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Case report

Laparoscopic cholecystectomy completely guided by indocyanine green fluorescence in a patient with gallstone: A case report

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ABSTRACT

Introduction: We report the execution of a cholecystectomy under complete fluorescence guidance using near-infrared camera images without switching to the white light mode, a method that has not been reported previously.

Presentation of case: An Asian woman in her fifties with no history of abdominal surgery was administered indocyanine green (ICG, 25 mg) intravenously 16 h before the surgery. Laparoscopic surgery was performed using VISION SENSE® with the four-trocar technique. The entire laparoscopic procedure was performed under fluorescence guidance. The orientation of the gallbladder neck can be recognized from the beginning of the procedure, and the serosal first incision could be positioned appropriately. All procedures were performed while the common bile duct was visualized. Peeling around the cystic duct and gallbladder bed was appropriately guided by ICG fluorescence.

Discussion: This method may be a safer form of surgery because the fluorescence did not disturb the surgical procedures.

Conclusion: Since this method was successful in this case, a case series is warranted.

1. Introduction

Ishizawa et al. first reported the use of intraoperative fluorescent cholangiography using indocyanine green (ICG) [1]. ICG was injected intravenously to enhance the illumination of the bile duct structure with near-infrared (NIR) light. Subsequently, a randomized controlled trial showed that near-infrared fluorescent cholangiography using ICG was superior for visualization of the extrahepatic bile duct [2]. Fluorescent cholangiography requires less time and is less expensive than intraoperative cholangiography, which makes use of X-rays [3,4]. Furthermore, the use of ICG is expected to reduce bile duct complications.

Significant progress has been made in the development of fluorescent cameras. Initially, only monochrome cameras were available [5]. As monochrome progressed to full color, the same developments were applied to laparoscopes, which became dichromatic [6]. At present, a full-color laparoscopic camera with a bright field is available [7]. Thus, high-definition images have become possible [8].

The bile duct can be visualized clearly when ICG is administered 15–18 h before surgery [9]. Since the liver is not a fluorescent organ, surgeons can perform procedures while visualizing fluorescent images. VISION SENSE® (Medtronic, Minneapolis, MN, USA) can provide clear, high-level images, and we examined whether it could be used to perform the entire surgery.

Using this administration method along with recent devices may allow the entire laparoscopic surgery to be performed under fluorescence guidance. We report the execution of a cholecystectomy under complete fluorescence guidance using near-infrared camera images without switching to the white light mode, a method that has not been reported previously. This work has been reported in line with the SCARE 2020 criteria [10].

2. Presentation of case

The patient was an Asian woman in her fifties with no history of abdominal surgery. She had several episodes of gallstone attack but no cholecystitis. We administered 25 mg of ICG intravenously 16 h before

Abbreviations: CBD, common bile duct; ICG, indocyanine green; IR, infrared; NIR, near-infrared.

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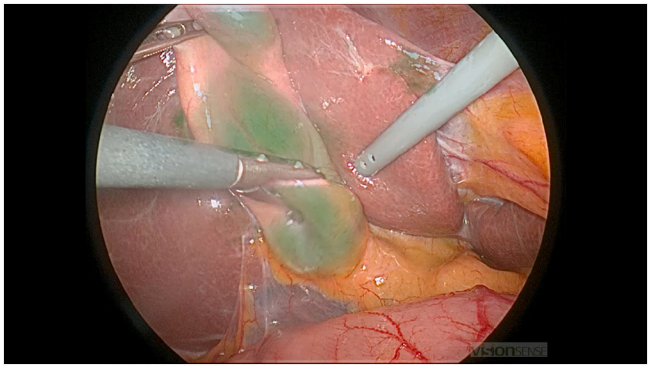

Fig. 1. First serosal incision.
The neck of the gallbladder can be easily visualized, and the serosal first incision can be positioned appropriately.

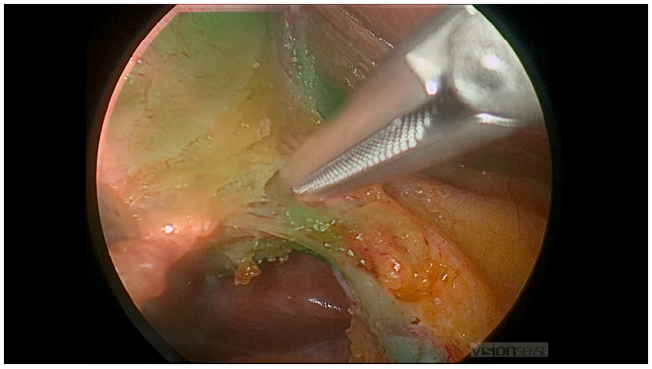

Fig. 2. Encircling the cystic duct.
Fluorescence guidance makes it easy to recognize the border between the cystic duct and the surrounding tissue, which facilitates encircling.

surgery. Laparoscopic surgery was performed using VISION SENSE®. We used the threshold-adjustment function of the device to discard NIR signal values below 0%. For example, if the overlay threshold is set to 50, all pixels with infrared (IR) values of <50 (out of 255) would not display an overlay color. IR Boost, which is essentially a multiplier of each IR pixel value, was set at 1.0.

The surgeon was a senior resident with no specialist qualifications from the Japanese Society of Endoscopic Surgery. The four-trocar technique (12-mm, 12-mm, 5-mm, and 5-mm trocars) was used for the operation. The entire laparoscopic procedure was performed under fluorescence guidance. Since the gallbladder neck was clearly visualized through intraperitoneal observation, we were able to position the first incision in the gallbladder neck. The gallbladder, cystic duct, and common bile duct were visualized, and the neck of the gallbladder was mobilized (Fig. 1). The gallbladder and cystic ducts were clipped and dissected. The circumference of the cystic duct could be easily removed by visualizing the edge of the cystic duct (Fig. 2).

The anatomy of the bile duct and common bile duct (CBD) was clearly observed, and we were able to visualize the border between the two, while avoiding involvement of the CBD during clipping (Fig. 3). Afterwards, the gallbladder bed was peeled off, and the gallbladder was removed. When peeling the gallbladder bed, we were able to identify the layer (Fig. 4). We also distinguished the liver parenchyma once it was visualized (Fig. 5).

The operation lasted 91 min and the amount of blood loss was 5 mL.

3. Discussion

Laparoscopic cholecystectomy under complete fluorescence

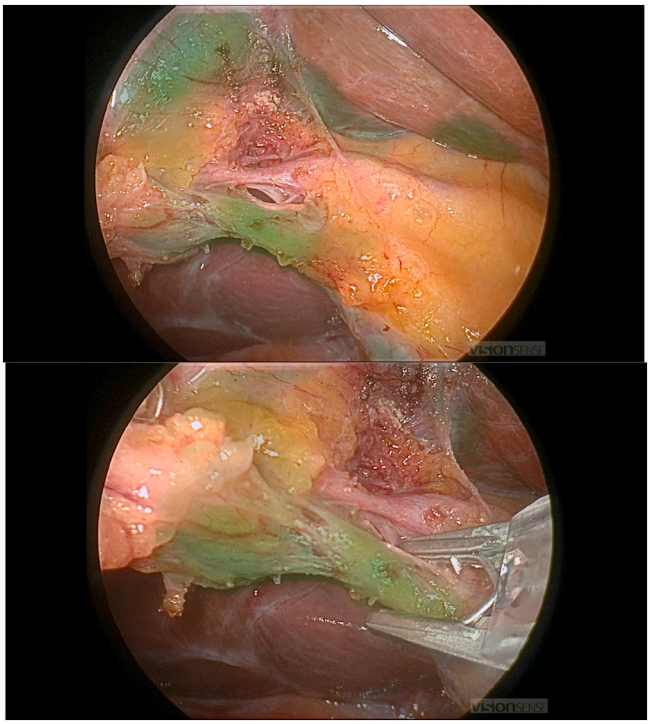

Fig. 3. Clipping of the cystic duct.
Fluorescence guidance depicts the anatomy of the cystic and common bile ducts and confirms that the clip is not inserted so deeply that it covers the common bile duct during clipping.

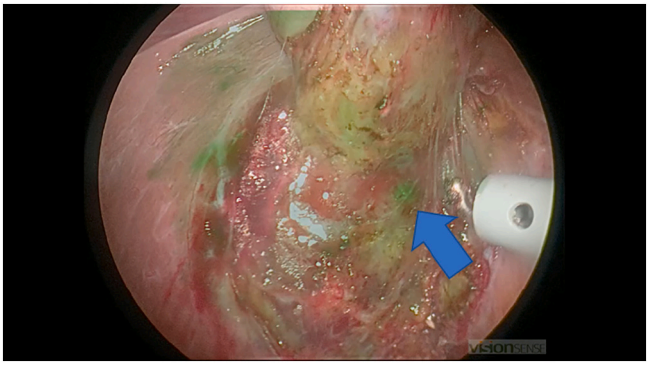

Fig. 4. Recognition of the liver parenchyma exposure.
When the liver parenchyma is exposed, it can be recognized by its dark green color (blue arrow).

guidance can be performed without switching to the white light mode, a practice which has various potential benefits. Under fluorescence guidance, the orientation of the gallbladder neck can be recognized from the beginning of the procedure, and the serosal first incision can be positioned appropriately. All procedures can be performed while visualizing the CBD. Peeling around the cystic duct and gallbladder bed can be appropriately guided by ICG fluorescence.

Although not applicable to this case, this practice may be useful if there is an accessory bile duct or an anatomical variant in the posterior bile duct segment branch, which is present in 21% of cases [11].

One of the drawbacks of this method is the possibility of an allergic reaction to ICG. In this case, there were no complications during the operation under complete fluorescence guidance since the fluorescence did not disturb the surgical procedures. However, fluorescence guidance may be difficult in cases of bile leak. To address the advantages and disadvantages of performing endoscopic cholecystectomy under

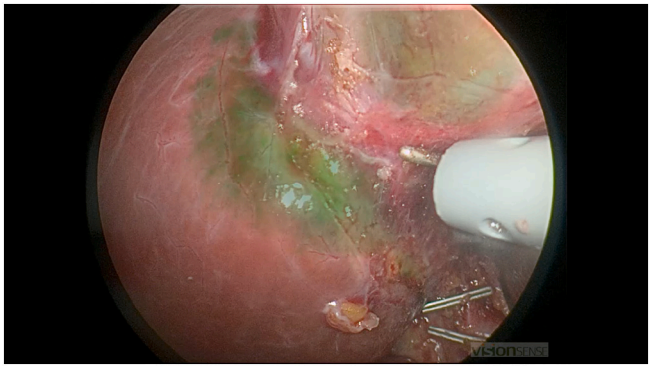

Fig. 5. Exfoliation of the gallbladder from the liver.
The line to be peeled is drawn as a layer between green and green.

complete fluorescence guidance, verification with a case series will be required in the future.

4. Conclusion

We performed a laparoscopic cholecystectomy under complete fluorescence guidance. This method may be a safer form of surgery. Verification by a case series will be required.

Ethical approval

This study has been exempted by our institution. Written informed consent was obtained from the patient for publication of this case report and any accompanying images.

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CRediT authorship contribution statement

JT: study design, data collection, data analysis, writing. MY: critical revision. YS: final approval of the article. Any other authors: study design, data collection. All authors read and approved the final manuscript. The SCARE 2018 Statement: Updating Consensus Surgical CAse REport (SCARE) Guidelines.

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Declaration of competing interest

None.

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