

INTRAOPERATIVE INFRARED FLUORESCENCE IMAGING SYSTEM DURING ROBOTIC ABDOMINAL SURGERY, PIONEER EXPERIENCE IN LATIN AMERICA

VLADIMIR SCHRAIBMAN & ANTONIO LUIZ DE VASCONCELLOS MACEDO

ALBERT EINSTEIN HOSPITAL, SAO PAULO, BRAZIL

Abstract

The advent of a new use for fluorescence is helping to improve the safety of minimally invasive procedures, particularly for robotic and robotic single-site procedures. The purpose of this report is to describe the first use of indocyanine green (ICG) during 2 robotic surgeries in Latin America. This is probably the start of a new era regarding safety for cholecystectomies and colectomies. This will improve results regarding biliary and colonic complications. Fluorescence can be used safely and efficiently during single site cholecystectomy and robotic colorectal procedures. Further studies should evaluate and demonstrate in large series its proper role.

Key words: fluorescence, robotic, cholecystectomy, colectomy, indocyanine

INTRODUCTION

Recently, near infrared fluorescence (NIF) imaging system (Firefly™, Intuitive Surgical Inc., Sunnyvale, CA, USA) was installed on a robotic system allowing surgeons to identify intravascular and biliary NIF signals in real time (1).

First description of the NIF imaging system was for sentinel lymph node biopsy in patients with breast or colorectal cancer. Since that time, application of this method received wide acceptance in various fields of surgical oncology. The advent of a new use for fluorescence is helping to improve the safety of minimally invasive procedures, particularly for robotic and robotic single-site procedures (2-4).

The use of fluorescence, although useful, is considered challenging. Only a few studies are currently available on the use of fluorescence in robotic general surgery. Many of these reports describe promising and satisfactory results. The indications for the use of NIF imaging include assessment of tissue perfusion, visualization of hepatobiliary anatomy, sentinel lymph node biopsy, and visualization of vascular anatomy (5-7).

Anastomotic leaks are an undesired complication in colorectal surgery. Hypoperfusion is an important risk factor for anastomotic leakage in colorectal surgery. Recently few papers have described the use of NIF during robotic colectomies (5-6). On the other hand, bile duct injury is a rare but serious complication of laparoscopic cholecystectomy and the primary cause is misinterpretation of biliary anatomy.

Intraoperative cholangiography is proposed to overcome this complication, although it is not used routinely. Indocyanine green NIF cholangiography is non invasive and provides real-time biliary images during surgery, which may improve the safety of single-incision cholecystectomy, allowing to assess biliary anatomy and Calot triangle (7). First description of its use was made by Ishizawa et al in 2010 (8).

The purpose of this report is to describe the first use of indocyanine green (ICG) during 2 robotic surgeries in Latin America.

CASE REPORT

#1 R.M.O.A 62 years-old patient presenting a sigmoid adenocarcinoma was submitted to a robotic sigmoidectomy. A medial to lateral approach with high vessel ligation was used. ICG-enhanced fluorescence was used during robotic colorectal resection in order to verify the adequate perfusion of the large bowel prior to anastomosis and correct identification of the superior mesenteric artery. ICG injection was performed using 2 bolus of 3.5 ml each at a concentration of 0.4 mg/ml/kg: the first to establish location of the superior mesenteric artery and its branches and the second just before performing the anastomosis to ensure adequate vascularization of the colon. We were able to obtain a real-time image that demonstrated the superior mesenteric artery and its branches and the perfusion of the bowel. Operative time was 170 minutes and the patient was discharged in the 4 PO day with no signs of leakage. Thirty six lymph nodes were retrieved and none was committed (Fig 1 and 2).

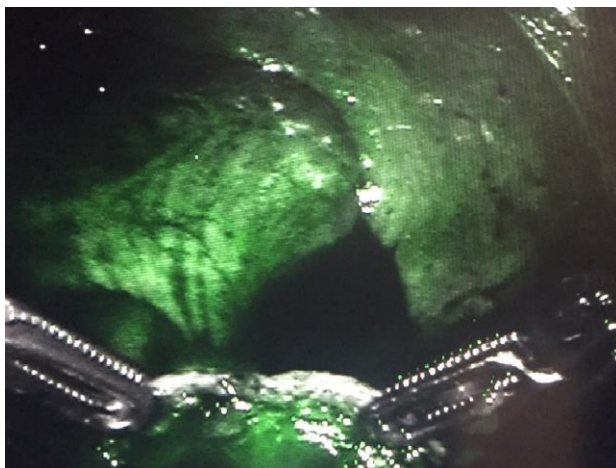
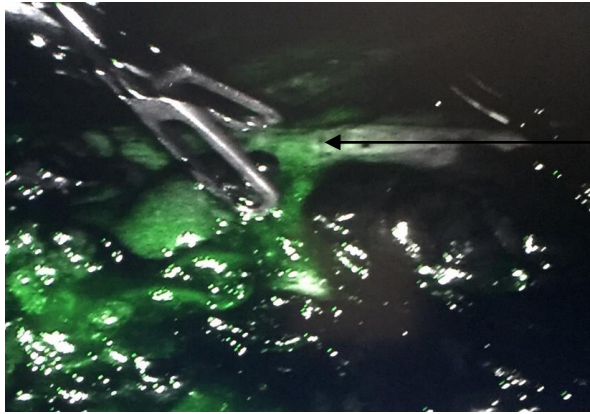


Figure 1 – Graspers holding descending colon well perfused (green light) that will be anastomosed



Superior mesenteric artery coming from aorta colored with indocyanine green

Figure 2 – Obese patient, superior mesenteric artery coming from aorta colored with indocyanine green

#2L.P.M.A , 42 years old presenting chronic cholecystitis. A robotic single site cholecystectomy was indicated. The ICG dye was injected intra-venously at least 30 min before surgery to allow ICG to concentrate in the bile, using a dose of 0.4 mg/ ml/kg. We were able to identify the biliary anatomy especially the cystic duct-common bile duct junction during Calots triangle dissection (Fig 3). Operative time was 45 minutes.

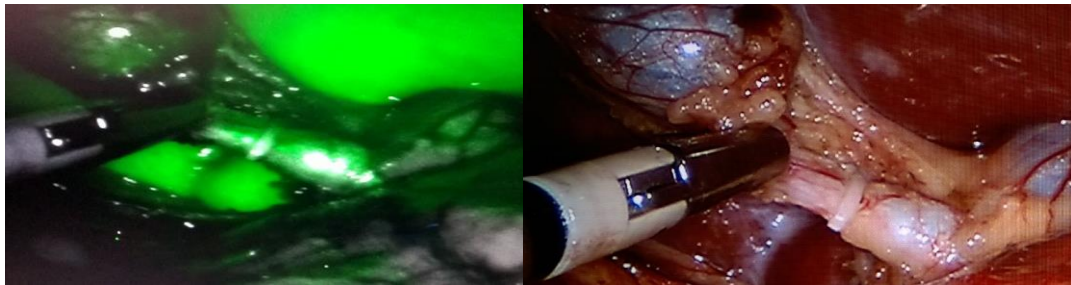


Figure 3 – Left side – clipped cystic duct colored with indocyanine green with NIF; Right side – clipped cystic duct without NIF

DISCUSSION

NIF imaging uses laser technology to activate an ICG, an intravenously delivered agent, which rapidly binds to plasma proteins and emits an infrared signal when excited by laser light *in situ*. It provides additional information during determination of transection location in left-sided colorectal procedures (6) and biliary tree anatomy during single site robotic cholecystectomies (3).

Biliary lesions can occur during laparoscopic procedures with and iatrogenic bile ducts injury is still one of the most dangerous complications of cholecystectomy. Indeed, intra-operative routine cholangiography still remains as a matter of debate. Normally intra-

operative cholangiography is indicated in selective cases. The use of NIF during single site robotic surgery allows a rapid image acquisition allowing a safer and quicker dissection when compared to intra-operative radiologic cholangiogram. We were able to perform a kind of "virtual" cholangiography at the very start of the procedure, allowing the surgeon to identify either the biliary tree and its variations. It is also cheap and easy to use, just needing an intra-venous injection 30 minutes before gallbladder dissection, in many situations avoiding difficult cholangiographies due to cystic duct variations (7-8).

On the other side, anastomotic leaks are a dreaded complication in colorectal surgery and account for significant postoperative morbidity and mortality. Despite adhering to recommended surgical practice, some anastomoses do leak, especially those placed in low anterior resections. NIF can be used safely during colorectal procedures allowing correct identification of the inferior mesenteric artery and its branches while dissecting the left colon. Also it can provide direct visualization of the colonic stump and descending colon perfusion after transection. In these situations use of NIF may diminish the incidence of post-operative colorectal fistula allowing surgeons to view and transect the colon in a well perfused area, thus avoiding anastomosis in a badly perfused colon segment.

Our group just published few papers regarding advanced robotic surgeries and single site surgeries in Brazil (9-13). This paper with these 2 cases described is the first literature report in Latin America of ICG use during robotic surgeries. This is probably the start of a new era regarding safety for cholecystectomies and colectomies. This will improve results regarding biliary and colonic complications.

CONCLUSION

NIF can be used safely and efficiently during single site cholecystectomy and robotic colorectal procedures. Further studies should evaluate and demonstrate in large series its proper role.

REFERENCES

- 1 Spinoglio G, Priora F, Bianchi PP, Lucido FS, Licciardello A, Maglione V, et al. Real-time near-infrared (NIR) fluorescent cholangiography in single-site robotic cholecystectomy (SSRC): a single institutional prospective study. *SurgEndosc* 2013;27:2156-62.
- 2 Buchs NC, Pugin F, Azagury DE, Jung M, Volonte F, Hagen ME, Morel P. Real-time near-infrared fluorescent cholangiography could shorten operative time during robotic single-site cholecystectomy. *SurgEndosc* 2013; 27: 3897-3901 [PMID: 23670747 DOI: 10.1007/ s00464-013-3005-5]
- 3 Bae SU1, Baek SJ, Hur H, Baik SH, Kim NK, Min BS. Intraoperative near infrared fluorescence imaging in robotic low anterior resection: three case reports. *Yonsei Med J.* 2013 Jul;54(4):1066-9. doi: 10.3349/ymj.2013.54.4.1066.
- 4 Marano A, Priora F, Lenti LM, Ravazzoni F, Quarati R, Spinoglio G. Application of fluorescence in robotic general surgery: review of the literature

- and state of the art. *World J Surg.* 2013 Dec;37(12):2800-11. doi: 10.1007/s00268-013-2066-x. Review.
- 5 Hellan M, Spinoglio G, Pigazzi A, Lagares-Garcia JA. The influence of fluorescence imaging on the location of bowel transection during robotic left-sided colorectal surgery. *Surg Endosc* 2014;28: 1695-702.
 - 6 Jafari MD, Lee KH, Halabi WJ, Mills SD, Carmichael JC, Stamos MJ, Pigazzi A. The use of indocyanine green fluorescence to assess anastomotic perfusion during robotic assisted laparoscopic rectal surgery. *SurgEndosc.* 2013 Aug;27(8):3003-8. doi: 10.1007/s00464-013-2832-8. Epub 2013 Feb 13.
 - 7 Buchs NC, Hagen ME, Pugin F, Volonte F, Bucher P, Schiffer E, Morel P. Intra-operative fluorescent cholangiography using indocyanin green during robotic single site cholecystectomy. *Int J MedRobot*2012; 8: 436-440 [PMID: 22648637 DOI: 10.1002/rcs.1437]
 - 8 Ishizawa T, Bandai Y, Ijichi M, Kaneko J, Hasegawa K, Kokudo N. Fluorescent cholangiography illuminating the biliary tree during laparoscopic cholecystectomy. *Br J Surg*2010; 97: 1369-1377 [PMID: 20623766 DOI: 10.1002/bjs.7125]
 - 9 Schraibman V, Epstein MG, Maccapani GN, Macedo AL. Single-port robotic cholecystectomy. Initial and pioneer experience in Brazil. *Einstein (Sao Paulo)*. 2015 Sep 18. pii: S1679-45082015005053275. [Epub ahead of print] Portuguese, English.
 - 10 Schraibman V, Macedo, ALV. ; Epstein MG, Mayte Y. ; Maccapani G, Matos D, Rizzo LV, Goldman SM. Comparison of the Morbidity, Weight Loss, and Relative Costs between Robotic and Laparoscopic Sleeve Gastrectomy for the Treatment of Obesity in Brazil. *Obes Surg.* 2014 Sep;24(9):1420-4.
 - 11 Macedo ALV, Schraibman V, Okazaki S, Mauro FC, Epstein MG, Goldman SM, Lustosa SAS, Matos D. Treatment of intraductal papillary mucinous neoplasms, neuroendocrine and periampullary pancreatic tumors using robotic surgery: a safe and feasible technique. *Journal of Robotic Surgery* , v. 5, p. 35-41, 2011.
 - 12 Schraibman V, Vasconcelos ALV, Okazaki S, Mauro FC, Epstein MG, Goldman SM, Lustosa SAS, Matos D. Surgical treatment of hiatus hernia and gastroesophageal reflux disease in complex cases using robotic-assisted laparoscopic surgery: a prospective study/consistent experience in a single institution. *Journal of Robotic Surgery* , v. 5, p. 29-33, 2011.
 - 13 Schraibman V, Epstein MG, Soares MY, Proenca IM, Maccapani G, Macedo ALV. Initial Experience of Robotics in General Surgery Procedures of the Gastrointestinal System. *Brazilian Journal of Videoendoscopic Surgery (Impresso)* , v. 6, p. 117-120, 2013.