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Classifications of clinical and bowel morphological changes and their relationship with characteristics of patients with incarcerated groin hernias

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Background: There is currently no grading standard for the degree of clinical and bowel morphological changes. The objective of this study was to define clinical and bowel morphological classifications and investigate the possible relationship with the characteristics of patients with incarcerated groin hernias.





Material/Methods: We retrospectively studied 195 patients who underwent emergency hernia repair with simultaneous bowel resection between January 1992 and January 2012. We classified the degree of clinical and bowel morphological changes into 3 grades based on the incarceration time, intestinal morphology after damage, hernia sac integrity, degree of inflammation, and the presence/absence of bacterial growth, peritonitis signs, mechanical obstruction, cellulitis, and systemic shock. We also recorded patient characteristics and analyzed their relationships with these degrees according to our grading system.

Results: We identified 134, 42, and 19 cases of Grades I, II, and III of clinical and bowel morphological changes, respectively. Pearson's chi-squared tests revealed that advanced age ($P=0.001$), presence of comorbid disease ($P=0.002$), and high American Society of Anesthesiologists (ASA) score ($P=0.017$) were related to the degree. Morbidity and mortality also showed significant relationships with the degree ($P<0.001$, $P=0.005$, respectively), especially with regard to post-operative infection.

Conclusions: The proposed 3-stage classifications of clinical and bowel morphological changes can be used to objectively reflect the degree of bowel damage. Greater levels of the changes were associated with higher incidences of complications and increased mortality, especially for older patients with comorbid diseases and poor ASA scores. Urgent surgery should be performed to avoid bowel damage exacerbation.

MeSH Keywords: **Incarceration • bowel morphological change • bowel resection • Hernia**

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Background

Intestinal damage necessitating bowel resection is an important factor affecting morbidity and mortality [1]. Although one group assessed risk and outcome of bowel resection in patients with incarcerated groin hernias [2], and another examined the predictive factors of bowel ischemia in patients with femoral hernias [3], there are no existing grading standards for the degree of clinical and bowel morphological changes. On the basis of our personal experience, bowel damage varies as an extension of incarceration time. Based on the incarceration time, intestinal morphology after damage, hernia sac integrity, degree of inflammation, and the presence/absence of bacterial growth, peritonitis signs, mechanical obstruction, cellulitis, and systemic shock, we defined classification degrees of clinical and bowel morphological changes, and then assessed the relationships of these different degrees with characteristics of incarcerated groin hernia patients who underwent simultaneous hernia repair and bowel resection. Our findings underscore the importance of repairing hernias prior to incarceration and are helpful for predicting the prognosis of patients who undergo emergency surgery for incarcerated hernia and bowel resection.

Material and Methods

Between January 1992 and January 2012, a total of 1147 adult patients with unilateral groin hernia underwent emergency operations for incarceration at Qilu Hospital, which is an academic and teaching hospital affiliated with Shandong University. This study was approved by the Institutional Review Board.

We retrospectively reviewed data from the 1147 adult patients who had undergone emergency groin hernia incarceration surgery. Patient bowel morphology was assessed visually at the time of surgery, with medical reports available for all patients and photographs available for most patients. For some patients, computed tomography and/or ultrasound images were

also available. Laboratory cultures of fluids from each patient were used to confirm infection. Those in whom no infarction or other contents (e.g. omentum) were found during surgical exploration were excluded. This left 195 (17%) patients with bowel damage who had undergone a simultaneous hernia repair and bowel resection. Data including sex, age, American Society of Anesthesiologists (ASA) classification, body mass index (BMI), comorbid disease, hernia type, content type, primary or recurrent, and side were recorded in detail for all patients. Outcomes, including morbidity and mortality, were recorded separately. Morbidities included post-operative wound complications, seroma or hematoma, anastomotic leak, and intra-abdominal abscess. Mortality refers to death within 30 days associated either directly or indirectly with the surgery.

The following 4 criteria we used to assess clinical and bowel morphological changes: (1) the intestinal wall was purplish-black and/or had collapsed, (2) the intestinal wall lost tension and peristalsis ability or paralytic expansion without shrinkage following stimulus, (3) disappearance of pulsation of the corresponding terminal mesenteric artery, and (4) application of hot compress with isotonic saline gauze or 5% procaine for vascular closure at mesenteric root (10–30 minutes) failed to produce improvement. With the extension of incarceration time, intestinal morphology disappeared, and the contents turned to purulent liquid or fragments.

We classified the degree of clinical and bowel morphological changes into 3 grades (Table 1) according to the above decision criteria and based on the incarceration time, intestinal morphology after damage, hernia sac integrity, degree of inflammation, and the presence/absence of bacterial growth, peritonitis signs, mechanical obstruction, cellulitis, and systemic shock.

Statistical analyses were performed using Pearson's chi-squared tests of R×C contingency tables. All analyses were performed with SPSS version 17.0 (SPSS Inc., Chicago, IL). P-values less than 0.05 were considered significant.

Table 1. Clinical and bowel morphological change degree classifications.

| Grade | Standards |
|-------|--|
| I | Incarcerated for 4–12 hours. The bowel was purplish-black but shows normal morphology. The hernia sac was complete without congestion and inflammation. The exudates within the hernia sac were yellow or dark red in color but tested negative for bacteria. The abdomen had no obviously mechanical bowel obstruction and peritonitis |
| II | Incarcerated for 12–36 hours. The bowel lost its normal form and collapsed or cracked. The hernia sac remained complete, but the sac wall exhibited congestion and swelling. The content was mixed liquids of intestinal juice and necrotic intestinal wall tissues, and there was evidence of bacterial growth. The abdomen showed clear mechanical bowel obstruction and mild signs of peritonitis |
| III | Incarcerated for more than 36 hours. The bowel was completely cracked without form, and the hernia sac is filled with purulent liquid. The hernia sac wall has also festered and cracked or perforated. There was evidence of cellulitis, and the patient presented with obvious peritonitis and systemic shock |

Table 2. Patient characteristics classified according to clinical and bowel morphological change grade.

| Patient characteristics | Total (n=195) | I (n=134) | II (n=42) | III (n=19) | P |
|-------------------------|---------------|-----------|-----------|------------|-------|
| Age (years) | | | | | |
| ≥65 | 45 | 20 | 16 | 8 | 0.001 |
| <65 | 150 | 114 | 26 | 11 | |
| Gender | | | | | |
| Female | 21 | 12 | 6 | 3 | 0.473 |
| Male | 174 | 122 | 36 | 16 | |
| ASA class | | | | | |
| I | 93 | 71 | 16 | 6 | 0.017 |
| II | 61 | 34 | 13 | 4 | |
| III | 28 | 14 | 9 | 5 | |
| IV | 13 | 5 | 4 | 4 | |
| Body mass index | | | | | |
| ≥30 | 27 | 17 | 7 | 3 | 0.782 |
| <30 | 168 | 117 | 35 | 16 | |
| Comorbid diseases | | | | | |
| Positive | 38 | 17 | 15 | 6 | 0.002 |
| Negative | 157 | 117 | 27 | 13 | |
| Hernia type | | | | | |
| Direct | 19 | 12 | 5 | 2 | 0.628 |
| Indirect | 161 | 122 | 23 | 16 | |
| Femoral | 15 | 10 | 4 | 1 | |
| Primary or recurrent | | | | | |
| Primary | 178 | 123 | 38 | 17 | 0.268 |
| Recurrent | 17 | 11 | 4 | 2 | |
| Left or right | | | | | |
| Left | 35 | 22 | 9 | 4 | 0.925 |
| Right | 160 | 112 | 33 | 15 | |
| Content type | | | | | |
| Small bowel | 182 | 125 | 31 | 18 | 0.870 |
| Large bowel | 13 | 9 | 3 | 1 | |

Results

A total of 195 patients were included in the final sample, ranging in age from 21 to 82 years (patient characteristics are summarized in Table 2). According to our clinical and bowel morphological change classification method (detailed in Table 1),

there were 134, 42, and 19 cases of Grade I, II, and III changes, respectively.

The differences in patient characteristics among the 3 groups are summarized in Table 2. There were 45 (23.1%) patients older than 65 years and 19.5% (38/195) with comorbid diseases.

Table 3. Patient outcomes by group.

| Outcome parameter | Total | I, n (%) | II, n (%) | III, n (%) | χ^2 | P |
|------------------------|-------|----------|-----------|------------|----------|--------|
| Morbidity | 29 | 4 (3.0) | 9 (26.5) | 16 (84.2) | 88.537 | <0.001 |
| Wound infection | 15 | 2 (1.5) | 5 (14.7) | 8 (42.1) | 39.992 | <0.001 |
| Seroma or hematoma | 7 | 1 (0.7) | 2 (5.9) | 4 (21.1) | 20.039 | <0.001 |
| Anastomotic leak | 3 | – (0.0) | 1 (2.9) | 2 (10.5) | 12.423 | 0.002 |
| Intraabdominal abscess | 4 | 1 (0.7) | 1 (2.9) | 2 (10.5) | 7.951 | 0.019 |
| Mortality | 18 | 7 (5.2) | 6 (14.2) | 5 (26.3) | 10.468 | 0.005 |

There were more men (89.2%) than women, and most hernias in this study were on the right side (82.1%), indirect (82.6%), and inguinal (82.6%). There were 154 ASA class I–II patients and 41 ASA class III–IV patients. Pearson's chi-squared analysis did not reveal any statistically significant differences with respect to sex, BMI, type of hernia and content, primary or recurrent, or side among the 3 damage groups. However, advanced age ($\chi^2=14.426$, $P=0.001$), presence of comorbid disease ($\chi^2=12.76$, $P=0.002$), and high ASA score ($\chi^2=15.385$, $P=0.017$) were associated with the clinical and bowel morphological grading.

A total of 29 (14.9%) morbidity and 18 (9.2%) mortality events were registered (Table 3). With regard to morbidity, we noted 15 cases of wound infections, 7 cases of seroma or hematoma, 3 cases of anastomotic leak, and 4 cases of intra-abdominal abscess. The incidence of complications differed significantly among the 3 groups (Table 3). Wound infection was the most common complication in our patients. The incidence rates of infection were 3.0%, 26.5%, and 84.2% for Grades I, II, and III, respectively, and the differences were statistically significant ($\chi^2=39.992$; $P<0.001$). Overall, 23 (11.8%) patients died within 30 days of surgery, and there were significant differences among the 3 groups ($\chi^2=10.468$; $P=0.005$).

Discussion

Approximately 15% of patients with incarcerated inguinal hernia develop bowel damage that requires resection [2,4], but to our knowledge there are no detailed clinical criteria for or definitions of the degree of clinical and bowel morphological changes. Here, we summarized our clinical experiences in 195 patients to create the classification criteria detailed above. The assessed parameters were incarceration time, damaged bowel morphology, hernia sac integrity, degree of inflammation, and the presence/absence of peritonitis signs. Not surprisingly, the length of damaging time was associated with intestinal morphological changes and other local and systemic signs. However, incarceration time is not equivalent to strangulation time. We used incarceration time to estimate the bowel damage time.

Kurt et al. [2] reported that hospital admission more than 6 hours after symptom onset was associated with greater bowel resection. Atila et al. [5] reported that symptoms lasting for more than 6 hours often resulted in resection. According to our clinical observations, most patients with incarcerated bowels for longer than 4 hours experienced strangulation that resulted in bowel infarction. For damage within 4–12 hours of incarceration, the exudates were yellow or dark red, the hernia sac was complete, the bowel was purplish-black but with complete morphology, and there were no signs of peritonitis, which we defined as Grade I. For these patients, the operating field was a potentially contaminated wound. We found that the rates of postoperative complications and mortality of Grade I patients were lower than those in Grades II–III.

Obvious peritonitis is valuable in identifying patients at high risk of bowel resection [5]. For Grade II–III patients, in addition to local signs, the abdomen could present obvious mechanical bowel obstruction and peritonitis due to a long period of damage; the bowel is cracked, and the operating fields show signs of clear contamination wound and bacteria breeding. Except for those with a long history of hernia, most of the Grade II patients were elderly and were unaware of the risk of incarceration, or they could not get timely medical treatment due to some other reason, such as living in a remote rural area or lack of health insurance, thus aggravating damage, which negatively affected prognosis. Late hospital admission meant extended damaging time and greater degree of severity, which was an important factor affecting morbidity due to greater bowel resection [2,6,7].

Grade III patients were rarely observed in our clinical practice. These patients were mostly elderly patients with concomitant diseases and with high ASA scores (III–IV) and relatively low response to pain. Because of personal or family reasons, these patients could not get timely treatment and therefore presented with serious peritonitis and septic shock.

Comorbid diseases and ASA class were important parameters in defining degrees of surgery- and anesthesia-related

risks [1,8–10]. In this study, we found that both of these factors were also related with the clinical and bowel morphological degree, which affected the outcomes. Young patients in good general conditions and ASA class I–II had better tolerance to anesthesia and surgery. Conversely, elderly patients often had comorbid conditions, such as cardiopulmonary disease or liver and kidney dysfunction. Their ASA class was often III–IV, and their clinical and bowel morphological degree was more likely to be aggravated due to the delay in medical treatment. These patients were at high risk for complications and had high mortality rates following surgery.

Our study had several limitations. Firstly, it was a retrospective review, and as such we were unable to routinely gather specific information on comorbid disease. We also did not perform immunohistochemical stains to quantify inflammation or cell death. In addition, we were unable to assess specifics of postoperative care, such as antibiotic management. A prospective study would be useful to clarify the effects of these variables and determine how the degree of clinical and bowel morphological changes impact clinical management.

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Conclusions

Previous studies have reported that many factors influence bowel resection outcomes, including age, severe coexisting disease, delayed hospitalization, high ASA class, and the presence of peritonitis [2,7,8,11]. However, some of these factors were shown to be interrelated with each other and could affect the degree of bowel damage. Therefore, we hypothesized that a classification scheme could objectively reflect the degree of clinical and bowel morphological changes. Our results indicate that incarceration time was the strongest predictor of bowel damage characterized by morphological changes and infection, and outcomes were worse in older patients, especially those with comorbid diseases and poor ASA scores. Emergency surgery could increase complication and mortality rates for incarcerated hernias [1,11,12], especially in elderly patients [13]; however, urgent surgery should be performed to avoid further damage.