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MULTIMEDIA ARTICLE

The Application of Indocyanine Green (ICG) Staining Technique During Robotic-Assisted Right Hepatectomy: with Video

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Abstract

Introduction The application of indocyanine green (icg) properties in the field of HPB surgery is gaining momentum. The adoption of the staining technique for the visualization of hepatic liver parenchyma is still preliminary.

Methods We performed a 1:1 case- matched comparison among 20 patients who underwent robotic liver resection with or without the application of icg fluorescence.

Results The icg enabled the reduction of postoperative liver abscess and bile leakage rate. The staining technique was not time-consuming and provided excellent enhancement of liver transection line.

Conclusion The routine use of icg-fluorescence could potentially reduce the postoperative complications during robotic liver surgery.

Keywords Robotic liver surgery · Indocyanine green fluorescence · Image-guided surgery

Dear Editor-in-Chief Professor Richard Hodin,

The fluorescence properties of indocyanine green (ICG) were applied in HPB surgery since 2000s for the intraoperative visualization of biliary tree.[1] The ICG is progressively gaining momentum as a navigation tool for the visualization of small superficial liver tumors, to ensure complete tumor resection and finally to detect potentially bile leaks on hepatic transaction surface.[2] Firstly reported in 2008, the ICG-based staining method was proposed with the aim to overcome the limitations of the dye injection technique proposed by Makuuchi et al.[3]

Despite its potential advantages in terms of more anatomical resection and clear visualization of portal vein territory on liver surface, its adoption is still slow in laparoscopic surgery due to the technical challenge associated to the impaired surgical dexterity.

The robotic approach due to its microdissection and microsuturing capabilities can potentially easily render the dissection of the targeted Glissonean portal pedicle and the injection of the ICG directly into the tumor-bearing portal branch. Moreover, the fluorescence software (Firefly™ mode) is integrated into the robotic console; thus, the surgeon can perform the surgical procedures without shifting his/her sight from the surgical field. After reporting our experience in robotic major hepatic resection,[4] in this video, we demonstrated the application of indocyanine green-fluorescence (ICG-F) during a robotic right hepatectomy. After the liver mobilization, the right portal pedicle is isolated and encircled. In case of a positive staining method, a diluted solution of ICG (2.5 mg) is injected into the right portal vein; subsequently, the right liver pedicle is occluded with Bulldog clamps in order to avoid the washout of the dye. The hepatic parenchyma to be removed appears stained (green). Otherwise, for a negative staining technique, the targeted portal branch is temporally clamped and the ICG is injected in a systemic vein; the hepatic parenchyma to be removed appears non-stained (gray). The firefly mode is activated by the surgeon and the liver surface is inspected.

The procedure continues marking the demarcation line along the stained/non-stained territory using the Monopolar Scissors™. The transaction of hepatic parenchyma is

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performed by the Harmonic ACE™ and the specimen is finally extracted trough a Pfannenstiel incision.

In our initial experience, 20 patients who underwent ICG-fluorescence-guided robotic right hepatectomy (ICG group) were case matched in a 1:1 ratio to a cohort who underwent the same surgical procedure without the application of ICG-fluorescence (no-ICG group). Despite the similar operative time (288 vs 275 min, $p = 0.778$), the rate of post-operative bile leakage (0% vs 16%, $p = 0.002$) and the rate of post-hepatectomy liver failure (4% vs 16%, $p = 0.034$) in the ICG-group were both inferior compared with the non-ICG group. Although reduced in the ICG-group, the rate of post-operative liver abscess (1 vs 3, $p = 0.388$) and R1 resection (0 vs 8%, $p = 0.22$) was not inferior compared with the non-ICG group. These data seems to confirm the promising results obtained by Terasawa et al. in their laparoscopic experience.[5]

The mean time between the ICG injection and fluorescence visualization was higher for the negative staining method in comparison with the positive staining method (350 vs 120 s).

The ICG-staining method is a safe and non-time-consuming approach it helps to perform an anatomical resection thus avoiding to spare the non-vascularised hepatic area. It potentially reduces the post-operative complication rate. It will progressively drive surgeons towards the concept of image-guided surgery.

Author Contribution All authors, Marco Vito Marino, Sergio Builes Ramirez and Marcos Gomez Ruiz gave substantial contributions to the conception or design of the work. All of them were involved in.

- Acquisition, analysis, and interpretation of data for the work;
- Drafting the work or revising it critically for important intellectual content;
- Final approval of the version to be published;
- Agreement to be accountable for all aspects of the work in ensuring that questions related to its accuracy and integrity.

Compliance with Ethical Standards

Conflict of Interest Authors Marco Vito Marino and Sergio Builes Ramirez declare they have no conflict of interest to disclose.

Author Marcos Gomez Ruiz declare is Proctor and Advisor for Intuitive Surgical Inc., Medtronic and Johnson & Johnson.

Abbreviations in the Video (InNin Oorder of Aappearance) RHA, right hepatic vein; CBD, common bile duct; RPB, right portal vein; IVC, inferior vena cava; RHD, right hepatic duct

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