

The Segment IV Approach: A Useful Method for Achieving the Critical View of Safety During Laparoscopic Cholecystectomy in Patients With Anomalous Bile Duct

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Technical advance

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Abstract

Background

The critical view of safety (CVS) method can be achieved by avoiding vasculo-biliary injury resulting from misidentification during laparoscopic cholecystectomy (LC). Although achieving the CVS has become popular worldwide, there is no established standardized technique to achieve the CVS in patients with an anomalous bile duct (ABD). We recently reported our original approach for securing the CVS using a new landmark, the diagonal line of the segment IV of the liver (D-line). The D-line is an imaginary line that lies on the right border of the hilar plate. The cystic structure can be securely isolated along the D-line without any misidentification, regardless of the existence of an ABD. We named this approach the segment IV approach in LC.

Methods

In this study, we adopted the segment IV approach in patients with an ABD. From October 2015 to June 2020, 209 patients underwent LC using the segment IV approach. Among them, three (1.4%) were preoperatively diagnosed with an ABD.

Results

The branching point of the cystic duct was the posterior sectional duct, anterior sectional duct, or left hepatic duct in each patient. The CVS was achieved in all cases without any complications.

Conclusion

The segment IV approach is useful for achieving CVS, especially even for patients with an ABD during LC.

Introduction

Misidentification is the major cause of vasculo-biliary injury (VBI) during laparoscopic cholecystectomy (LC). The common bile duct is frequently mistaken for the cystic duct, while less frequently, an aberrant hepatic duct can be misidentified as the cystic duct [3, 8]. Exposing the proximal one-third of the gallbladder bed and skeletonizing the gallbladder neck before dividing cystic structures are useful processes for avoiding VBI, as proposed by Strasberg et al. in 1995 in the concept of critical view of safety (CVS) [7]. Later, the Tokyo guidelines 2018 (TG-18) advocated the safe steps for achieving the CVS, where the proximal part of the gallbladder is first dissected and the cystic structure is then skeletonized to avoid misidentification [9]. Recently, we used the right posterior corner of the quadrate lobe of the liver, corresponding to the inferior surface of the segment IV, as a specific point to start dissection of the gallbladder. The dissection of the gallbladder is securely performed along the diagonal line (D-line) of the

quadrate lobe, represented by the imaginary line connecting the left ventral and right posterior corner of the quadrate lobe of the liver [6]. We named this the segment IV approach. In the present study, we evaluated this approach during LC in patients with an anomalous bile duct (ABD).

Patients

From October 2015 to June 2020, 209 LCs were performed for cholecystolithiasis or gallbladder polyps using the segment IV approach. Among them, three patients with cholecystolithiasis were preoperatively diagnosed with an ABD.

Surgical technique and case presentation

The concept of the segment IV approach has been published elsewhere [6]. The anatomical variation of the biliary system in relation to the segment IV approach is illustrated in Fig. 1. The gallbladder is first isolated along the imaginary D-line and its extended line. An operating gauze, which was packed behind the gallbladder along the D-line, acted as the visible endpoint while the cystic structure was dissected to achieve CVS (Fig. 1). Theoretically, the biliary components, including the ABD, are not injured because the dissection of the cystic structure proceeds along the right border of the hepato-duodenal ligament.

Fig. 2 demonstrates the preoperative image and intraoperative still pictures of Case 1. Preoperative drip-infusion cholangiography (DIC)-CT indicated that the cystic duct was branched from the anomalous anterior sectional bile duct (Fig. 2a). The two-port LC method was used for this operation. The gallbladder was first isolated along the imaginary D-line (Fig. 2b yellow arrow and Fig. 2c). The cystic structure was skeletonized on the front side of the isolating surgical gauze packed behind the D-line. Subsequently, the CVS was achieved successfully after removing the isolating gauze (Fig. 2d). Fig. 3 demonstrates the preoperative image and intraoperative still pictures of Case 2. The preoperative DIC-CT indicated cystic duct branching from the anomalous posterior sectional bile duct, which joined the common hepatic duct (Fig. 3a, white arrow). The single-port LC method was used for this operation. The gallbladder was dissected using angulated dissection forceps along the D-line (Fig. 3b, 3d) through a multi-access port, which was placed through the umbilicus. The CVS was achieved successfully without exposing the anomalous posterior sectional duct (Fig. 3a). Fig. 4a indicates the preoperative DIC-CT image in Case 3, where the cystic duct was branched from the left hepatic duct. The two-port LC method was used for this operation. The gallbladder was isolated and dissected along the imaginary D-line (Fig. 4b and 4c), and the CVS was achieved (Fig. 4d). No peri- or post-operative complications were encountered. The intraoperative blood loss was minimal, and the operation times in Case 1, 2, and 3 were 82, 75, and 65 minutes, respectively. All patients were discharged on POD3 without any complications.

Discussion

As LC became more common, the frequency of VBI was expected to decrease; however, the incidence of VBI remained steady at 0.5% [2, 4]. One explanation for this discrepancy could be the existence of

anatomical variations such as the anomalous bile duct. It is universally accepted that in all biliary systems, including the anomalous bile duct converging to the hilar plate system [1, 5, 6, 10], the risk of VBI can be decreased by avoiding dissection through the hilar plate. The segment IV approach is based on the operative management by dissecting the gallbladder along the right edge of the hilar plate system, also known as the D-line. As such, the segment IV approach avoids dissecting through the hilar plate system. The operating gauze, which is isolated along the D-line, acts as a constantly visible landmark to safe dissection. Based on our experience, the D-line corresponds to the narrow segment of the gallbladder neck, which facilitates the isolation of the gallbladder [6]. Thus, the segment IV approach may be useful for avoiding VBI while performing LCs in patients with an ABD. In this study, the CVS was achieved in all cases without exposing the ABD. Intraoperative still pictures of the CVS indicated that the dissection proceeded to the right border of the hilar plate. The advantage of the segment IV approach is its simplicity. This approach only requires two steps to achieve the CVS: isolation of the gallbladder along the D-line and dissection of the cystic structure towards the D-line. Once the gallbladder is isolated by surgical gauze, the CVS can be achieved by removing fat and fibrous tissue in front of the gauze. Thus, the segment IV approach enables a surgeon to achieve the CVS simply, regardless of the presence or absence of an ABD.

The segment IV approach has some limitations. The approach is not applicable in cases where the margin of the gallbladder cannot be recognized for anatomical identification of the D-line due to inflammatory adhesion with surrounding structures [6]. Although we have not experienced such complications in the current study, which is better to convert to open surgery, since laparoscopic dissection of the gallbladder from the lateral side can lead to anterior Glissonian sheath injuries.

In conclusion, the segment IV approach during LC is also useful for achieving CVS, even in patients with an ABD.

List Of Abbreviations

CVS critical view of safety, LC laparoscopic cholecystectomy, ABD anomalous bile duct, D-line diagonal line of the segment IV of the liver, VBI vasculo-biliary injury, TG-18 Tokyo guidelines 2018, DIC drip-infusion cholangiography

Declarations

Ethics approval and consent to participate: This study was conducted retrospectively in accordance with the Declaration of Helsinki and with the approval of the Ethics Committee of Jikei University School of Medicine (approval no. 30-150 (9171)). All patients provided written informed consent for publication of the report and images. We have no conflicts of interest to declare.

Consent to publish: Not applicable.

Availability of data and materials: Not applicable.

Competing interests: The authors declare that they have no competing interests.

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Authors' Contributions: SF and KN participated in project development, data collection and manuscript writing. HK, YT, YK, TM and TH participating in treating these patients and searching for literature. TA, TI, and KY participated in manuscript editing. All authors read and approved the final manuscript.

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Figures

Fig 1

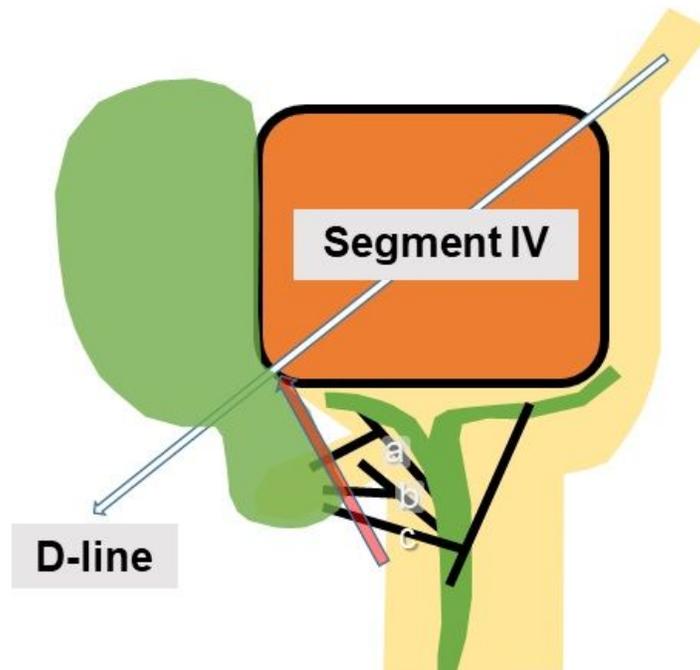


Figure 1

Schematic depiction of the segment IV approach. The gallbladder was first isolated along the diagonal line (D-line) of the segment IV of the liver (white arrow). The cystic structure was then dissected toward the D-line to achieve the critical view of safety (CVS, red arrow). In these case series, anomalous cystic ducts branched off the aberrant anterior hepatic duct (a), aberrant posterior hepatic duct (b), and aberrant left hepatic duct (c), respectively.

Fig 2

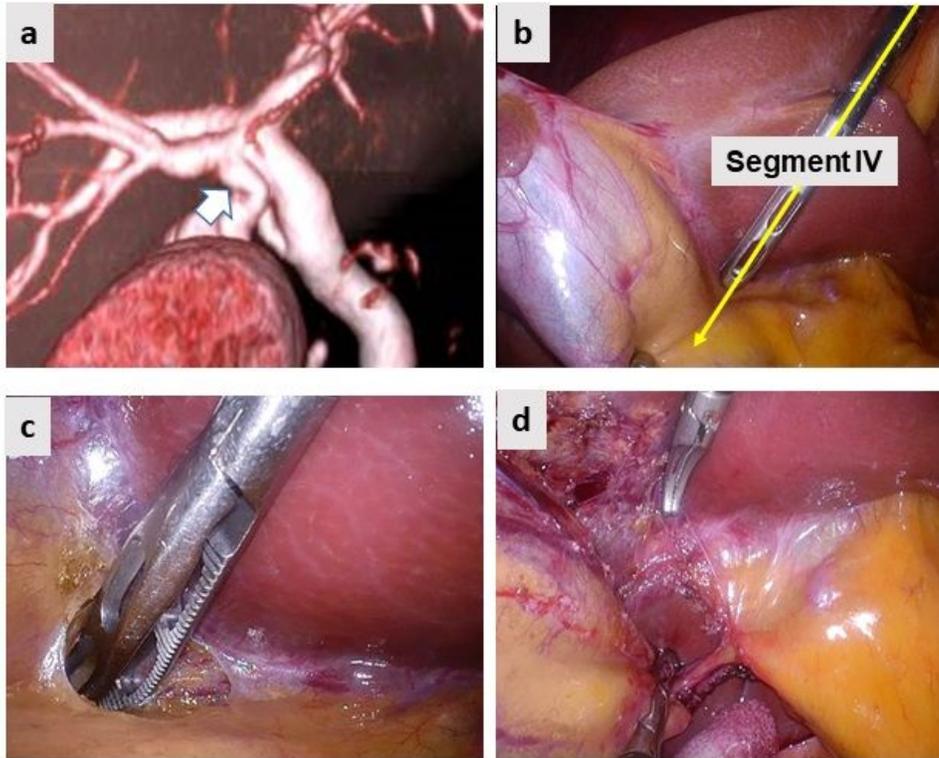


Figure 2

Case 1. The cystic duct branched off the aberrant anterior hepatic duct. a. Preoperative drip-infusion cholangiography CT. The white arrow indicates the cystic duct branched off the aberrant right hepatic duct. b. The imaginary diagonal line (D-line) of the segment IV of the liver (yellow arrow) was first identified. c. The serosa of the gallbladder was incised, and the subserosal layer of the gallbladder wall was dissected along the D-line. d. Subsequently, the critical view of safety was achieved

Fig 3

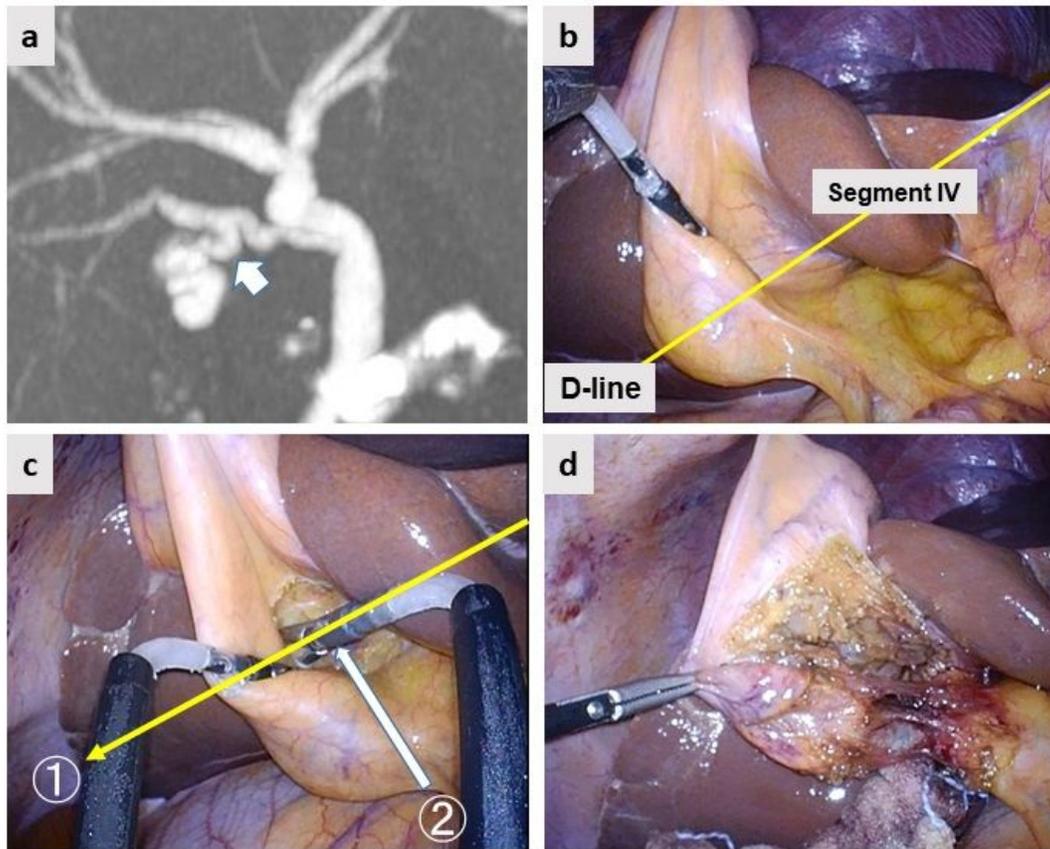


Figure 3

a. Preoperative drip infusion cholangiography CT image. The white arrow indicates the cystic duct branched off the aberrant posterior sectional duct. b. The imaginary diagonal line (D-line) of the segment IV of the liver (yellow arrow) was identified. c. Dissection of the gallbladder proceeded along the D-line (yellow arrow). The cystic structure was dissected towards the D-line (white arrow). d. The critical view of safety was achieved.

Fig 4

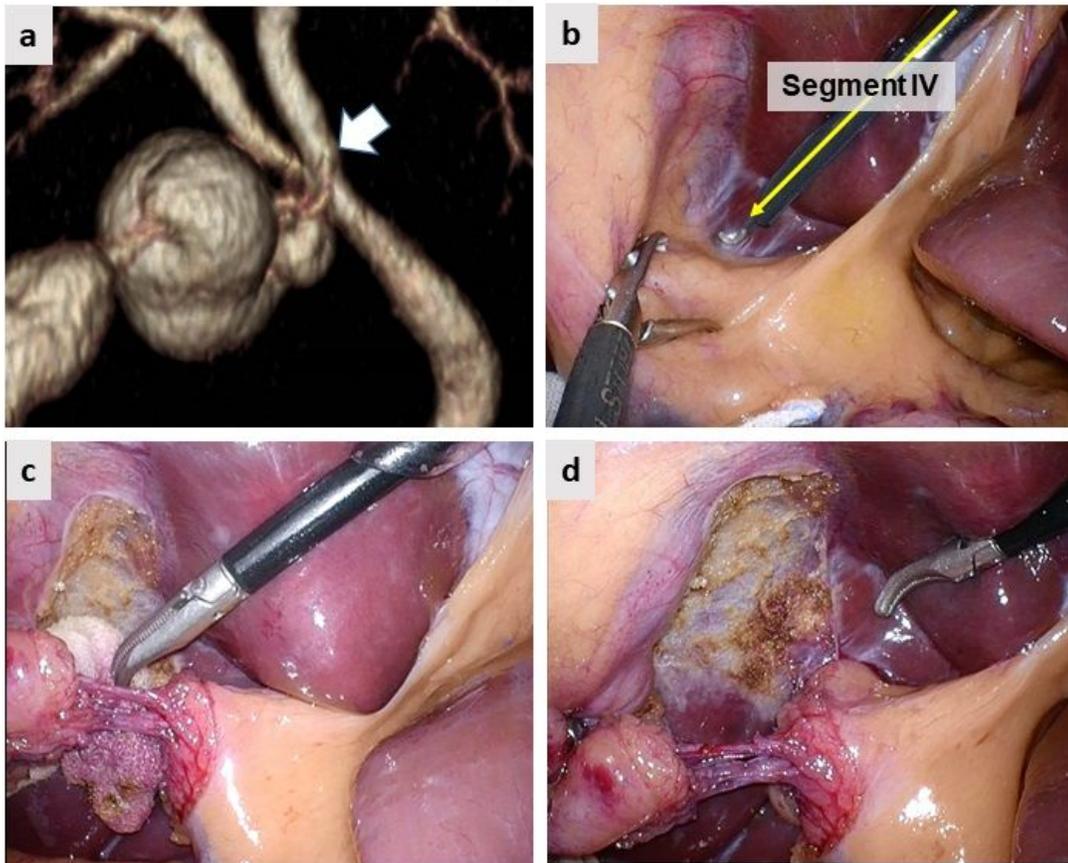


Figure 4

a. Preoperative drip infusion cholangiography CT image. The white arrow indicates the cystic duct branching off the left hepatic duct. b. The imaginary diagonal line (D-line) of the segment IV of the liver (yellow arrow) was identified. c. The dissection of the cystic structure proceeded along the D-line. d. The critical view of safety was achieved.