

Title: Advantages of ultrasound-guided reduction and elective surgery versus emergency repair for incarcerated obturator hernia

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Abstract

Purpose: To compare the benefits of ultrasound-guided reduction (UGR) followed by elective versus emergency repair for incarcerated obturator hernia (OH).

Methods: This is a retrospective cohort study. Before UGR implementation, all patients with incarcerated OH underwent emergency surgery. To compare the UGR candidates fairly, only patients who did not require bowel resection were classified as the emergency group. Following UGR implementation, patients without bowel necrosis, based on our criteria, underwent UGR. Among these, those who underwent elective repair were classified into the elective group. Surgical outcomes were compared between the groups and are presented as the median (range).

Results: Among the 60 patients with incarcerated OH, 23 were in the emergency group and 11 in the elective group. UGR was successful in 16 of 17 cases (94%). The elective group had significantly shorter times to first defecation (4 [1–7] vs. 0 [0–1]) and meal initiation (3 [1–8] vs. 1 [1–3] days) than the emergency group. Although not statistically significant, the mesh repair rate was higher in the elective group (100% vs. 78%, respectively).

Conclusions: UGR can be safely performed with an appropriate diagnosis. Compared with emergency surgery, UGR followed by elective repair led to reduced postoperative ileus and elevated mesh repair rates.

Keywords: Obturator hernia, Ultrasound, Incarceration

Introduction

Incarcerated obturator hernia (OH) is a rare type of pelvic wall hernia that occurs mainly in elderly and multiparous thin women and accounts for 0.073%–1% of all hernia repair cases [1–3]. The detection of incarcerated OH tends to take longer than that of other incarcerated hernias because OH cannot be easily observed by palpation. Prolonged incarceration may result in necrosis and perforation. Emergency surgical repair has traditionally been the standard treatment [2].

Recently, non-invasive ultrasound-guided reduction (UGR) has been adopted for incarcerated OH, and its safety has been reported [4]. Although UGR can potentially avoid the need for emergency surgery, the risk of inadvertently reducing necrotic bowel remains. Furthermore, the potential benefits of UGR followed by elective surgery remain unclear.

The present study evaluated the advantages of a treatment strategy involving UGR followed by elective surgery compared to emergency surgery for incarcerated OH.

Methods

Patients

All consecutive patients diagnosed with incarcerated OH using computed tomography (CT) at Kameda Medical Center from 2004 to 2018 were included.

From 2004 to 2013, all patients with incarcerated OH underwent emergency repairs. To compare the UGR candidates fairly, patients with no severe damage to the incarcerated intestine and those who did not require bowel resection were classified into the emergency group. The evaluation of intestinal damage and the decision to perform bowel resection were based on the gross appearance of the incarcerated intestine during laparotomy.

Since June 2013, UGR has been adopted at our institution. In patients diagnosed with incarcerated OH without signs of intestinal necrosis, UGR was immediately performed at the bedside, and those whose incarcerated intestines were successfully reduced were classified into the UGR group. Those who provided their informed consent and underwent elective surgical repair were assigned to the elective group.

Criteria for UGR candidacy

In the current study, we performed UGR under the following criteria: time from onset of <2 days; no high fever, severe stomach ache, or shock vital signs; white blood cell count (WBC) <20000/ μ L; C-reactive protein (CRP) level <10 mg/dL; and no CT findings such as abscess or free air around the OH sac. Informed consent for this procedure was required.

Procedure of UGR

Initially, an incarcerated intestine in the OH sac was identified between the adductor longus and pectineus muscles [5] using a 1–6 MHz convex transducer (Prosound Alpha 6; Hitachi, Ltd., Tokyo, Japan) (Fig. 1a). After abduction and external rotation of the affected thigh

followed by flexion of the knee, the intestine was compressed vertically and gently with the probe under ultrasound guidance (Fig. 1b). Successful reduction was observed in real time, as the OH sac was retracted into the pelvic cavity under ultrasound guidance. Reduction of the incarcerated OH and resolution of small bowel obstruction (SBO) were confirmed using CT. The patients were carefully observed overnight, and elective surgical repair was planned for those who provided their consent. In cases where the maneuver failed due to resistance from the OH sac or when patients were excluded based on the UGR criteria, emergency laparotomy was performed.

Surgical technique

In this study, OH repair was predominantly performed through an approximately 15-cm lower abdominal incision, and the preperitoneal space from the area between the bladder and the pubic bone to the area below the obturator canal was dissected. If OH was suspected on both sides, both sides were dissected. Alternatively, inguinal incision was selected based on the surgeon's preference. For cases requiring enhanced visualization, such as confirmation of bowel necrosis, a 15-cm lower abdominal midline incision and laparotomy were performed.

We preferred repair with a light polypropylene mesh for both emergency and elective surgeries. The Cooper ligament in the area below the obturator canal was covered with a mesh. When contamination or severe adhesion was observed, closure of the OH sac or covering of the defect using an adjacent organ was performed.

The use of general or spinal anesthesia was based on discussions between surgeons and anesthesiologists.

Data collection

We investigated the following clinical characteristics upon admission: sex, age, weight,

incarcerated side, onset-to-arrival time, WBC, CRP level, the American Society of Anesthesiologists physical status (ASA-PS) score [6, 7]. The following surgical data were evaluated: operation time, bleeding, surgical procedure, anesthesia procedure, mesh repair rate, postoperative tube insertion rate, first defecation and meal start date after release from incarceration, hospital stay, and major complications (Clavien-Dindo classification grade >III) [8, 9]. To assess the recovery time from OH incarceration and surgical repair, the time of first defecation and the meal start date between the emergency group and the UGR and elective groups were compared. Decisions regarding postoperative bowel decompression tube insertion, meal start date, and discharge date were based on the surgeon's preference.

Ethical issues

This was a retrospective study. The institutional review board approved the study protocol (17-207). Given the retrospective nature of the study, the requirement for written informed consent was waived; instead, an opt-out method was employed.

Statistical analyses

All statistical analyses were performed using the JMP software program, ver. 12 (SAS Institute Inc., Cary, NC, USA). Statistical significance was set at a p value <0.05 , using the Mann-Whitney U test and chi-square test. Results are shown as the median (range).

Results

Patient characteristics

Sixty consecutive patients diagnosed with incarcerated OH via CT, all of whom were female, were included in this study.

Between October 2004 and May 2013, 38 patients were diagnosed with incarcerated OH upon admission to our institution. Among them, 37 underwent emergency laparotomies. Of these, 12 cases were excluded because of necrosis of the incarcerated small intestine observed during surgery, necessitating intestinal resection. One patient with occult colon cancer who underwent intestinal resection and another who underwent transient tube enterostomy were also excluded. Consequently, 23 patients were assigned to the emergency group (Fig. 2a).

Between June 2013 and August 2016, 22 patients were diagnosed with incarcerated OH on admission. Seventeen patients met our criteria for UGR candidacy and underwent UGR at the bedside. As a result, 16 patients (94.1%) had successfully reduced OH without any complications and were assigned to the UGR group (Fig. 2b). Reduction failed in one case because the surgeon felt resistance. The patient underwent an emergency laparotomy, and no necrosis was observed.

Of the 16 patients who avoided emergency surgeries, 11 provided their informed consent and underwent elective surgical repair with mesh, and they were assigned to the elective group. Among these, eight patients were initially discharged and later readmitted for surgery. Elective surgeries were performed 17 (6–59) days after UGR.

No significant differences were found between the emergency and UGR groups in terms of sex, age, weight, side of OH, WBC counts, CRP level, presence of SBO based on CT, onset-to-arrival time, or ASA-PS score (Table I) as well as between the emergency and elective groups (Table II).

Safety and benefits of UGR

The results of the comparison between the emergency and UGR groups are presented in Table III. Over 90% of the cases in both the emergency and UGR groups had SBO due to incarcerated OH. A significant difference in the gastric/small bowel decompression tube insertion rate was noted between the emergency and UGR groups (60.9% vs. 18.8%, $p = 0.009$). Patients in the emergency group had a longer time before the first defecation (4 [1–7] vs. 0 [0–4] days, $p < 0.001$) (Fig. 3a) and before the start of the first meal (3 [1–8] vs. 1 [1–3] days, $p < 0.001$) than those in the UGR group (Fig. 3b).

Surgical outcomes

A significant difference was observed between the emergency and elective groups: a longer operation time in the elective group and greater bleeding in the emergency group (Table IV). The number of days to the first meal (3 [1–8] vs. 1 [0–1] days, $p < 0.001$) (Fig. 3b) was significantly different; thus, the postoperative hospital stay was also statistically different (10 [3–24] vs. 4 [3–8] days, $p < 0.001$) (Fig. 3c). Furthermore, in the elective group, all 11 patients underwent mesh repair, whereas in the emergency group, mesh repair could not be performed in 5 of 23 (21.7%) patients because of poor patient conditions in 3 cases, suspected contamination in 1 case, and insufficient surgical space in 1 case.

We preferred preperitoneal dissection for the surgical procedures. However, in the emergency group, 21 patients (91.3%) underwent open laparotomy to ensure the viability of the incarcerated intestine or to facilitate manual reduction during surgery: one patient underwent an inguinal procedure, and the other underwent preperitoneal dissection. In the elective group, only 1 patient (9.1%) underwent open laparotomy, 1 had an inguinal procedure, and 9 had preperitoneal dissection (81.8%). General anesthesia was preferred as the anesthesia

procedure in the emergency group compared to the elective group (95.7% vs. 63.6%, $p = 0.014$).

The treatment policy, including the postoperative care and discharge criteria, remained consistent throughout the study period. Three major complications were observed in the emergency group: postoperative acute heart failure, severe disuse atrophy, and prolonged intubation due to the postoperative exacerbation of asthma (3/23; 13.0%).

Discussion

This study demonstrated that UGR for incarcerated OH was performed with a high success rate (16/17, 94.1%) and with no complications under our established criteria. Even in the single case where UGR was unsuccessful, no viability issues or necrosis were observed during the subsequent emergency surgery. In addition, elective surgery following successful UGR reduction improved the recovery from postoperative ileus and facilitated mesh repair.

The safety of UGR for incarcerated OH has been described previously [4]. Recently, Kawanaka et al. proposed a new treatment strategy for incarcerated OH and employed UGR using criteria based on the time from the onset, CRP level, and CT findings [10]. In the current study, we performed UGR considering the following issues: time from onset, patients' vital signs and symptoms that would be associated with bowel necrosis or sepsis, and CT findings, such as abscess and free air around the OH sac. Similar to our strategy, many previous studies [5, 10–14] considered the onset-to-arrival time, WBC count, CRP level, vital signs, and characteristic CT findings, such as increased length of the incarcerated intestine, as possible risk factors predicting necrosis in the incarcerated bowel.

Our strategy of avoiding emergency surgery improves the bowel function, reduces tube insertion rates, enables earlier meals, and shortens hospital stay, ultimately lowering patient distress. While elective surgery is expected to improve postoperative bowel movements in patients without SBO compared to emergency cases with SBO [15], it is surprising that SBO recovery differed significantly between the emergency and UGR groups (Figs. 3a, b), as both had pre-treatment SBO. This suggests that avoiding emergency surgery significantly aids in recovery from SBO.

Although not statistically significant, the mesh repair rate of the reduction strategy was slightly higher than that of the emergency strategy (100% vs. 78.3%; $p = 0.09$). To date, various types of repair, including simple closure, autogenous fascia repair, and repair using prosthetic

materials, have been reported [2, 16]. However, because of the low incidence of OH, few studies on OH recurrence prevention have been conducted despite the high recurrence rate. To date, one study has described the advantage of mesh repair for long-term OH recurrence prevention [16]; thus, we consider prosthetic mesh repair with careful dissection around the OH sac to be crucial.

Several limitations associated with the present study warrant mention, including its single-center design, small sample size, and use of retrospectively collected data. Owing to the small sample size, several parameters of the patients' backgrounds were not significantly different. However, these factors may have influenced our results. As analyzed in this study, the emergency group was not a strict comparison target for the UGR group. To address these limitations, a prospective multicenter study using standardized UGR criteria is necessary.

Conclusions

In conclusion, with an appropriate assessment of the viability of the incarcerated intestine, UGR followed by elective surgical repair for incarcerated OH could be performed safely. This strategy can help improve bowel movement recovery after SBO and may contribute to an increased mesh repair rate.

Ethics declarations

Conflict of interest

The authors declare no conflicts of interest in association with the present study.

Ethical approval

This study was conducted in accordance with the principles of the Declaration of Helsinki. Approval was granted by the Ethics Committee of Kameda Medical Center (17-207).

Informed consent

Given the retrospective nature of the study, the requirement for written informed consent was waived; instead, an opt-out method was employed.

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Figure legends

Figure 1. An ultrasonographic (US) image showing an incarcerated obturator hernia. (a) The US image during observation. The inset shows the position during observation. (b) The US image during reduction. The inset shows the position during ultrasound-guided reduction. OH; sac of obturator hernia. II; incarcerated intestine; OC, obturator canal; FA, femoral artery; FV, femoral vein; AL, adductor longus; PM, pectineus muscle; PC, peritoneal cavity.

Figure 2. (a) Flow diagram of the emergency group. (b) Flow diagram of the ultrasound-guided reduction (UGR) and the elective groups.

Figure 3. A comparison of the time to first bowel movement, time to first meal, and length of hospital stay between patients undergoing emergency surgery, elective surgery, and those who underwent ultrasound-guided reduction (UGR) for incarcerated obturator hernia. Bars represent the median values. (a) Days to first defecation after reduction of incarceration. In the emergency group, one case was excluded because the patient died before defecation. In the UGR group, four cases were excluded because they were discharged before defecation. (b) Days to first meal after each treatment. (c) Day to discharge after emergency and elective surgery. Three cases were excluded because of warfarin control, and two cases were excluded because of in-hospital death in the emergency group. Two cases were excluded because of warfarin control in the elective group. Bars represent the median values.

Table I. Characteristics of patients in the emergency and UGR groups

	Emergency (n=23)	UGR (n=16)	<i>p</i> value
Sex	All female	All female	-
Age, years	82 (75-92)	85 (67-95)	0.414
Weight, kg	35.9 (24.6-46)	33.8 (24-42)	0.196
Incarcerated side (Right/Left/Both)	13/7/3	12/2/2	0.403
WBC, / μ L	7500 (2100-13200) *	6800 (3300-11600)	0.168
CRP level, mg/dL	0.28 (0.01-8.46)	0.1 (0.01-5.64)	0.134
Presence of SBO on CT (%)	22 (95.7)	15 (93.8) [†]	0.754
Onset-to-arrival time $\geq$ 2 days (%)	10 (43.5)	3 (18.7)	0.107
ASA-PS	3 (2-4)	2 (2-3)	0.113

UGR, ultrasound-guided reduction; WBC, white blood cell; CRP, C-reactive protein; SBO, small bowel obstruction; CT, computed tomography; ASA-PS, the American Society of Anesthesiologists (ASA) physical status classification system

*Two cases were excluded due to polycythemia vera and malignant lymphoma.

[†]One case was diagnosed by ultrasonography alone.

Table II. Characteristics of patients in the emergency and elective groups

	Emergency (n=23)	Elective (n=11)	<i>p</i> value
Sex	All female	All female	-
Age, years	82 (75-92)	85 (67-95)	0.567
Weight, kg	35.9 (24.6-46)	35.9 (24-42)	0.553
ASA-PS	3 (2-4)	2 (2-3)	0.503

ASA-PS, the American Society of Anesthesiologists (**ASA**) physical status classification system

Table III. Outcomes of the emergency and UGR groups

	Emergency (n=23)	UGR (n=16)	<i>p</i> value
Tube insertion after release from incarceration, (%) (short tube/ long tube)	14 (60.9) (12/2)	3 (18.8) (3/0)	0.009
First meal start date after release from incarceration, days	3 (1-8)	1 (1-3)	<0.001
First defecation after release from incarceration, days	4 (1-7) *	0 (0-4) †	<0.001
UGR, ultrasound-guided reduction			

* One case excluded because the patient died before defecation.

† Four cases excluded because they were discharged before defecation.

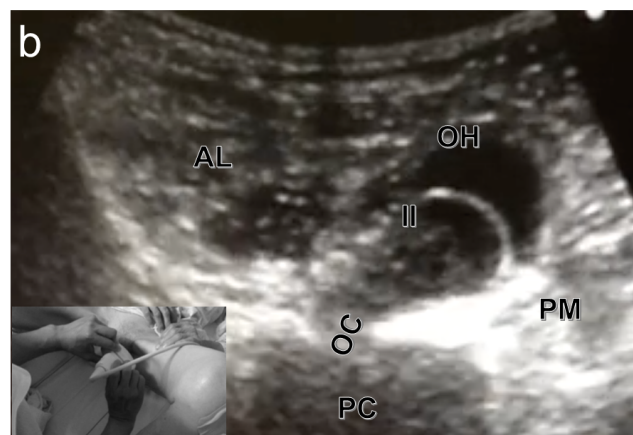
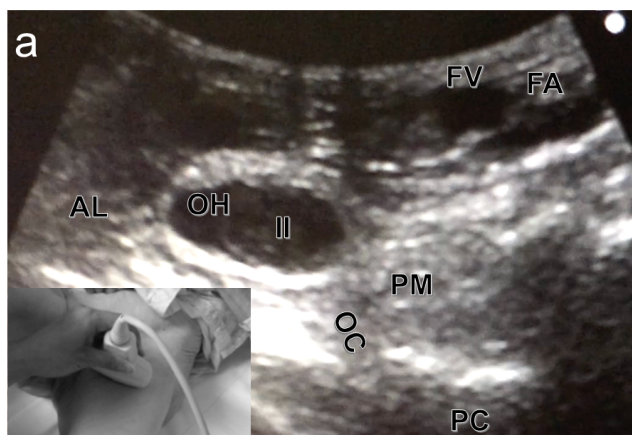
Table IV. Outcomes of the emergency group and the elective group

	Emergency (n=23)	Elective (n=11)	<i>p</i> value
Operation time, minutes	63.5 (38-123)	72 (44-166)	0.005
Amount of bleeding, mL	20 (1-330)	20 (1-230)	0.047
Open laparotomy, (%)	21 (91.3)	1 (9.1)	<0.001
General anesthesia rate, (%)	22 (95.7)	7 (63.6)	0.014
Mesh repair rate, (%)	18 (78.3)	11 (100.0)	0.09
Postoperative meal start date, days	3 (1-8)	1 (0-1)	<0.001
Postoperative hospital stay, days	10 (3-24) *	4 (3-8) †	<0.001
Complications greater than Grade III according to CD, (%)	3 (13.0)	0 (0.0)	0.210

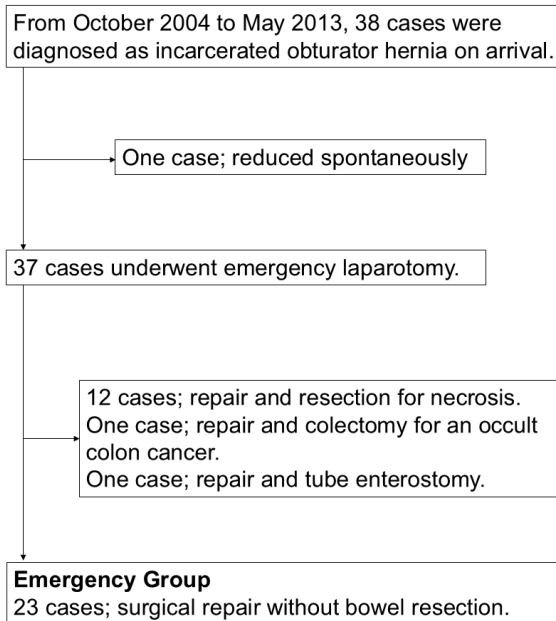
CD, Clavien-Dindo classification

* Three cases excluded because of warfarin control, and two cases excluded because of in-hospital death.

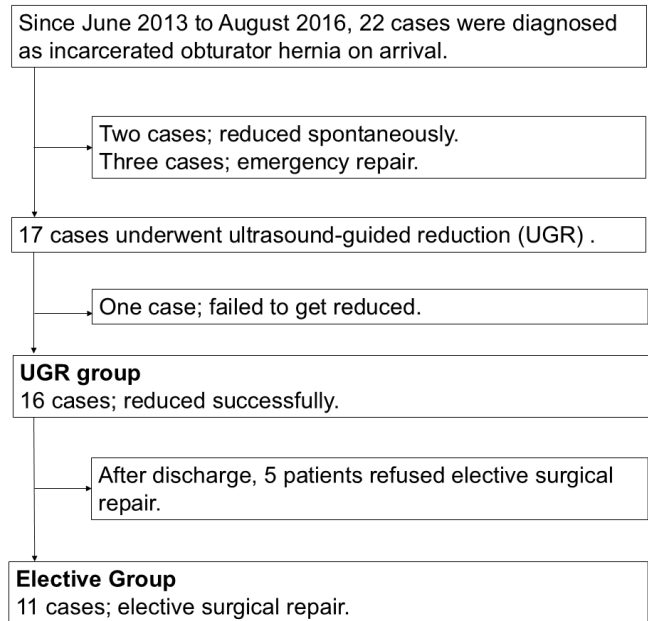
† Two cases excluded because of warfarin control.



a



b



Scatter plot showing the number of days for Emergency and UGR categories. The y-axis is labeled 'Days' and ranges from 0 to 8. The x-axis has two categories: 'Emergency' and 'UGR'. For 'Emergency', data points are clustered between 1 and 7 days, with a mean line at approximately 4 days. For 'UGR', data points are mostly at 0 days, with one outlier at 4 days.

A box plot showing the distribution of the number of patients per day for three categories: Emergency, UGR, and Elective. The y-axis represents the number of patients, ranging from 0 to 10. The x-axis labels are Emergency, UGR, and Elective. For Emergency, the median is approximately 3, with a box from 2.5 to 3.5 and whiskers from 2 to 4. For UGR, the median is approximately 1, with a box from 0.5 to 1.5 and whiskers from 0.5 to 1.5. For Elective, the median is approximately 1, with a box from 0.5 to 1.5 and whiskers from 0.5 to 1.5. Outliers are present for Emergency (values 5, 6, 7, 8) and UGR (value 3).

Scatter plot showing the number of correct answers for Emergency and Elective cases. The y-axis represents the number of correct answers (0 to 30). The x-axis shows two categories: Emergency and Elective. Emergency cases show a wider distribution of correct answers (ranging from approximately 3 to 25) compared to Elective cases (ranging from approximately 3 to 8). The mean for Emergency is around 10, and for Elective, it is around 4.