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Intraoperative ICG fluorescence contrast imaging of the main artery watershed area in colorectal cancer surgery: Report of a case



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ABSTRACT

INTRODUCTION: Visualization of the main artery watershed area may be useful for determining the area that should be resected in colorectal cancer surgery. Resection of the main artery watershed area may result in complete resection of lymph nodes along the main artery and area of potential ischemia.

PRESENTATION OF CASE: A man in his 60 s with a chief complaint of hematochezia visited our hospital, was diagnosed with colorectal cancer and underwent surgery. A case that underwent colorectal resection with intraoperative indocyanine green (ICG) fluorescence angiography from the resection-side of the superior rectal artery (SRA) in order to confirm the watershed area is reported. Observation was performed using a PINPOINT® bright-field, color, near-infrared fluorescence camera, and the watershed area of the SRA fluoresced 33 s after the intra-arterial injection of ICG. After observation resection and anastomosis was performed. The patient's postoperative course was good.

DISCUSSION: The method is simple and can be performed within a short time, and it enables visual evaluation of the blood flow in the intestinal tract before anastomosis.

CONCLUSION: This method can be expected to provide useful information for complete resection of lymph nodes along the main artery and area of potential ischemia.

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1. Background

In colorectal cancer surgery, lymph node dissection is performed by ligating and resecting the inferior mesenteric artery or the superior rectal artery (SRA) [1]. Intravenous injection of ICG was reported to be useful to decide the point of proximal colon resection [2]. However, even after this technique, malperfusion of anastomosis was observed. Takedown and revision of the completed anastomosis was performed in 2 cases [2].

If the watershed area of each major artery can be identified prior to anastomosis, it may be possible to prevent malperfusion of anastomosis. Moreover, the resection of the main artery watershed area may result in complete resection of lymph nodes along the main artery and area of potential ischemia.

Abbreviations: ICG, indocyanine green; SRA, superior rectal artery.

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Colorectal cancer surgery was performed in a patient using fluorescence angiography to determine the watershed area of the SRA. This research was approved by the International University of Health and Welfare Research Ethics Committee (Approval No. 13-B-60) and carried out using a PINPOINT® (NOVADAQ, Mississauga, ON, Canada) bright-field, color, near-infrared fluorescence camera. Personal information of patient was protected.

This paper has been reported in line with CARE criteria.

2. Case presentation

A man in his 60 s with a chief complaint of hematochezia visited our hospital, was diagnosed with colorectal cancer and underwent laparoscopic low anterior resection with D3 dissection. After resecting the rectum on the anal side, 1 mL of 5 mg/mL indocyanine green (ICG) was injected into the resection-side SRA, which was the main artery watershed area of the tumor, as an extraperitoneal cavity procedure. Observation was performed using the PINPOINT®, and the watershed area of the SRA fluoresced 33 s after the intra-arterial injection of ICG (Fig. 1). The scope of the resection on the oral side was decided so that it included the SRA watershed area, and anastomosis was performed. This procedure took 2 min, 7 s. The patient's postoperative course was good, with no complications.

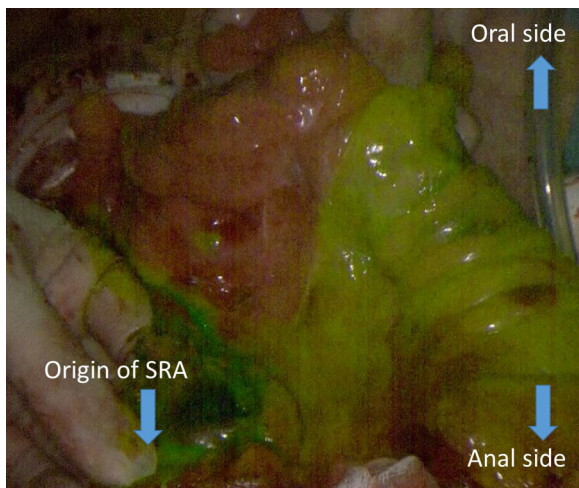


Fig. 1. ICG intra arterial injection to SRA.

3. Discussion

3.1. Past reports relating to colon resection and fluorescence angiography

Few reports have used the fluorescence properties of ICG for intraoperative imaging diagnosis for colorectal cancer surgery. Ris et al. reported performing anterior resection of the rectum and right hemicolectomy in 30 patients in whom they injected ICG intravenously and used the PINPOINT® to observe the anastomotic site [3]. Kudzus et al. [4] and Jafari et al. [5] reported that the rate of anastomotic leakage was lower when fluorescence angiography was used in colorectal cancer surgery. ICG is usually used for fluorescence angiography, but Kudzus et al. [4] observed while performing intravenous administration after or immediately before anastomosis, while Jafari et al. [5] performed intravenous administration immediately before anastomosis. Kudzus et al. [4] judged the tissue blood flow to be insufficient in the planned anastomotic site in 13.9% (28/201) of their patients, and they expanded the extent of the resection. Sherwinter [6] reported a method for evaluating the mucosal blood flow at the site of rectal anastomosis by inserting the PINPOINT® via the anus and injecting ICG intravenously. Intravenous injection of ICG was reported to be useful to decide the point of proximal colon resection [2]. However, even after this technique, malperfusion of anastomosis was observed. Takedown and revision of the completed anastomosis was performed in two cases [2]. Intravenous injection of ICG may not be perfect for deciding the point of proximal colon resection.

3.2. Fluorescence angiography by intra-arterial injection of ICG

Observation of intestinal blood flow has previously been reported by ICG fluorescence method using a brightfield color near-infrared fluorescence camera (HyperEye Medical System) [7]. In this study, ICG was injected into the severed main artery, and the watershed area of the artery was observed by fluorescence angiography using the PINPOINT®. This method differs from the previously reported method of achieving contrast via peripheral veins, since the ICG is introduced via an artery on the resection-side. Our literature search of Pub Med using “ICG” and “intra-arterial injection” as keywords found no similar reports.

There was concern that the boundary might be blurred in this method of fluorescence angiography via a main artery because there is communication with marginal arteries, but, in fact, the boundary of the watershed area of the main artery was clearly

visualized with this method. Therefore, it was possible to clearly identify the area that would be affected by treatment of the vessel, and it was expected that it would be possible to determine the optimal intestinal tract resection site for anastomosis. Moreover the resection of the main artery watershed area may result in complete resection of lymph nodes along the main artery. However, this method does not evaluate the blood flow in the anal-side rectum, because it is performed after the anal-side rectum is resected by an intraperitoneal procedure.

This method can be carried out merely by puncture-needle cannulation of the main artery and observation, and it is possible to easily identify the main artery watershed area. The time required for the procedure is approximately 2 min, so it can also be considered acceptable from the perspective of operative time. This is a method of evaluation before intestinal resection, and it appears to be a useful intraoperative diagnostic imaging technique for confirming the blood flow.

4. Conclusions

A method for performing ICG fluorescence angiography of the SRA watershed area during colorectal cancer surgery was reported. The method is simple and can be performed within a short time, and it enables visual evaluation of the blood flow in the intestinal tract before anastomosis. This method can be expected to provide useful information of lymph nodes along the main artery and area of potential ischemia.

Conflicts of interests

The authors declare that they have no conflicts of interest.

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We have no sponsors.

Ethical approval

This study was approved (approval No. 13-B-60) by the Research Ethics Committee at the International University of Health and Welfare, Tochigi, Japan.

Consent

We had obtained such consent.

Authors' contributions

SR have made substantial contributions to conception and design, or acquisition of data, or analysis and interpretation of data.

MY have been involved in drafting the manuscript or revising it critically for important intellectual content.

OH have get in on a discussion about this study.

NT have get in on a discussion about this study.

NS have get in on a discussion about this study.

EI have get in on a discussion about this study.

KN have get in on a discussion about this study.

SY have get in on a discussion about this study.

MK have get in on a discussion about this study.

YS have given final approval of the version to be published.

All authors read and approved the final manuscript.

Guarantor

Shunjin Ryu.

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