

# Critical View of Safety Plus: Improving the Safety of Laparoscopic Cholecystectomy with Indocyanine Green Dye

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## Background

During a Laparoscopic Cholecystectomy, the critical view of safety is obtained through dissection of the gallbladder from the liver until there is anterior and posterior visualization of the cystic duct and cystic artery. This view is used to allow for proper identification of the cystic duct and artery that will be clipped and incised during the operation.

Indocyanine green (ICG) can be used during the operation to directly visualize of the biliary tract because of its excretion through the biliary system and elimination via the GI tract.

Using a laparoscope capable of visualizing ICG allows for identification of bile duct anatomy including common hepatic bile duct, cystic duct, and aberrant or accessory bile ducts. With the addition of ICG visualization of the biliary structures prior to clipping and incision will allow for identification and prevention of missed biliary anatomy, which could reduce incidence of bile leak, a known complication of cholecystectomies.

Operative photos will include: the critical view, the critical view plus, and the post-dissection view to allow for scoring both by the operative surgeon and our control surgeons.

We hypothesize that using the critical view of safety plus method for laparoscopic cholecystectomy will yield better scores compared to critical view of safety and yield more surgeons opting to cut after obtaining the critical view following calculator developed in Cut or Do Not Cut? Assessing Perception of Safety During Laparoscopic Cholecystectomy Using Surgical Videos.

## Literature Review

In Cut or Do Not Cut? Assessing Perception of Safety During Laparoscopic Cholecystectomy Using Surgical Videos, a standardized scoring system was developed to grade intra-operative laparoscopic cholecystectomy videos. These videos were graded by both attendings and residents with an overall score of an adequate dissection having a score of  $\geq 4$ , whereas  $\leq 3$  considered inadequate. There was no significant difference between faculty and residents when comparing their decision to divide structures for videos with an adequate CVS (62.6% vs. 58.2%,  $p = 0.822$ ) and not to divide structures for videos with an inadequate CVS (85.8% vs. 81.7,  $p = 0.7811$ ) [1].

In Boni et al. [2] fifty-two laparoscopic cholecystectomies were performed for symptomatic cholelithiasis ( $n=17$ ) and acute cholecystitis ( $n=35$ ) with injection of ICG via peripheral vein allowing 15 minutes for concentration in bile afforded visualization of the biliary tree. Their study included a 100% sensitivity for identification of cystic and common bile ducts.

## Methodology

In conjunction with pre-operative antibiotics, 2.5 mg of ICG dye is injected intravenously. The patient is prepped and draped in the usual fashion; trocars placed in accordance with surgeon's preference. A laparoscope capable of ICG fluoroscopy is utilized. Operative dissection per surgeon's preference with exposure of critical view of safety. When the operative surgeon determines that the critical view of safety has been identified, a photo of the critical view of safety is taken in the white light mode. Next, a photo is taken of the same view using the ICG fluoroscopic mode. Completion of the cholecystectomy is performed according to operative surgeon's preference. Post-operatively the images of the critical view of safety were analyzed using the grading system developed in Cut or Do Not Cut? Assessing Perception of Safety During Laparoscopic Cholecystectomy Using Surgical Videos [1].

These images were then de-identified and presented to the control surgeon for evaluation. The first image to be graded by the control surgeon will be the critical view of safety in white light mode. Next, the control surgeon will decide whether they would proceed with clip application and incision of the cystic artery and cystic duct based on the operative photo. If no, the control surgeon will describe what intervention they would proceed with prior to clip application and incision. The control surgeon will then be shown the image with ICG fluoroscopy and grade the dissection. Again, the control surgeon will decide whether they would proceed with clip application and incision of the cystic artery and cystic duct based on the operative photo.

**TABLE 1.** Critical View of Safety Scoring Assessment tool

Criteria	0 Points	1 Points	2 Points
<b>1. Two structures connected to the gallbladder</b>	Unable to identify 2 structures or only 1 structure is seen	2 structures connected by some overlap	2 structures clearly seen connect to gallbladder
<b>2. Cystic plate clearance</b>	Not visible	Visible but overlapped by structures or not clearly shown	Bottom 1/3rd of gallbladder is clearly demonstrated and cystic plate is shown
<b>3. Hepatocystic triangle clearance</b>	Tissue in triangle obscures view of structures	Some obscurement of triangle	Hepatocystic triangle cleared of all tissue except the cyst duct and cystic artery

- Scoring of critical view of safety in white light mode.
  - See above scoring system.
- Cut or do not cut?
  - Yes
    - Proceed to scoring critical view of safety in ICG fluoroscopy mode.
  - No
    - Further dissection to isolate cystic artery.
    - Further dissection to isolate cystic duct.
    - Further dissection to expose cystic plate.
- Scoring of critical view of safety in ICG fluoroscopy mode.
  - See above scoring system.
- Cut or do not cut?
  - Yes
    - Proceed to scoring next image.
  - No
    - Further dissection to isolate cystic artery.
    - Further dissection to isolate cystic duct.
    - Further dissection to expose cystic plate.

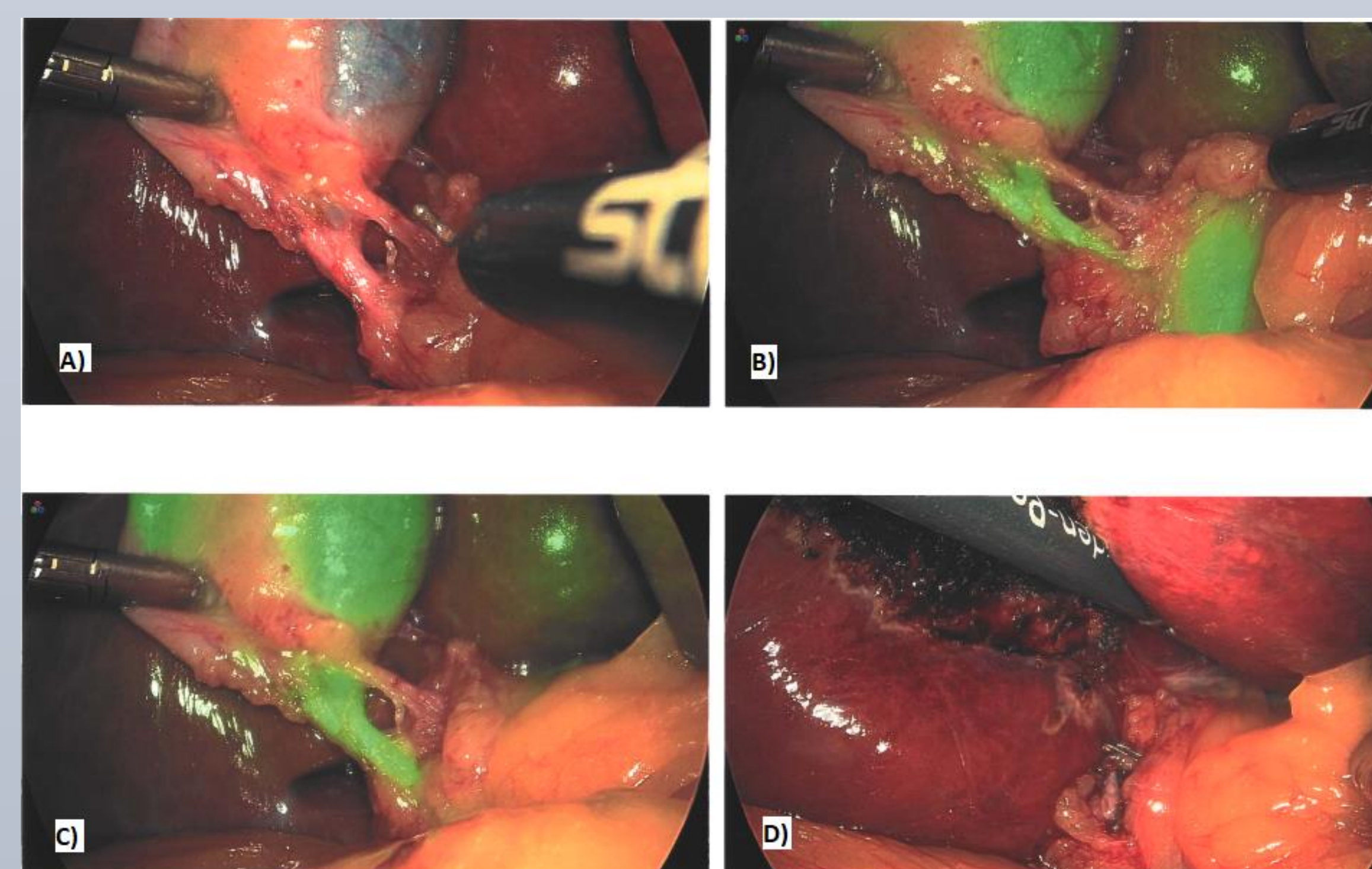


Figure 1: Intra-operative photo during laparoscopic cholecystectomy. A) white light mode critical view of safety. B) critical view of safety plus with view of common bile duct. C) critical view of safety plus without visualization of common bile duct. D) status post cholecystectomy.

## Discussion

The critical view of safety is an established step during cholecystectomy allowing identification of structures to minimize risk of inadvertent injury to common bile ducts or hepatic arteries. With the introduction of the critical view of safety plus, we hypothesize that there will be confirmation of the critical biliary anatomy which will allow for decreased operative times.

The use of ICG fluoroscopy has already proven useful in our laparoscopic cholecystectomies to identify aberrant accessory bile ducts and during a return to the operating suite for diagnostic laparoscopy following laparoscopic cholecystectomy allowed for identification of a bile leak.

## References

1. Carr B, Matusko N, Sandhu G, Varban O. Cut or Do Not Cut? Assessing Perceptions of Safety During Laparoscopic Cholecystectomy Using Surgical Videos. *J Surg Educ.* 2018;75(6):1583-1588. doi:10.1016/j.jsurg.2018.05.005
2. Boni L, David G, Mangano A et al. Clinical applications of indocyanine green (ICG) enhanced fluorescence in laparoscopic surgery. *Surg Endosc.* 2014;29(7):2046-2055. doi:10.1007/s00464-014-3895-x