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ORIGINAL ARTICLE

Laparoscopic cholecystectomy for left-sided gallbladder

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Abstract

Purpose Left-sided gallbladder (LSGB) is a rare congenital anomaly in the gallbladder, which is defined as a gallbladder located on the left side of the falciform ligament without situs inversus. We retrospectively analyzed 13 patients diagnosed with LSGB in a single center to confirm the safety of laparoscopic cholecystectomy (LC) and reviewed the anatomical implications in those patients.

Methods Of the 4910 patients who underwent LC for the treatment of gallbladder disease between August 2007 and December 2019, 13 (0.26%) were diagnosed as having LSGB. We retrospectively analyzed these 13 patients for general characteristics, perioperative outcomes, and other variations through the perioperative imaging workups.

Results All patients underwent LC for gallbladder disease. In all cases, the gallbladder was located on the left side of the falciform ligament. The operation was successfully performed with standard four-trocar technique, confirming "critical view of safety (CVS)" as usual without two cases (15.4%). In one case, which had an intraoperative complication and needed choledochojejunostomy because of common bile duct injury, there was an associated variation with early common bile duct bifurcation. The other patient underwent an open conversion technique because of severe fibrosis in the Calot's triangle. Furthermore, on postoperative computed tomography, abnormal intrahepatic portal venous branching was found in all cases.

Conclusions Although LSGB is usually encountered by chance during surgery, it can be successfully managed through LC with CVS. However, surgeons who find LSGB have to make efforts to be aware of the high risk of bile duct injury and possibility of associated anomalies.

Keywords Left-sided gallbladder · Laparoscopic cholecystectomy · Anatomic variation · Gallbladder disease

Introduction

Laparoscopic cholecystectomy (LC) is a common procedure performed as a standard treatment for gallbladder disease [1–3]. In the Republic of Korea, approximately 77,000 cases of LC, which is the sixth most common surgery, are performed annually. With this large number of surgeries, most surgeons encounter a variety of anomalies related to the gallbladder. Indeed, approximately 70% of the cases had normal gallbladder structures. On the other hand, the remaining 30% of patients had variations or anomalies [4].

Of these various anomalies, left-sided gallbladder (LSGB) is the gallbladder located on the left side of the falciform ligament without situs inversus, which is reported to have an incidence of approximately 0.1–0.7% [5–9]. As LSGB is an anomaly that can be clearly confirmed during a surgical procedure, it has been reported frequently and is one of the relatively widely known gallbladder anomalies [9–11]. In addition, preoperative diagnostic techniques such as ultrasonography (US) and computed tomography (CT) before LC have been rapidly developed. Nevertheless, LSGB is rarely diagnosed before surgery and is mostly discovered by chance during surgery [6, 12, 13].

This study aimed to evaluate the safety of LC for LSGB and to examine the presence of characteristic anomalies through retrospective analysis of patients undergoing LC who were diagnosed with LSGB in a single center.

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Materials and methods

We retrospectively analyzed 13 patients diagnosed with LSGB among 4910 patients who underwent LC from August 2007 to December 2019 at the Hanyang University Hospital, Seoul, Republic of Korea. The patients' clinical data were obtained by reviewing the electronic medical records of the hospital. These clinical data included general characteristics such as age, sex, preoperative diagnosis and surgical records such as operation name and operation time, and imaging workups performed before and after surgery.

This retrospective study was approved by the Institutional Review Board (IRB) of the Hanyang University Hospital, Seoul, Republic of Korea, and all research conducted adhered to the tenets of the Declaration of Helsinki (IRB No. 2018–09-019).

Surgical techniques of LC

All surgical techniques were performed in the same way as for general LC. After inserting a 12-mm trocar in the subumbilical area using the Hasson technique, three trocars were additionally inserted under camera vision to perform four-port operations. LSGB did not require an additional port. The subserosal layer of the gallbladder was dissected in the hepatocystic area to confirm the cystic artery and cystic duct. After completely confirming the "critical view of safety (CVS)," the cystic artery and cystic duct were separately ligated [14]. If the structure was not accurately identified, intraoperative cholangiography (IOC) was additionally performed through the cystic duct. IOC was performed by inserting a pediatric feeding tube into the cystic duct after making an incision less than half the circumference of the cystic duct. When the absence of acute complication was confirmed, the gallbladder was removed, and the operation was completed. If necessary, the technique was changed to an open technique following the decision of the surgeon.

Results

LSGB was diagnosed in 13 (0.26%) out of 4910 patients who underwent LC at a single center from August 2007 to December 2019. All patients diagnosed as having LSGB were not diagnosed before surgery; LSGB was discovered and diagnosed by chance during the surgery. Figure 1 shows the surgical field of LSGB found during operation. Table 1 includes the general characteristics, perioperative outcomes, and combined anomaly of the 13 patients diagnosed as having LSGB during LC.

General characteristics of patients

The general characteristics of the 13 patients are as follows: average age, 50.69 years (range: 24–86 years); the number of male patients, 11 (84.6%); and the number of female patients, two (15.4%). Acute cholecystitis was the most common preoperative diagnosis in seven patients (53.9%). Other patients were diagnosed as having chronic cholecystitis (n = 2, 15.4%), symptomatic gallbladder stone (n = 3, 23.1%), and gallbladder polyp (n = 1, 7.7%). Most of the preoperative diagnosis was confirmed through the CT

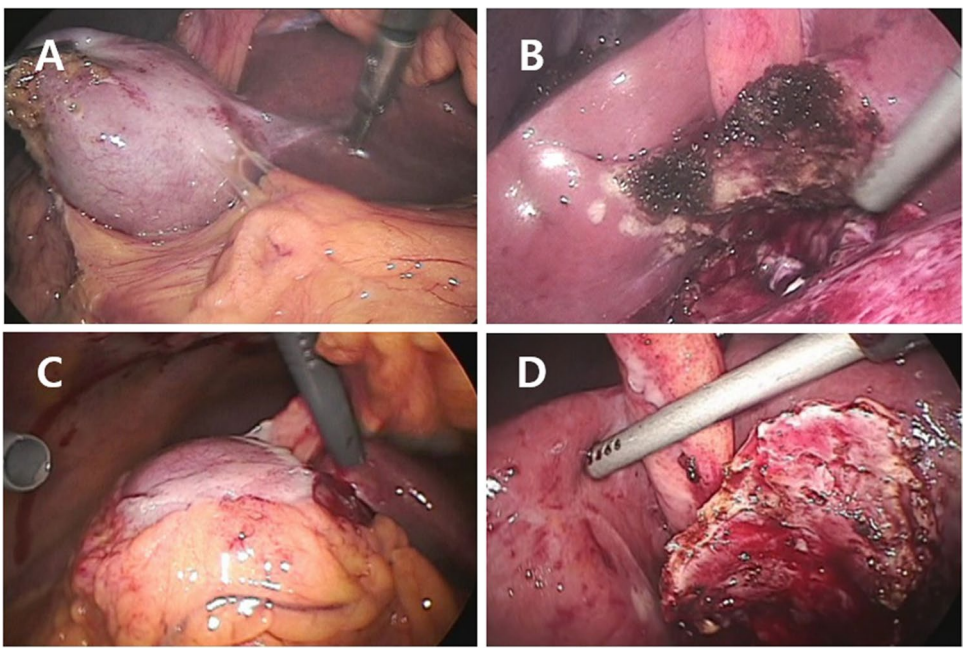

Fig. 1 Laparoscopic view of left-sided gallbladder (LSGB). **A**, **C** Intraoperative view of LSGB before dissection. **B**, **D** Intraoperative view of LSGB after cholecystectomy. Before dissection, LSGB may not be accurately identified because of the inflammation and distension of the gallbladder. However, after the gallbladder is removed, LSGB can be clearly confirmed as the gallbladder bed is located on the left side of the falciform ligament before the start of dissection

Table 1 General characteristics and perioperative outcomes of patients diagnosed with LSGB

Case no	Age	Sex	Diagnostic modality	Preoperative diagnosis	Operation	Operative time (min)	Conversion	CVS	IOC	Postoperative complications	Combined variations
1	55	M	CT	Acute cholecystitis	Laparoscopic cholecystectomy	85	No	Yes	No	No	RAPV from LPV
2	67	M	CT	Gallbladder stone	Laparoscopic cholecystectomy	105	No	Yes	No	No	RAPV from LPV
3	24	M	US	Gallbladder polyp	Laparoscopic cholecystectomy	60	No	Yes	No	No	Not checkable
4	54	M	CT	Gallbladder stone	Laparoscopic cholecystectomy	125	No	Yes	No	No	RAPV from LPV
5	58	M	CT	Acute cholecystitis	Laparoscopic cholecystectomy	80	No	Yes	No	No	RAPV from LPV
6	41	M	CT	Acute cholecystitis	Conversion cholecystectomy and choledochojejunostomy	240	Yes	No	Yes	No	RAPV from LPV Early bifurcation of CBD
7	44	M	CT	Acute cholecystitis	Laparoscopic cholecystectomy	90	No	Yes	Yes	No	RAPV from LPV
8	36	M	US	Chronic cholecystitis	Laparoscopic cholecystectomy	80	No	Yes	No	No	Not checkable
9	52	F	CT	Chronic cholecystitis	Laparoscopic cholecystectomy	70	No	Yes	Yes	No	RAPV from LPV
10	49	M	CT	Gallbladder stone	Laparoscopic cholecystectomy	65	No	Yes	No	No	RAPV from LPV
11	35	F	CT	Acute cholecystitis	Laparoscopic cholecystectomy	90	No	Yes	No	No	RAPV from LPV
12	59	M	CT	Acute cholecystitis	Laparoscopic cholecystectomy	105	No	Yes	Yes	No	RAPV from LPV
13	86	M	CT	Acute cholecystitis	Conversion cholecystectomy	150	Yes	No	Yes	No	RAPV from LPV

CVS critical view of safety, *IOC* intraoperative cholangiography, *CT* computed tomography, *US* ultrasonography, *RAPV* right anterior portal vein, *LPV* left portal vein, *CBD* common bile duct

(n = 11, 84.6%), and the patient who did not undergo CT was diagnosed through US (n = 2, 15.4%).

Perioperative outcomes of patients

The average operation time was 103 min (range: 65–240 min); in two patients (15.4%), the technique was converted to the open technique. One of these two patients underwent the open technique as the Calot's triangle was not identified because of severe fibrosis. In the other patient, IOC confirmed the presence of early common bile duct (CBD) bifurcation and right CBD injury, and hepaticojejunostomy was performed by converting to the open technique. CVS was identified in most patients (n = 11, 84.6%) except for two patients. One of two patients converted to the open technique because CVS could not be confirmed due to severe fibrosis of Calot's triangle. In the other patient, it seemed that Calot's triangle was identified by finding CBD, cystic duct, and cystic artery during dissection. However, when the IOC was checked, CBD was early bifurcated, and because of this, the left bile duct was misunderstood as CBD and the right bile duct as cystic duct. Eventually, CVS was not properly secured, resulting in injury to the right bile duct, and the choledochojejunostomy was done for this patient. IOC, which was performed in five patients (38.5%), was done according to the surgeon's decision when the structure was not accurately identified. Postoperative complications did not occur in any cases.

Variations found with LSGB

We reviewed all preoperative images after finishing the operation for all patients diagnosed as having LSGB to confirm if there were any other associated variations or anomalies. The same variation, the right anterior portal vein originating from the left portal vein (Fig. 2), was found in the intrahepatic portal vein in all eleven patients (84.6%), except for patients where the exact anatomy could not be reviewed because only non-enhanced CT or US was perioperatively performed. In addition, only one patient (7.7%), who was one of the two patients who underwent open technique, had early CBD bifurcation (Fig. 3).

Discussion

LSGB is defined as the gallbladder located to the left side of the falciform ligament without situs inversus [5]. It is a very rare anomaly, with an incidence of 0.1–0.7% [6–9]. There are two theories explaining LSGB occurrence. First, it occurs during fetal development. In general, in the course of fetal development, the right ligament degenerates, and the umbilical portion is located in the left portion of the liver.

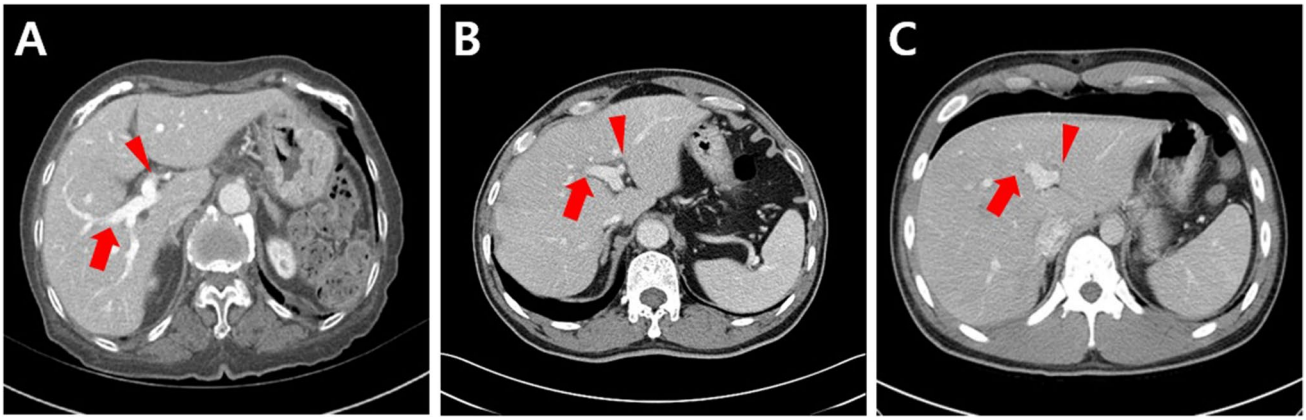

Fig. 2 Enhanced computed tomography (CT) images of abnormal portal venous branching in patients with left-sided gallbladder (LSGB) compared to those of individuals with a normal anatomy. **A** CT scan showing the normal portal vein anatomy. After bifurcation to right and left first, right anterior portal vein is branched from the right portal vein. **B**, **C** CT scans of patients diagnosed as having LSGB, and unlike the normal anatomy, it is confirmed that the right anterior portal vein is branched from the left portal vein (Arrow: right anterior portal vein, Arrowhead: left portal vein)

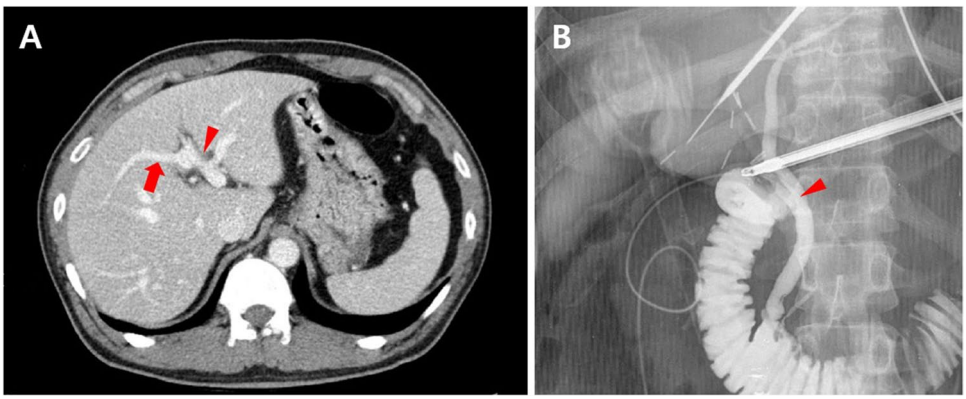

Fig. 3 Images of a patient diagnosed as having left-sided gallbladder (LSGB) with various variations. **A**, **B** Images of a patient diagnosed as having LSGB. **A** The right anterior portal vein originating from the left portal vein by contrast-enhanced computed tomography scan (Arrow: right anterior portal vein, Arrowhead: left portal vein). **B** Intraoperative cholangiography showing right duct injury with an early bifurcated common bile duct (Arrowhead: common bile duct bifurcation)

However, when this process is reversed, LSGB is structurally generated while the umbilical portion is located in the right liver. Second, the gallbladder is located in the normal position, but the round ligament is simply located on the right side and is classified as LSGB. This is clearly different from the first theory, and to be precise, this gallbladder should not be classified as an anomaly, because it is in a normal position. However, it is classified as LSGB because it meets the definition of LSGB [5, 15].

LSGB has been well known compared with other anomalies. Moreover, preoperative diagnostic imaging for gallbladder disease has been developed, making structural evaluation easy. However, it is rarely diagnosed before surgery [6, 12, 13]. In fact, in our study, all patients were diagnosed as having LSGB during surgery, but not before surgery. Therefore, it is often encountered unexpectedly in the course of performing LC, the standard treatment for gallbladder disease. Nonetheless, LC can be successfully performed in patients diagnosed with LSGB if it is performed adhering to the basic principles of LC, such as by confirming CVS [14]. However, LSGB is often accompanied by other variations than in the normal gallbladder. A systematic review by Pereira et al. reported an incidence of CBD injury of 4.4%, which occurred when LC was performed in patients with LSGB; this incidence was much higher than the incidence (0.5%) of CBD injury reported in general population undergoing LC [7, 16]. Therefore, if the exact anatomy is not confirmed, it is safe to perform IOC to confirm the accurate structure, and if necessary, conversion to an open technique should be considered [17–19].

LSGB is not just related to gallbladder location, but is often accompanied by other variations [20]. In our study, several patients also had different types of variation. The most common of these variations was the right anterior portal vein originating from the left portal vein, which has been identified in an estimated 84.6% of patients. Nagai et al. also reported the relationship between LSGB and abnormal intrahepatic portal venous branching [5]. In addition, variations related to LSGB, including early CBD bifurcation observed in this study, have been reported in several variations such as segment IV atrophy, gallbladder duplication, and pancreatobiliary junction abnormality [21–23]. Most of these anomalies require careful evaluation of the anatomy, although they are not a major problem in LC but in other surgeries, especially in the hepatobiliary and pancreatic areas [24–26]. In particular, as reported by Hwang et al., more attention is needed in surgery where vascular and bile duct structures are important, such as in liver transplantation [27]. LSGB itself may not be a major problem for surgery. However, as the findings suggest a high likelihood of anatomical variation, surgeons should consider this when encountering LSGB.

This study has a few limitations. First, this is a retrospective analysis of patients diagnosed with LSGB by a single center. Second, this study has a relatively small number of patients. However, of the studies related to LSGB, so far, the study conducted in Australia in 2013 was the only one with more than 10 patients [11]. Nonetheless, because of the nature of LSGB, namely chance discovery during surgery and low incidence, this retrospective analysis of 13 patients is quite valuable. Future large-scale, multicenter studies should be conducted to analyze the clinical implications of LSGB.

Conclusion

In conclusion, LSGB is a rare gallbladder anomaly. However, even in patients with LSGB, LC can be safely performed under general principles such as the confirmation of CVS. Conversely, LSGB usually has many other accompanying variations; therefore, if the complete anatomy is not confirmed, surgeons should consider performing IOC to reduce complications. In addition, in all surgical procedures other than LC, LSGB suggests the possibility of having other variations. Therefore, when a surgeon encounters LSGB by chance regardless of the type of surgery, the anatomy should be carefully checked.

Declarations

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. This retrospective study was approved by the Institutional Review Board (IRB) of the Hanyang University Hospital, Seoul, Republic of Korea, and all research conducted adhered to the tenets of the Declaration of Helsinki (IRB No. 2018-09-019).

Informed consent Not applicable.

Conflict of interest The authors declare no competing interests.

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