Predictive factors of bowel resection due to an incarcerated groin hernia

Tetsunobu Udaka
Mitoyo General Hospital

Atsuki Taniguchi
Mitoyo General Hospital

Jun Kozai
Mitoyo General Hospital

Tomoaki Ootsuka (✉ tom.ohtsuka@mitoyo-hosp.jp)

Nobuyuki Watanabe
Mitoyo General Hospital

Izuru Endou
Mitoyo General Hospital

Osamu Yoshida
Mitoyo General Hospital

Hiroaki Asano
Mitoyo General Hospital

Masatoshi Kubo
Mitoyo General Hospital

Research article

Abstract

Purpose

In this retrospective study, we assessed factors that can be used to predict the need for bowel resection due to an incarcerated groin hernia.

Methods

We enrolled a total of 83 patients diagnosed with an incarcerated groin hernia on preoperative unenhanced computed tomography (CT) between January 2010 and December 2019 in our hospital. They were divided into two groups: those who underwent bowel resection and those who did not. The clinical findings, blood test results, and unenhanced CT values of patients were examined and compared between the two groups. The indication of intestinal resection was macroscopic necrosis or perforation of the incarcerated intestine.

Results

A total of 83 patients with incarcerated groin hernias were included in our study, of whom 13 (15.7%) had undergone bowel resection surgery. A univariate analysis identified a prolonged time from the symptom onset to surgery, increased white blood cell (WBC) count, increased C-reactive protein (CRP) level, decreased albumin level, and CT attenuation of the incarcerated intestinal wall at the fundus as significant predictive factors. The cut-off value for prediction of intestinal resection was 25 HU for the average CT attenuation of the incarcerated intestinal wall at the fundus and a WBC of 11,550 based on the receiver operating characteristic (ROC) curve. A multivariate analysis showed CT attenuation of the incarcerated intestinal wall at the fundus and an increased WBC count to be independent predictive factors.

Conclusions

Measuring unenhanced CT attenuation of the incarcerated intestinal wall at the fundus and the WBC count was suggested to be necessary for determining whether or not resection of the incarcerated intestine is required in cases of groin hernia.

Introduction

Groin hernia, which is a combination of inguinal and femoral hernia, occurs in 27% of men and 3% of women [1] and is commonly encountered on a daily basis. Around 5%-15% of hernia patients have incarceration, and approximately 15% of cases may develop bowel necrosis requiring bowel resection [2]. Patients with bowel necrosis have a significantly longer hospitalization period and a higher rate of

postoperative complications than those without necrosis, ranging from 6–43% [3–6], with a mortality rate of 1%-7% [3, 5].

If the ischemia in the intestinal tract is reversible, it is common to attempt manual reduction of the incarcerated groin hernia, and if manual reduction of the incarcerated groin hernia is successful, the elective surgery can be performed. However, when intestinal ischemia is irreversible, manual reduction is a risky procedure and emergency surgery is required.

Early recognition of bowel resection risk and timely surgery are critical for ensuring the best outcome of incarcerated groin hernia. Various risk factors for bowel resection have been reported including a female sex, older age, severe coexisting disease, delayed hospitalization, femoral hernia, high American Society Anesthesiologists (ASA) class, presence of peritonitis, and lack of health insurance [3, 5, 7, 8, 9]. However, some of these factors are interrelated and some cannot be obtained through a regression analysis, which limits the clinical applicability of these results [3]. Furthermore, these factors do not include the unenhanced computed tomography (CT) attenuation.

In the present study, we aimed to investigate the factors that determine the need for intestinal resection before surgery including unenhanced CT attenuation.

Methods

Patients and Study Design

The study protocol was approved by the Institutional Review Board of Mitoyo General Hospital, and it conformed to the concepts of the Declaration of Helsinki and its amendments. We enrolled a total of 83 patients who were diagnosed with groin hernia and underwent emergency surgery from January 2010 to December 2019 in our hospital. Patients underwent unenhanced CT and had a measurable CT value of the incarcerated intestinal wall at the fundus.

Patients were divided into two groups according to the operative findings; the bowel resection group included patients found to have an incarcerated small intestine requiring resection, and the non-resection group included patients who did not require small intestine resection. Where or not to perform intestinal resection was determined on intraoperative findings, and intestinal resection was indicated only when clear intestinal necrosis or perforation was found.

The preoperative data gathered were the age, gender, classification of hernia, time from the symptom onset to the surgery, preoperative body temperature, preoperative white blood cell (WBC) count, preoperative C-reactive protein (CRP), preoperative albumin (Alb), preoperative lactate dehydrogenase (LDH), preoperative creatine phosphokinase (CPK), and unenhanced CT value.

For the specific measurement of CT values, CT attenuation of the incarcerated small intestine at the fundus was determined by unenhanced CT at three locations (when possible, the mean values were

extracted from the horizontal, coronal, and sagittal cross-sectional images) (Fig. 1).

Outcome measures

The main outcome examined was the factors predictive of an incarcerated small bowel necessitating surgical resection in patients with groin hernia.

Statistical analyses

Statistical analyses were performed using the Statistical Package for Social Science (SPSS) version 24 (Chicago, IL, USA) software program. The chi-square and Fisher's exact tests were used to compare categorical variables, and Student's *t*-test or the Mann-Whitney test was used to compare continuous variables. Subsequently, receiver operating-characteristic (ROC) curves [9] were constructed to illustrate the sensitivity and false positive rate (1-specificity) of parameters for the prediction of bowel resection. A multiple logistic regression analysis was performed to identify significant predictors associated with the need for bowel resection. All tests were two-sided and *P* values lower than 0.05 were considered significant.

Results

A univariate analysis of the risk factors based on resection of the intestine

A total of 83 patients with incarcerated groin hernias were included in our study, of whom 13 (15.7%) had undergone bowel resection surgery. The mean age was 77.2 ± 8.6 years old in the resection group and 76.4 ± 13.9 years old in the non-resection group, which was not significantly different. There were also no significant differences in the gender, classification of hernia, or body temperature between the two groups.

The mean time from the symptom onset to the surgery was significantly longer in the resection group (39.5 ± 27.8 h) than in the non-resection group (16.8 ± 17.7 h) (P = 0.0014). The WBC count and CRP, LDH, and CPK levels were significantly higher in the resection group than in the non- resection group, and Alb was significantly lower in the resection group than in the non-resection group. The average CT attenuation of the incarcerated small intestinal wall at the fundus was 20.65 ± 3.16 HU in the resection group and 28.12 ± 3.51 HU in the non-resection group showing a significant difference (P < 0.001).

A multivariate analysis of risk factors based on resection of the intestine

Regarding the CT value, the cut-off value for predicting intestinal resection was 25 HU (sensitivity: 0.923, specificity: 0.229, according to the examination of the ROC curve. Figure 2). The results showed that 12

of 13 patients in the resection group had a CT value of ≦ 25 HU, and 57 of 70 patients in the non-resection group had a CT value of > 25 HU.

Regarding the WBC count, the cut-off value for predicting intestinal resection was 11,550 (sensitivity: 0.769, specificity: 0.200, according to the examination of the ROC curve. Figure 3). The results showed that 10 of 13 patients in the resection group had a WBC count of ≧ 11,550, and 56 of 70 patients in the non-resection group had a WBC count of < 11,550. Similarly, the cut-off values for the time from the symptom onset to surgery, and the CRP, and Alb levels were determined based on the ROC curve (the time from symptom onset to surgery = 22 h, sensitivity: 0.769, specificity: 0.286, CRP = 1.99, sensitivity: 0.615, specificity: 0.286, Alb = 3.95, sensitivity: 0.769, specificity: 0.486).

A multivariate analysis was performed in the groups classified by CT attenuation of incarcerated intestinal wall at the fundus, WBC count, the time from symptom onset to surgery, and CRP and Alb levels, parameters that were all significantly different in the univariate analysis. The multivariate analysis showed that the odds ratio for the presence of intestinal resection was 32.502 (95% confidential interval (CI): 3.116-339.028) (P = 0.004) for the CT attenuation of the incarcerated intestinal wall at the fundus and 10.153 (95%CI: 1.585–65.045) (P = 0.014) for the WBC count, which were independent predictors of intestinal resection.

Discussion

Alvarez et al. [2] observed that 13% of incarcerated groin hernia patients had undergone bowel resection surgery. Kurt et al. [5] reported that bowel resection was required in approximately 15% of patents with an incarcerated groin hernia. Suppiah et al. [11] revealed that emergency femoral hernia surgery had a higher rate of bowel resection than did elective femoral hernia surgery. Kemler et al. [12] reported that small bowel resection was required in up to 60% of patients with strangulated femoral hernias. Therefore, the rate of bowel resection is high in incarcerated groin hernia. In our study of 83 patients with incarcerated groin hernias 13 patents (15.7%) underwent bowel resection surgery.

It is very important to understand the preoperative condition of the incarcerated intestinal tract, information that is indispensable for deciding on the surgical technique, such as whether or not to resect the intestinal tract and whether or not to use mesh.

Chen et al. [13] reported in a meta-analysis that the total rate of resection was 21.0% (160/762) in the patients with incarcerated groin hernia. Eight factors were significantly related to the risk of bowel resection in their pooled analysis: female sex, femoral hernia, bowel obstruction duration of incarceration (hours), WBC count and neutrophilic leukocyte count. Our study indicated that CT attenuation of the incarcerated intestinal wall and the WBC count were significantly associated with the risk of bowel resection in incarcerated groin hernia patients.

In our study, we measured the CT value of the incarcerated intestinal wall at the fundus with the groin hernia patients and examined the need for intestinal resection retrospectively. The CT value is the image

density value in a two-dimensional CT image. In recent years, there have been some reports on the utility of CT values in the field of abdominal emergency [14, 15]. Geffroy et al. [15] showed that increased unenhanced bowel-wall attenuation on 64-section multidirector CT had a useful sensitivity and high specificity for the diagnosis of bowel wall ischemia in a highly selected population of patients with surgically treated small bowel obstruction (SBO). Chuong et al. [14] showed that adding unenhanced images to contrast-enhanced images when performing CT to detect bowel wall ischemia based on the presence of decreased bowel wall enhancement in patents with SBO improved the sensitivity, level of confidence in assessing decreased bowl enhancement, and interobserver agreement. In our study, we measured the CT values of the incarcerated small intestine at the fundus by unenhanced CT at three locations (when possible, the mean values were extracted from the horizontal, coronal, and sagittal cross-sectional images). The average CT attenuation of the incarcerated small intestinal wall at the fundus was 20.65 ± 3.16 HU in the resection group and 28.12 ± 3.51 HU in the non-resection group. Significant differences were observed between two groups. The cut-off value for predicting intestinal resection was 25 HU (sensitivity: 0.923, specificity: 0.229, according to the examination of the ROC curve).

Inflammation indicators such as the WBC count, percentage of neutrophils, and neutrophil-to-lymphocyte ratio (NLR) were increased when incarcerated hernia evolved into a strangulated hernia [16–18]. These elevated inflammatory markers suggest a high risk of bowel necrosis, so emergency surgery should be performed immediately. In our study, regarding the WBC count, the cut-off count foe predicting intestinal resection was 11,550, (sensitivity: 0.769, specificity: 0.200, according to the examination of the ROC curve). A multivariate analysis showed that the odds ratio for the presence of intestinal resection was 10.153 (95% CI: 1.585 to 65.045) for the WBC count, making it an independent predictor of intestinal resection.

Our study indicated that CT attenuation of incarcerated intestinal wall and the WBC count were significantly associated with the risk of bowel resection in incarcerated groin hernia patients. Several limitations associated with the present study warrant mention. First, this was a retrospective study and our data are based on the medical examinations performed at our hospital. Selection bias therefore could not be completely avoided. Second, due to the single-center setting, this model requires further validation. Further large-scale and well-designed studies are needed.

Conclusions

In the present study, CT attenuation of the incarcerated intestinal wall at the fundus and the WBC count were useful as predictive factors for intestinal resection of incarcerated groin hernia. Predicting whether or not to resect the intestinal tract before surgery is useful clinically, including for determining the need for resection, the use of mesh, the method of reaching the surgical field, and the need for manual reduction before surgery.

Abbreviations

ALB
Albumin
CI
confidential interval
CPK
creatine phosphokinase
CRP
C-reactive protein
CT
Computed tomography
LDH
lactate dehydrogenas
MLK
neutrophil-to-lymphocyte ratio
ROC
Receiver operating-characteristic
SBO
Small bowel obstruction
SIRS
Systemic inflammatory response syndrome
SPSS
Statistical Package for Social Science
WBC
white blood cell

Declarations

Ethical Approval and Consent to participate

Not applicable

Consent for publication

Not applicable

Availability of supporting data

Please contact the authors for data requests

Competing interests

The authors declare that they have no competing interests.

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Tables

Due to technical limitations, Tables 1-2 are provided in the Supplementary Files section.
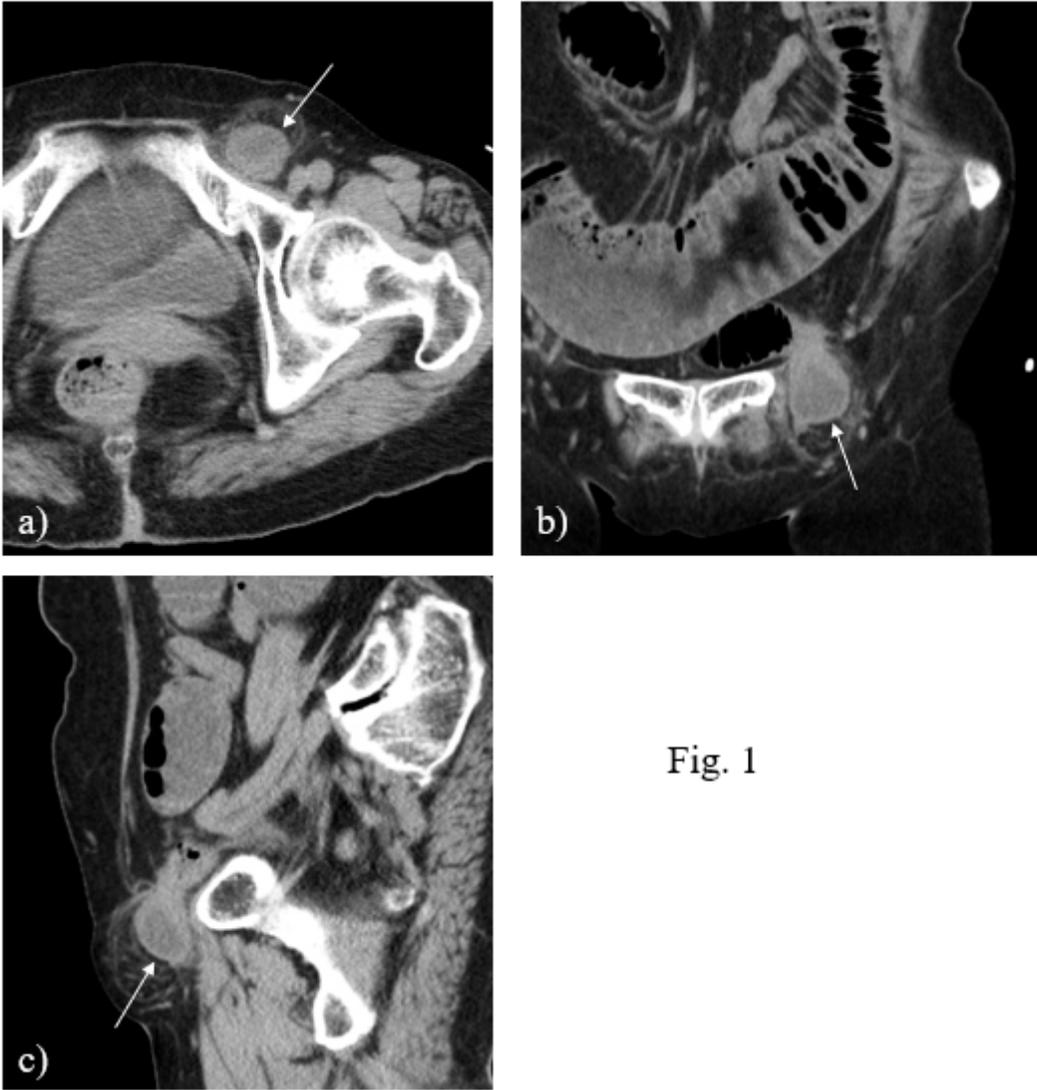
Figures

Fig. 1

Figure 1

Unenhanced CT. (a) Incarcerated intestinal wall of the fundus: horizontal image (Arrow). (b) Incarcerated intestinal wall of the fundus: coronal image (Arrow). (c) Incarcerated intestinal wall of the fundus: sagittal image (Arrow).
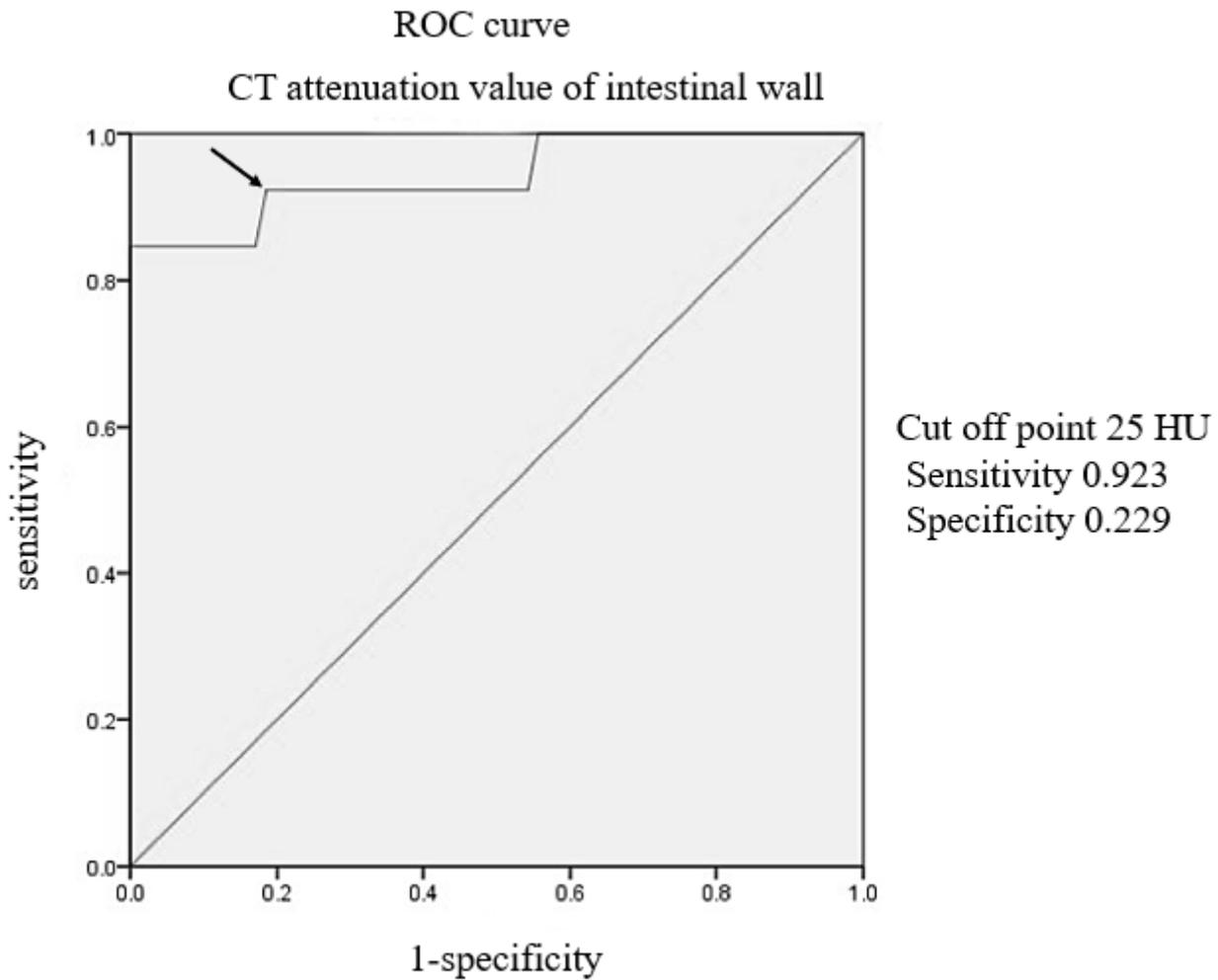
ROC curve

CT attenuation value of intestinal wall

Cut off point 25 HU
Sensitivity 0.923
Specificity 0.229

Figure 2

ROC curve for determining the cut-off CT attenuation value in the presence of an incarcerated intestinal wall of the fundus.

ROC curve
WBC count

Cut off point 11,550
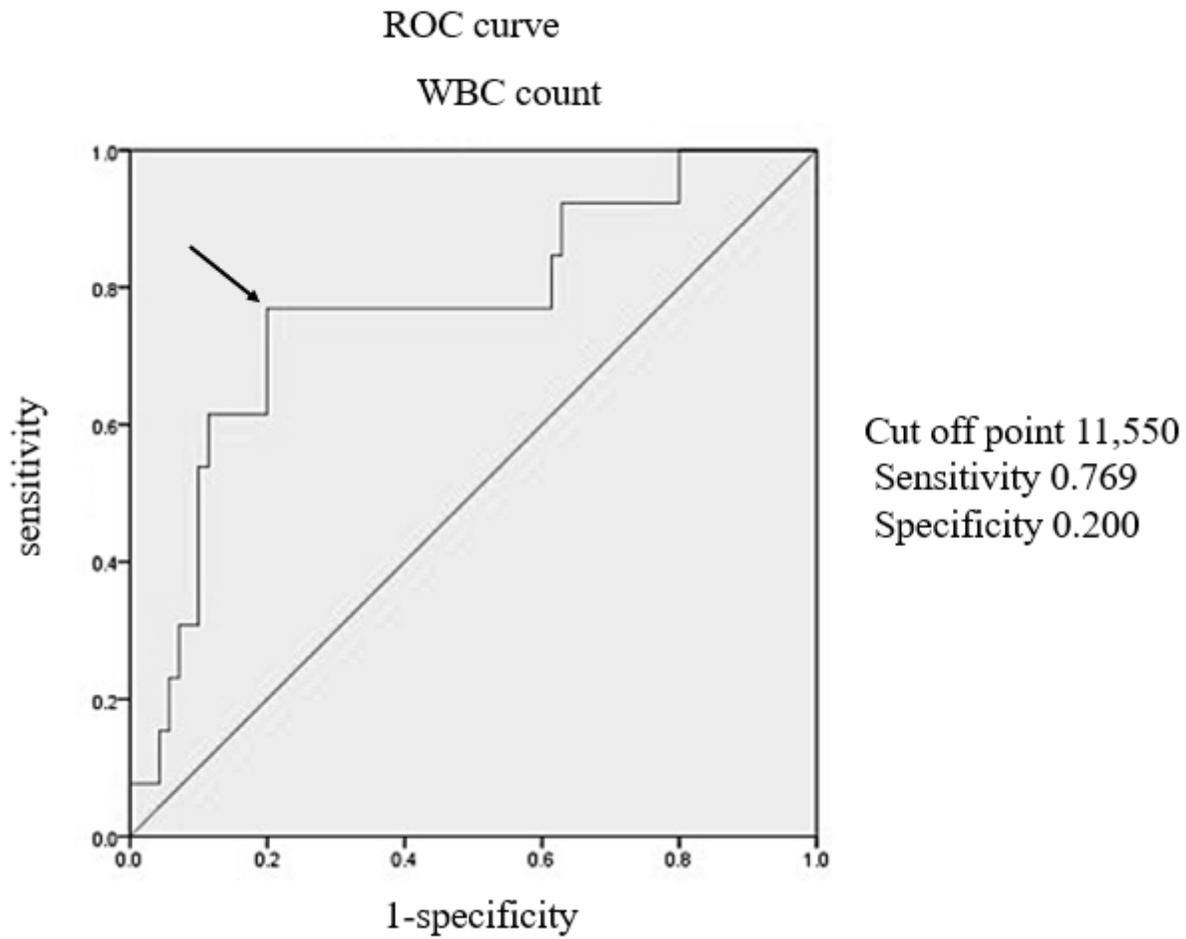Sensitivity 0.769
Specificity 0.200

Figure 3

ROC curve for determining the cut-off WBC count.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Table1.xlsx
- Table2.xlsx