



Case report

Intestinal blood flow assessment by indocyanine green fluorescence imaging in a patient with the incarcerated umbilical hernia: Report of a case



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HIGHLIGHTS

- We have reported the case of a patient with incarcerated umbilical hernia.
- The small bowel that had been incarcerated showed deep-red discoloration.
- The bowel could be preserved after intraoperative evaluation of intestinal blood flow.
- The intestinal blood flow was evaluated by ICG fluorescence.
- PINPOINT, a brightfield color fluorescence camera was used for ICG fluorescence.

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ABSTRACT

After reduction of the incarceration during surgery for incarcerated hernia, intestinal blood flow (IBF) and the need for bowel resection must be evaluated. We report the case of a patient with incarcerated umbilical hernia in whom the bowel was preserved after evaluating IBF using indocyanine green (ICG) fluorescence. A woman in her 40s with a chief complaint of abdominal pain visited our hospital, was diagnosed with incarcerated umbilical hernia and underwent surgery. Laparotomy was performed to reduce bowel incarceration. After reducing the incarceration, IBF was observed using ICG fluorescence detected using a brightfield full-color fluorescence camera. The small bowel that had been incarcerated showed deep-red discoloration on gross evaluation, but intravenous injection of ICG revealed uniform fluorescence of the mesentery and bowel wall. This indicated an absence of irreversible ischemic changes of the bowel, so no resection was performed. The patient showed a good postoperative course, including resumption of eating on day 4 and discharge on day 11. In surgery for incarcerated hernia, ICG fluorescence may offer a useful method to evaluate IBF after reducing the incarceration. This case implied that PINPOINT could be used in open conventional surgery.

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1. Background

In surgery for incarcerated hernia, intestinal blood flow (IBF)

and the possible need for bowel resection must be evaluated after reducing the incarceration. We report herein the case of a patient with incarcerated umbilical hernia in whom the bowel could be preserved by evaluation of IBF using a brightfield color near-infrared fluorescence camera (PINPOINT; Novadaq, Mississauga, Canada) and indocyanine green (ICG) fluorescence. This study using the PINPOINT system was approved by the Research Ethics Committee at the International University of Health and Welfare, Tochigi, Japan (approval no. 13-B-60). Personal information of patient was protected.

This paper has been reported in line with CARE criteria.

Abbreviations: IBF, intestinal blood flow; ICG, indocyanine green; CT, computed tomography; NOMI, non-occlusive mesenteric ischemia.

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2. Case presentation

Patient: A woman in her 40s.

Chief complaint: Abdominal pain.

3. Past medical history

Hypertension and diabetes (well controlled with oral medications).

4. History of present illness

The patient developed pain involving the entire abdomen starting 3 days earlier and gradually exacerbating, so she visited our hospital.

5. Findings on admission

Vital signs were normal, except for a body temperature of 38.1 °C. The abdomen was distended, with an 8-cm mass palpable at the umbilicus, but no tenderness was apparent (Fig. 1).

6. Blood test findings

The patient was anemic, with a hemoglobin level of 5.8 g/dl. Inflammatory response was also elevated, with a white blood cell count of 12,370/ μ l and a C-reactive protein level of 2.9 mg/dl.

7. Abdominal contrast-enhanced computed tomography (CT)

Imaging revealed an umbilical hernia and incarceration of a loop of small bowel. The entire small bowel was distended with fluid-fluid levels, with ascites on the liver surface and in the pelvis. Large multilocular masses with calcification were evident in the pelvis. The patient was diagnosed with anemia due to bilateral ovarian tumors and bowel obstruction due incarcerated umbilical hernia, so surgery was performed.

8. Surgical findings

A midline incision was made in the lower abdomen for laparotomy, and the incarcerated bowel was reduced. Serous ascites was present in the hernia sac. The small bowel that had been incarcerated showed dark-red discoloration (Fig. 2). Two milliliters of ICG (5 mg/ml) was injected intravenously, and blood flow was

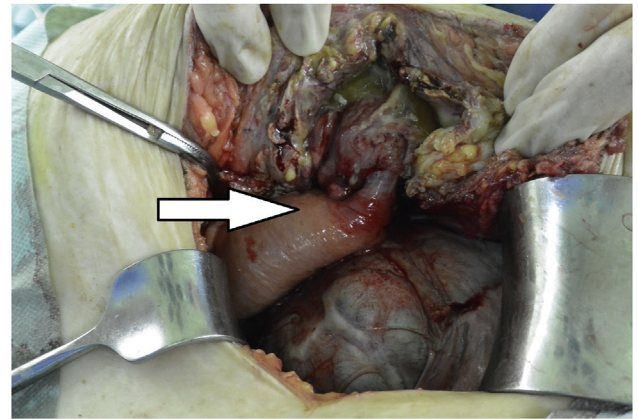


Fig. 2. The small bowel that had been incarcerated (white arrow) shows dark-red discoloration.

observed using the PINPOINT system. Fluorescence was seen in the arteries of the mesentery, followed by uniform fluorescence throughout the small bowel wall. The bowel with dark-red discoloration also showed fluorescence, thus indicating the absence of irreversible ischemic changes. Bowel resection was therefore not performed (Fig. 3). Because of anemia requiring blood transfusion, simple total hysterectomy and bilateral salpingo-oophorectomy were performed for the ovarian cysts bilaterally, then the hernia sac was removed, and the abdomen was closed.

9. Postoperative course

The patient resumed eating on day 4 after surgery and was discharged on day 11. There is no adverse event. Histopathology of the resected uterus and adnexa showed bilateral ovarian cysts, uterine myoma, and adenomyosis. At 6 months postoperatively, no evidence of recurrence of the umbilical hernia has been identified.

10. Discussion

10.1. ICG fluorescence using a near-infrared fluorescence camera

Observation of IBF has previously been reported by ICG fluorescence method using a brightfield color near-infrared fluorescence camera (HyperEye Medical System) [1]. In our patient, ICG



Fig. 1. The abdomen is distended, and an 8-cm mass is apparent protruding from the umbilicus.



Fig. 3. Observation using the PINPOINT system. The discolored area of small bowel (white arrow) shows uniform fluorescence.

was injected from a peripheral vein, and blood flow in the incarcerated bowel was evaluated using the PINPOINT, brightfield color near-infrared fluorescence laparoscopy system. This PINPOINT system simultaneously displays fluorescence and color imaging in a single video, enabling simultaneous observation of usual fluorescence and color images. Surgery can therefore proceed without interruption during fluorescence imaging. This system can also be used in laparoscopic surgery [2].

10.2. Evaluation of incarcerated hernias and intestinal ischemia

IBF and the possible need for bowel resection must be observed after incarceration is reduced during surgery, not only for incarcerated umbilical hernias, but in all incarcerated hernias. IBF is usually evaluated by observing bowel color, the presence or absence of peristalsis, the presence or absence of bleeding from the bowel resection stump, and arterial pulsations in the mesentery. Bowel resection is necessary if signs of irreversible ischemia are apparent in the previously incarcerated bowel. However, evaluation of bowel ischemia is difficult in some patients. There may be little evidence of viability when bowel ischemia is suspected, and in patients with pathologies such as non-occlusive mesenteric ischemia (NOMI), in whom deciding on the extent of resection may be difficult at initial surgery, a second-look operation has been recommended [3,4].

Intraoperative angiography and laser Doppler flowmetry have also been used to evaluate IBF during surgery [5] [6]. With evaluation by ICG fluorescence, blood flow can be observed by injecting ICG from a peripheral vein. This can be highly useful from the perspectives of convenience, speed, and allowing wide-area observation. ICG fluorescence evaluation of blood flow has already been reported in superior mesenteric artery occlusion [7], strangulation ileus [8], and NOMI [9], but application in incarcerated hernias has not previously been described in the existing literature. We found no similar reports in a PubMed search using the keywords “incarcerated hernia, ICG” or “strangulated hernia, ICG.”

The small bowel in our patient was discolored after reducing the incarceration, and deciding whether to perform bowel resection was difficult. However, ICG fluorescence confirmed good IBF, so we completed surgery without bowel resection. The patient showed a good postoperative course. If we had not performed the ICG fluorescence, we would have performed bowel resection to maximize safety. We thus believe that ICG fluorescence may be useful for evaluating IBF in patients with incarcerated hernias.

11. Conclusions

ICG fluorescence may be useful for evaluating IBF in patients after reducing incarcerated hernias, but should be evaluated in clinical trials Prior to its broad implementation.

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.

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We have no sponsors.

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.

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MK have get in on a discussion about this study.

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

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Conflicts of interest

The authors declare that they have no conflicts of interest.

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Consent

Written informed consent was obtained from the patient for publication of this Case report and any accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal.

Competing interests

The authors declare that they have no competing interests.

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References

- [1] K. Kubota, M. Yoshida, J. Kuroda, A. Okada, K. Ohta, M. Kitajima, Application of the HyperEye Medical System for esophageal cancer surgery: a preliminary report, *Surg. Today* 43 (2013) 215–220.
- [2] M.D. Jafari, S.D. Wexner, J.E. Martz, E.C. McLemore, D.A. Margolin, D.A. Sherwinter, et al., Perfusion assessment in laparoscopic left sided/anterior resection (PILLAR) II: a multi-institutional study, *J. Am. Coll. Surg.* 220 (2015) 82–92.
- [3] J. Kuramochi, Y. Inoue, K. Sugihara, Intestinal ischemia. Treatments of the mesenteric artery occlusion, *Gastroenterol. Surg.* 28 (2005) 37–43 (in Japanese).
- [4] X. Meng, L. Liu, H. Jiang, Indications and procedures for second-look surgery in acute mesenteric ischemia, *Surg. Today* 40 (2010) 700–705.
- [5] J.L. Ballard, W.M. Stone, J.W. Hallett, P.C. Pairolero, K.J. Cherry, A critical analysis of adjuvant techniques used to assess bowel viability in acute mesenteric ischemia, *Am. Surg.* 59 (1993) 309–311.
- [6] C.A. Redaelli, M.K. Schilling, T.P. Carrel, Intraoperative assessment of intestinal viability by laser Doppler flowmetry for surgery of ruptured abdominal aortic aneurysms, *World J. Surg.* 22 (1998) 283–289.
- [7] Y. Watanabe, S. Okushiba, D. Miyasaka, T. Sasaki, Y. Ebihara, M. Kawada, et al., Intraoperative near-infrared video angiography for superior mesenteric arterial occlusion with Antiphospholipid Syndrome, *Jpn. J. Gastroenterol. Surg.* 46 (2013) 603–610 (in Japanese).
- [8] Y. Yoshioka, S. Tamura, A. Takeno, A. Yanai, M. Kobayashi, R. Suzuki, et al., A case of strangulation ileus avoiding bowel resection with observation of intestinal blood flow using indocyanine green fluorescence, *Gastroenterol. Surg.* 35 (2012) 369–373 (in Japanese).
- [9] N. Nitori, T. Deguchi, K. Kubota, M. Yoshida, A. Kato, M. Kojima, et al., Successful treatment of non-occlusive mesenteric ischemia (NOMI) using the HyperEye Medical System™ for intraoperative visualization of the mesenteric and bowel circulation: report of a case, *Surg. Today* 44 (2014) 359–362.