injury to major branch of the middle hepatic vein during laparoscopic cholecystectomy

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OBJECTIVE: To investigate the causes of hemorrhage from the gallbladder bed during laparoscopic cholecystectomy.

METHODS: 617 patients who had received laparoscopic cholecystectomy from September, 2000 to March, 2001 at this hospital were reviewed retrospectively. Ninety-one of these patients were selected randomly for prospective observation. Color Doppler ultrasound was used to examine the cause of venous hemorrhage from the gallbladder bed during laparoscopic cholecystectomy and to examine the anatomic relationship between the gallbladder bed and the branches of the middle hepatic vein in 91 patients preoperatively.

RESULTS: A large branch of the middle hepatic vein extended closely behind the gallbladder bed in all 91 patients. The mean distance between the closest point (C point) of this branch to the gallbladder bed was 5.0 ± 4.6 mm. The branch of the middle hepatic vein was completely adherent to the gallbladder bed in 14 (15.38%) of the 91 patients. The distance between this branch and the gallbladder bed was within 1 mm in 10 (10.99%) of the 91 patients. The inside diameter at C point of this branch was 3.2 ± 1.1 mm. The C point was found on the left side of the longitudinal axis of the gallbladder in 31 (34.66%) of the 91 patients, on the right side in 39 patients (42.86%), just on the axis in 21 patients (23.08%). The venous blood flow rate at the C point was 9.9 ± 3.3 cm/s.

CONCLUSIONS: A large branch of the middle hepatic vein passes behind the gallbladder. The inside diameter of this branch is relatively larger. The bleeding of this branch during operation can only be stopped by transfixion. The closest point of this vein to the gallbladder is mostly situated on the right side of the longitudinal axis of the gallbladder. Patients with large branches of the middle hepatic vein close to the gallbladder bed are at risk of hemorrhage during laparoscopic cholecystectomy and should be identified preoperatively with ultrasound.

(*HBDP Int 2003; 2: 126–130*)

Key words: cholecystectomy; gallbladder bed; hemorrhage; middle hepatic vein

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Introduction

In a recently reported series, 0 to 1.9% of laparoscopic cholecystectomies were converted to open procedures because of uncontrollable hemorrhage.^[1] Hemorrhage during laparoscopic cholecystectomy is usually more difficult to control than that during open cholecystectomy because of the diffi-

culty in removal of blood obscuring the operative field. Injuries to the hepatic artery, cystic artery, and portal vein are frequent complications of laparoscopic cholecystectomy with an incidence of about 0.16%, followed by injuries to the aorta, inferior vena cava, and iliac vessels with an incidence between 0.01% and 0.05%.^[1-3]

The gallbladder bed is considered as a common vascular injury site as well, and uncontrollable hemorrhage from the gallbladder bed necessitates conversion to open cholecystectomy.

What is the real cause leading to the hemorrhage from the gallbladder bed? And which vessel is injured? The middle hepatic vein is a large vessel which is closest to the gallbladder in local anatomy.^[4] It is reported that hemorrhage from the gallbladder bed may lead to hypotension and shock and possibly to the opening of a large venous channel that can allow carbon dioxide into the vascular system. But no such case has ever been reported in China.^[5]

To investigate the cause of extensive venous hemorrhage from the gallbladder bed during laparoscopic cholecystectomy, we examined preoperatively the patients by color Doppler ultrasound to clarify the anatomical relationship of the middle hepatic vein to the gallbladder bed and assess the risk of hemorrhage based on the findings during operation.

Methods

Prospective study

From September 2000 to March 2001, a total of 617 patients underwent laparoscopic cholecystectomy at our hospital. Ninety-one volunteers [34 men (37.36%) and 57 women (62.6%), mean age 52.84 years] were selected randomly from these patients. They received color Doppler ultrasound examination (HP PowerPoint HX Doppler ultrasonography) preoperatively in addition to routine checkup. Most (83.52%, 76/91) of the patients had had cholelithiasis, and 15 patients (16.48%) had had gallbladder polyp. One of the patients had undergone cholecystostomy 6 months ago because of acute cholecystitis. All of the 91 patients were

successfully treated with laparoscopic cholecystectomy. The mean duration of operation was 31.22 minutes. The point on the branch of the middle hepatic vein which is closest to the gallbladder bed was nominated as C point. The parameters to be evaluated included (1) the size of the gallbladder; (2) the condition of the gallbladder wall; (3) the relationship between the middle hepatic vein and the gallbladder bed; (4) the blood flow rate at the C point of the middle hepatic vein; (5) the relationship of the C point to the longitudinal axis of the gallbladder.

Retrospective study

Hemorrhage from the gallbladder bed was found in one (0.16%) of the 617 patients treated by laparoscopic cholecystectomy at our hospital. The patient, female, at age of 56 years was admitted for cholelithiasis complicated by cervical incarceration. The dimension of the gallbladder was measured 114 mm × 42 mm × 2 mm operatively. The tissue of the gallbladder bed was compact. A large branch of the blood vessel was found transversely across the gallbladder bed when removing the gallbladder. Bleeding persisted as this blood vessel was injured when dissecting the gallbladder. Electrocautery, pressure and argon electrotome were all ineffective. Open surgery was undertaken as blood loss reached 500 ml. The hemorrhage was stopped by transfixion with a big suturing needle. The patient was followed up with ultrasonography.

Results

Results of prospective study

Size of the gallbladder

The mean size of the gallbladder was 63.15 mm × 23.74 mm. During the operation, 68 patients (74.73%) were found with loose tissue in the gallbladder bed, and 23 patients (25.27%) with relatively compact tissue of the gallbladder bed. The mean thickness of the gallbladder bed was 28.64 ± 6.85 mm ($\bar{x} \pm s$).

Wall of the gallbladder

The mean thickness of the gallbladder wall

was 3.23 ± 1.20 mm.

Relationship between the middle hepatic vein and the gallbladder

Doppler ultrasound showed that a large branch of the middle hepatic vein passed behind the gallbladder bed in all 91 patients preoperatively (Fig. 1). The distance from the C point to the gallbladder bed was 5.0 ± 4.6 mm. The middle hepatic vein was completely adherent to the gallbladder bed in 14 (15.38%) of the 91 patients (Fig. 2). The distance between the C point and the gallbladder bed was 0 mm in these patients. In 10 (10.99%) of the 91 patients, the distance between the C point and the gallbladder bed was within 1 mm (including 1 mm) (Fig. 3). So totally in 24 patients (26.37%), the distance between the C point and the gallbladder was within 1 mm (Table). The largest distance between the C point and the gallbladder bed was 21 mm (Fig. 4). The in-

side diameter of the vessel at C point was 3.2 ± 1.1 mm.

Table. Distance between the C point and the gallbladder bed and the inside diameter at the C point of a branch of the middle hepatic vein

Distance between the C point and the gallbladder bed (mm)	No. of cases	%	Inside diameter (mm)
0	14	15.38	3.14
0-5	37	40.66	1.39
0-1	10	10.99	3.42
1-2	7	7.69	1.73
2-3	7	7.69	3.40
3-4	4	4.40	4.07
4-5	9	9.89	3.33
5-10	26	28.57	3.19
10-15	13	14.29	2.85
15-20	1	1.10	16.30
>20	1	1.10	21.00
Total	91		3.2 ± 1.1

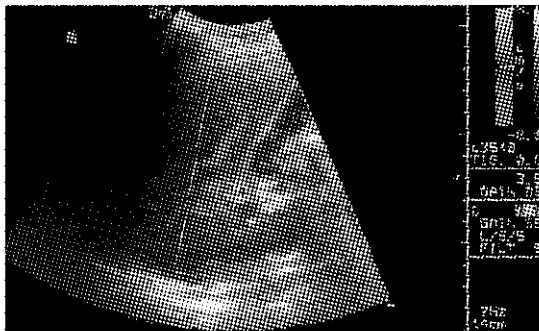


Fig. 1. The middle hepatic vein and its branch lying behind the gallbladder bed.

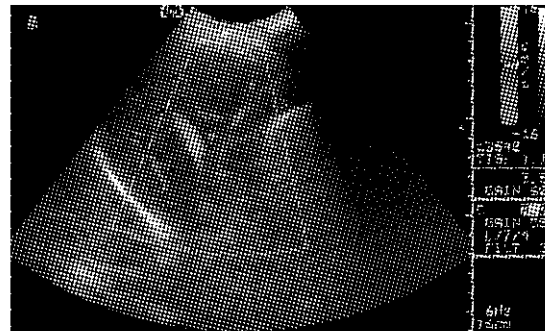


Fig. 2. A branch of the middle hepatic vein closely adherent to the gallbladder bed.

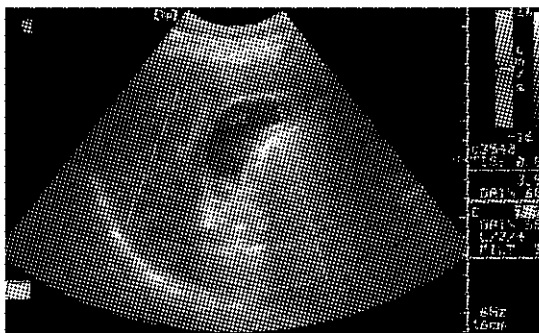


Fig. 3. The distance between a branch of the middle hepatic vein and the gallbladder bed was <1 mm.

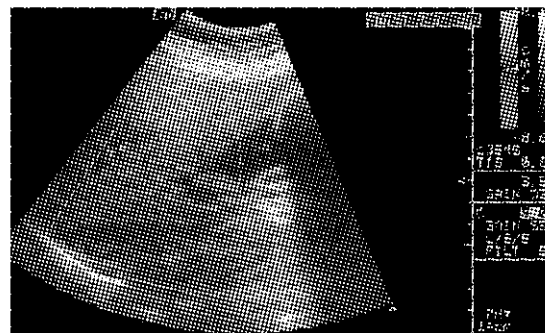


Fig. 4. A branch of the middle hepatic vein was relatively separated from the gallbladder bed.

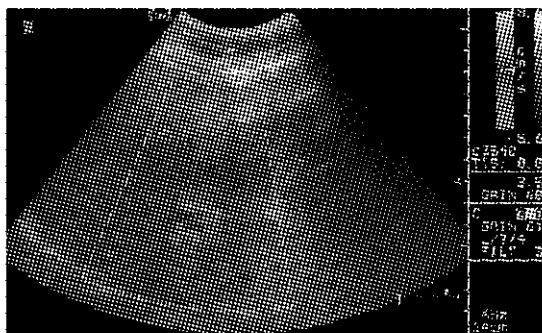


Fig. 5. A branch of the middle hepatic vein penetrated the gallbladder bed after cholecystectomy.

Blood flow rate

The blood flow rate at the C point of the middle hepatic vein was 9.9 ± 3.3 cm/s (3.0–20.0 cm/s).

Relationship between the C point and the longitudinal axis of the gallbladder

The C point was situated on the left side of the longitudinal axis of the gallbladder in 31 (34.66%) of the 91 patients, on the right side in 39 (42.86%), and just on the axis in 21 (23.08%).

Results of retrospective study

The patient with massive bleeding during surgery was followed up for 7 days after operation. Doppler ultrasound indicated that the injured vein leading to hemorrhage was a large branch of the middle hepatic vein. The distance between the C point and the gallbladder bed was 0 mm. The inside diameter at the C point of the branch was 2 mm. The blood flow rate at this point was 8 cm/s (Fig. 5).

Discussion

Hemorrhage from the gallbladder bed is a common complication during open or laparoscopic cholecystectomy. Sometimes the bleeding can be stopped easily, but in some cases hemostasis is not so easy. Transfixion with a big suturing needle must be applied to stop the hemorrhage. In recent years, the application of laparoscopic cholecystectomy has been increasing. By this procedure, the image of

operative field is magnified 4–6 times on the screen of laparoscope. A “large” vein lying across the gallbladder bed can be seen clearly after dissecting the gallbladder bed. In one (retrospective group) of our series, such a “large” vein lying across the gallbladder bed was found even when dissecting the gallbladder. The size of the gallbladder was 114 mm × 42 mm because the patient had gallbladder hydrops. The tissue of the gallbladder bed was compact, but the vessel was injured by electric hook because of accident. Blood effused continuously from the opening, but electrocautery and pressure with gauze failed. Open surgery was performed thereafter. The hemorrhage was stopped after transfixion with a 9 × 34 hepatic suturing needle. Similar cases^[1] have been reported of conversion to open laparotomy in 80 of 77 604 laparoscopic cholecystectomies because of intraoperative hemorrhage (0.1%) from the gallbladder bed. The number accounted for 93.75% of all of the hemorrhagic patients, and 0.096% of those undergoing laparoscopic cholecystectomy. Two patients died of massive hemorrhage from the gallbladder bed. Takeyuki et al^[4] reported that 4 (0.45%) of 896 patients treated with laparoscopic cholecystectomy had hemorrhage from the gallbladder. Two (0.22%) of them were converted to undergo open laparotomy. Our study indicated that the ratio of patients requiring conversion to open laparotomy because of bleeding from the gallbladder bed was 0.02%. It is not surprising to note the warning by Reddick et al^[5] that attention must be paid to “the hepatic vein sinusoid adherent to the gallbladder bed.”

What’s the underlying cause leading to the major hemorrhage from gallbladder bed? Nenner et al^[6] reported that hemorrhage from the gallbladder bed was due to the injured middle hepatic vein in laparoscopic cholecystectomy. Our retrospective study also confirmed that the “large” vessel lying across the gallbladder bed in the patient was a large branch of the middle hepatic vein. The branch “penetrated” the gallbladder bed. The distance between the C point of the vein and the gallbladder bed was 0 mm. The inside diameter of the vein at the C point was 2 mm, while the blood flow rate at the C point was 8 cm/s.

Our prospective study confirmed that there

was a large branch of the middle hepatic vein lying behind the gallbladder bed in all of the 91 patients. The mean closest distance between this branch and the gallbladder bed was 5.0 ± 4.6 mm. In our series, the branch was adjacent directly to the gallbladder bed in 15.38% of the patients. The distance between the C point and the gallbladder bed in 10.99% of the patients was within 1 mm (including 1 mm). Totally in about 26.37% of the patients, the distance between the branch of the middle hepatic vein and the gallbladder bed was within 1 mm. It is undoubtedly that these patients are high-risk subjects for hemorrhage from the gallbladder bed when undergoing cholecystectomy. The inside diameter of the middle hepatic vein at the segment entering the gallbladder bed was 3.2 ± 1.1 mm. The largest inside diameter of this branch was 6.8 mm in our series. The blood flow rate at the C point was 9.9 ± 3.3 cm/s. But where is the most vulnerable point on the branch? Our findings suggested that with reference to the longitudinal axis of the gallbladder, the point at the middle hepatic vein closest to the gallbladder was situated on the left side of the axis in 34.66% of the patients, on the right side in 42.86% of the patients, just on the axis in 23.08% of the patients.

The following conclusions can be drawn from this study.

1. There is a large branch of the middle hepatic vein behind the gallbladder bed. The distance between this branch and the gallbladder bed is within 1 mm in about 26.37% of the population. The inside diameter of this branch is relatively large (3.2 ± 1.1 mm). Massive hemorrhage from the gallbladder bed may be due to the disruption of this branch. Electrocautery and pressure are not effective for control of hemorrhage, but transfixion with a suturing needle is needed to stop bleeding. If such hemorrhage happens during operation, conversion to open laparotomy is necessary.

2. The point at the branch vein closest to the gallbladder bed is mostly (42.86%) situated on the right side of the longitudinal axis of the gallbladder.

3. Considering the existence of this branch, routine color Doppler examination is required before laparoscopic cholecystectomy to demonstrate the anatomical relationship between the middle hepatic vein and the gallbladder bed. When the distance between the middle hepatic vein and the gallbladder bed is within 1 mm, extreme attention must be paid to the risk of hemorrhage, especially when the tissue of the gallbladder bed is compact. Such precautions are helpful to prevent hemorrhage from the injured middle hepatic vein during operation. The proportion of patients being converted to have open laparotomy in our study was lower than 0.1% as reported by Deziel et al.^[1] and 0.22% by Takeyuki et al.^[4]

Competing interest

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

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Received September 18, 2002

Accepted after revision November 19, 2002