

Feasibility of Laparoscopic Transabdominal Preperitoneal Hernioplasty for Incarcerated Inguinal Hernia

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ABSTRACT

Background/Objectives: An incarcerated inguinal hernia (InclH) is defined as an irreducible inguinal hernia. The problems caused by long-term incarceration are adhesion between the incarcerated organ and hernial sac and difficulty in reduction of the edematous incarcerated organ. The present study was performed to evaluate the feasibility of laparoscopic transabdominal preperitoneal (TAPP) hernioplasty to treat chronic InclH.

Methods: This retrospective study included 154 patients aged >20 years who were treated for InclH from January 1, 2015 to October 31, 2020. Patients were categorized into those with symptoms for ≥ 3 months (chronic InclH group, 134 patients) and those with symptoms for < 3 months (acute InclH group, 20 patients).

Results: The type of incarcerated organ differed between groups. The most frequently incarcerated organ was the intestine (85%, 17/20) in the acute InclH group and the omentum (98%, 131/134) in the chronic InclH group ($p < 0.000$). Compared with the chronic InclH group, the

acute InclH group had a higher prevalence of pre-operative inguinal pain (85%, 17/20 vs 3%, 4/134; $p < 0.000$) and a lower prevalence of adhesion between the incarcerated organ and the hernial sac (5%, 1/20 vs 37%, 49/134; $p = 0.011$). Organ resection was performed in 1 patient in the acute InclH group and 19 in the chronic InclH group.

Conclusion: In patients with chronic InclH, TAPP hernioplasty was used to successfully resolve adhesion between the incarcerated organ and the hernial sac, avoiding organ resection by enabling intra-abdominal reduction in many patients. TAPP hernioplasty may be a feasible surgical method for the treatment of InclH.

Key Words: Chronic incarceration, Inguinal hernia, TAPP, Laparoscopy.

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INTRODUCTION

It is estimated that 5% of the general population will develop an abdominal hernia, and about 75% of all hernias occur in the inguinal region.¹ An irreducible hernia is referred to as an incarcerated hernia.¹ An incarcerated inguinal hernia (InclH) represents 5% to 10% of all groin hernias.^{2,3} Acute incarceration causes acute pain and requires emergency surgery.⁴ However, rather than pain, the clinical signs of chronic incarceration are scrotal or labial bulging.⁵ Although the exact distinction between acute and chronic has not been defined, chronic incarceration is considered to be characterized by persistent symptoms without the development of new symptoms. In the present study, acute and chronic were classified based on a cut-off of 3 months.

The initial procedure for the treatment of InclH is manual reduction. If manual reduction of acute InclH fails, emergency surgery is required because of the high risk of strangulation.⁶ In contrast, chronic InclH is usually treated via elective surgery. Because the clinical signs and risks differ between acute and chronic InclH, the surgical method and postoperative results may also differ. Bowel incarceration is common in acute InclH, and thus the most important aspect of surgery is reduction through

rapid decompression of the entrapped bowel.⁴ However, chronic IncIH commonly involves omental incarceration, and it is important to resolve the adhesion caused by long-term incarceration and to carefully reduce the edematous incarcerated organs.⁵ Some surgeons prefer to treat IncIH via open surgery rather than laparoscopic surgery because of the severe symptoms and the possibility of organ resection.⁷ However, some surgeons consider laparoscopic surgery as the first treatment option for IncIH.^{8,9}

Patients with chronic IncIH may face two problems as a result of long-term incarceration: the first is adhesion between the incarcerated organ and hernial sac, and the second is edema of the incarcerated organ. Therefore,

there are various opinions on the optimal surgical method for chronic IncIH. To reduce the need for organ resection in the treatment of chronic IncIH, surgeons must resolve the adhesion and overcome the difficulty of reduction due to edema of the incarcerated organs. The advantage of laparoscopic transabdominal preperitoneal (TAPP) hernioplasty is that it enables the surgeon to perform intra-abdominal adhesiolysis between the incarcerated organ and hernial sac using a laparoscopic instrument. Furthermore, the TAPP approach enables the surgeon to confirm the viability of the incarcerated organ based on the return of color and peristalsis, which allows reassessment of the viability of the incarcerated organs at the end of the procedure and avoids unnecessary organ

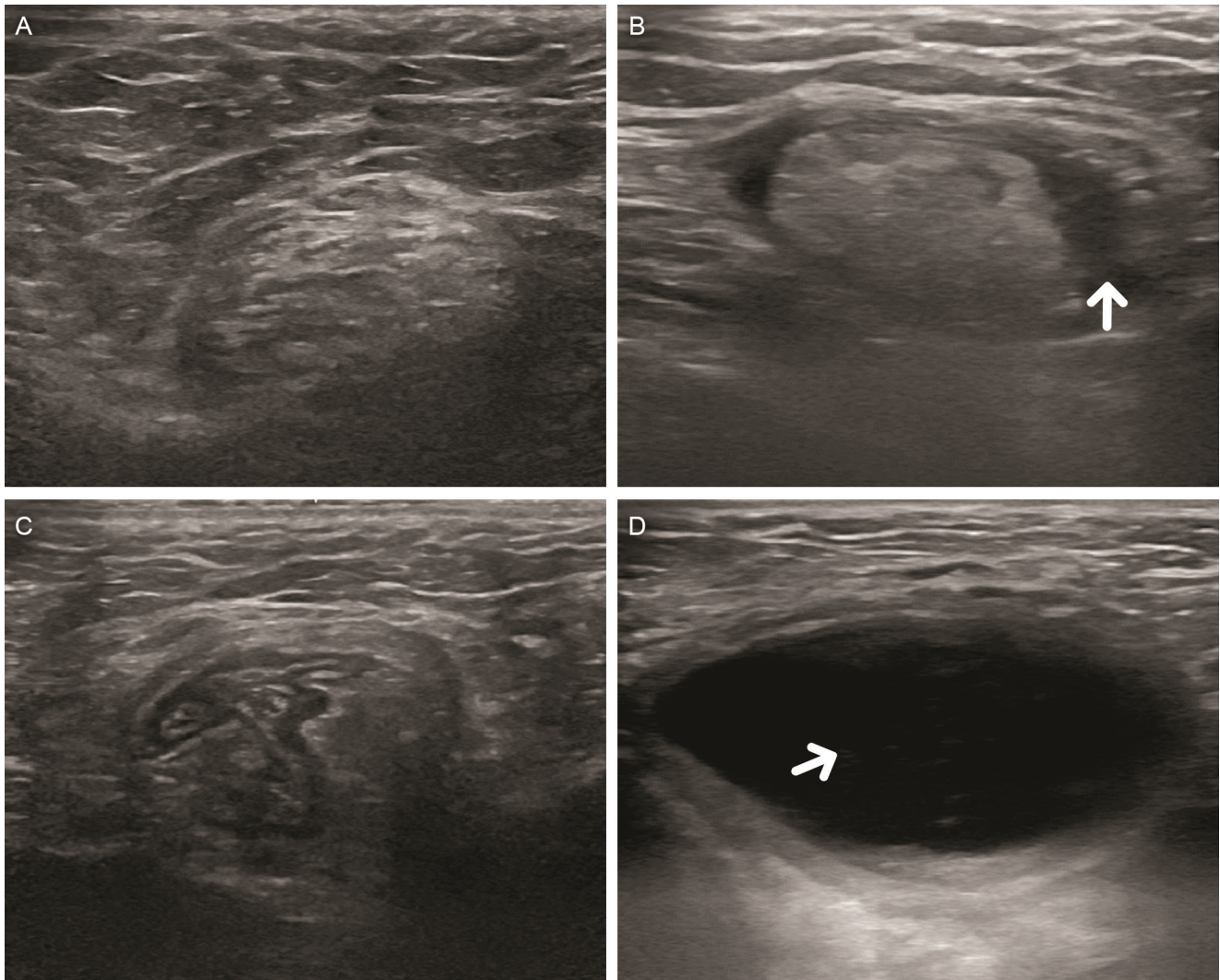


Figure 1. Ultrasonographic findings in a patient with an incarcerated inguinal hernia. (A) Omental prolapse. (B) Omental Incarceration. A hypoechoic fluid collection (white arrow) is seen around the incarcerated omentum, and the omentum appears as a hyperechoic shape. (C) Bowel Prolapse. (D) Fluid collection (white arrow) in the entrapped bowel loop.

resection.¹⁰ Several studies have shown favorable results using TAPP hernioplasty to treat acute IncIH.¹¹⁻¹³ However, the best surgical approach for chronic IncIH has not yet been elucidated. The purpose of this study was to evaluate the feasibility of TAPP hernioplasty to treat chronic IncIH, focusing on organ resection and safety.

MATERIALS AND METHODS

All procedures performed in studies involving human participants were in accordance with the ethical standards of our institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. This study was reviewed and approved by the Institutional Review Board.

This retrospective study included patients aged > 20 years who were treated for IncIH from January 1, 2015 to October 31, 2020. During this study period, 2,550 patients underwent hernioplasty for groin hernias. Of these

patients, 2,382 patients with reducible inguinal hernias and 14 patients with femoral hernias were excluded from this study. Therefore, 154 patients were analyzed. Incarceration was defined as an irreducible hernia; patients with self-reduction after anesthesia and hernia reduction through external manual pressure were excluded. Our institutional protocol was to perform TAPP hernioplasty for all inguinal hernias, including IncIH, unless there were specific contraindications. All patients with IncIH underwent TAPP hernioplasty during the study period. The patients were categorized into the acute IncIH group (20 patients) and the chronic IncIH group (134 patients). Chronic incarceration was defined as symptoms of irreducible scrotal or labial bulging persisting for more than 3 months, and the incarcerated organ was confirmed by ultrasonography (**Figure 1**). Patients with acute pain in whom an incarcerated intestinal loop or entrapped omentum was confirmed by ultrasonography underwent emergency surgery within 2 hours of the diagnosis of IncIH. The key point in surgery for acute IncIH was decompression of the entrapped bowel. If

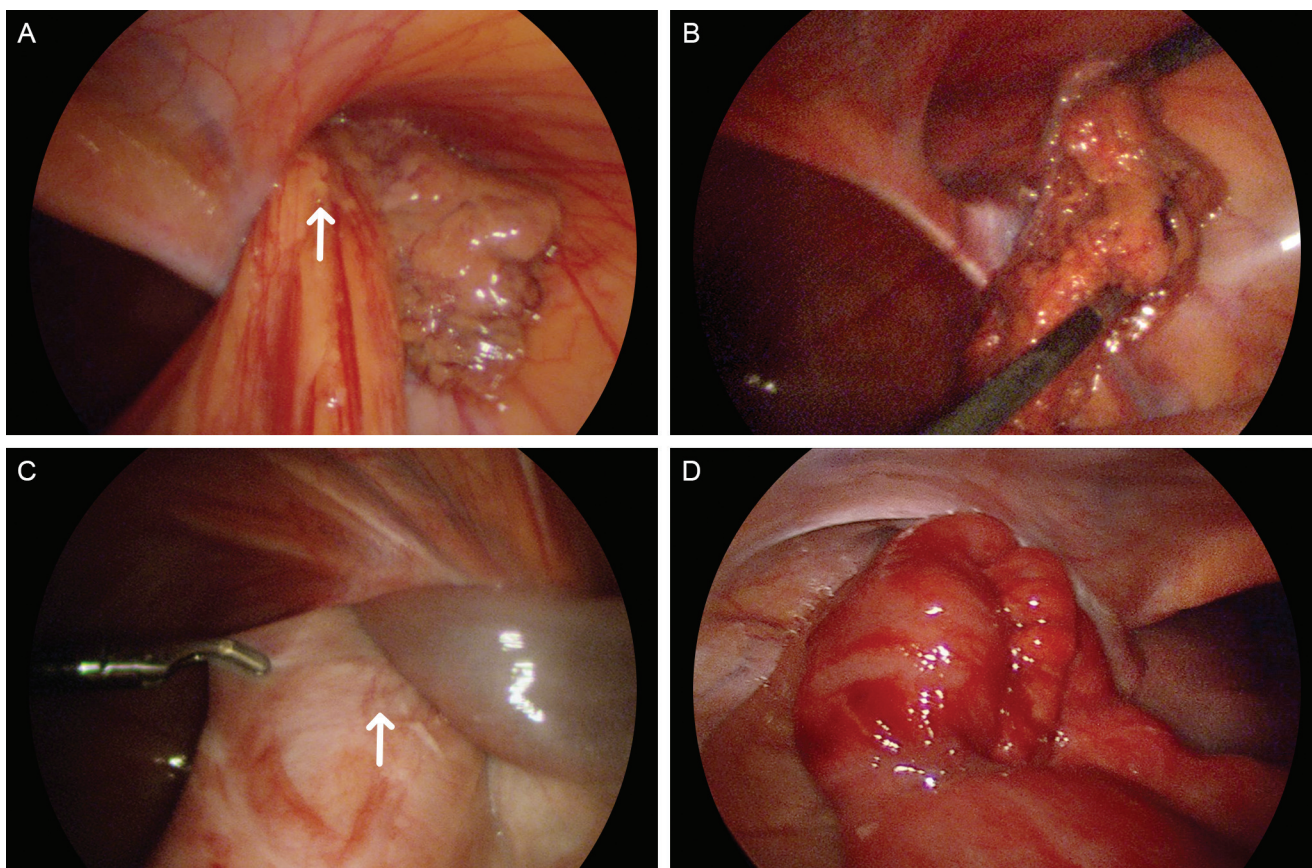


Figure 2. Confirmation of organ viability. (A) Omental incarceration (white arrow). (B) Intracorporeally reduced omentum. (C) Bowel incarceration (white arrow). (D) Intracorporeally reduced bowel.

there was no pain and the presence of an unstrangulated incarcerated organ was confirmed by ultrasonography, elective surgery was performed for chronic IncIH. The key points in surgery for chronic IncIH were adhesiolysis and reduction of the edematous organs. After intra-abdominal reduction (IAR), the viability of the reduced organ was confirmed (**Figure 2**).

Patients' characteristics, operative findings, and outcomes were obtained from the medical records and retrospectively reviewed. Each patient with bilateral symptoms was considered as one case. Recurrence was defined as the development of a hernia on the original symptomatic side after the first surgery, whereas a metachronous hernia was defined as the development of a hernia on the asymptomatic contralateral side after the first surgery.

Operative Procedure

All procedures were performed with the patient under general anesthesia in the supine position, and TAPP hernioplasty was performed using a three-port technique. The laparoscopic system comprised a 50.0-mm camera and 50.0-mm instruments. A 5-mm port was inserted through a transumbilical incision, and a 30-degree laparoscope was inserted after the establishment of carbon dioxide pneumoperitoneum. The intraabdominal pressure was maintained at 8 to 10 mmHg.

The incarcerated organs were identified and IAR was attempted (**Figure 3**). If en bloc reduction was difficult even without the presence of adhesion, a part of the incarcerated organ was pulled to create a space for reduction of the entire incarcerated organ. Otherwise, a peritoneal incision was created near the internal ring. If adhesion was present between the hernial sac and incarcerated organ, adhesiolysis was performed first.

If the reduction failed, partial omentectomy was performed (**Figure 4**). First, an ultrasonic scalpel was used to cut the omentum near the internal inguinal ring to divide the abdominal omentum from the incarcerated omentum located in the scrotum. Second, the separated omentum was removed through either the umbilical port site or the scrotal incision. This is because the presence of adhesion and fibrosis makes it difficult to remove the hernial sac by pulling it into the abdominal cavity. Third, the distal hernial sac was resected through a scrotal incision. Fourth, TAPP mesh implantation was performed. The mesh was covered with dissected peritoneum.

Because of the risk of mesh infection in patients undergoing bowel resection, intra-abdominal iliopubic tract repair was performed without mesh in these patients. However, TAPP repair was performed using mesh in patients undergoing omental resection.

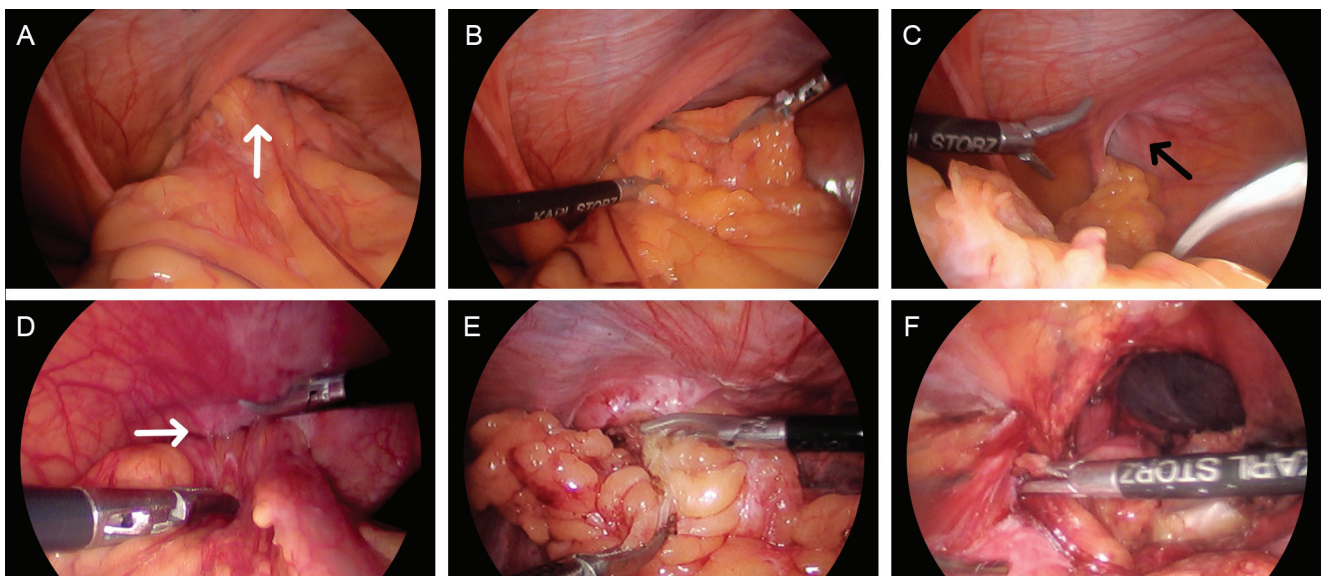


Figure 3. Procedures for intracorporeal reduction. (A) Incarcerated omentum (white arrow) in a patient with right indirect chronic incarcerated inguinal hernia. (B) No adhesion was observed, if en-bloc reduction was difficult, a part of the incarcerated organ was pulled to create a space to reduce the entire incarcerated organ. (C) Full reduction and internal ring (black arrow). (D) Adhesion (white arrow) between the incarcerated omentum and the internal inguinal ring in a patient with left indirect chronic incarcerated inguinal hernia. (E) If there was adhesion between the hernial sac and the incarcerated organ, adhesiolysis was performed using electrocautery. (F) Full reduction.

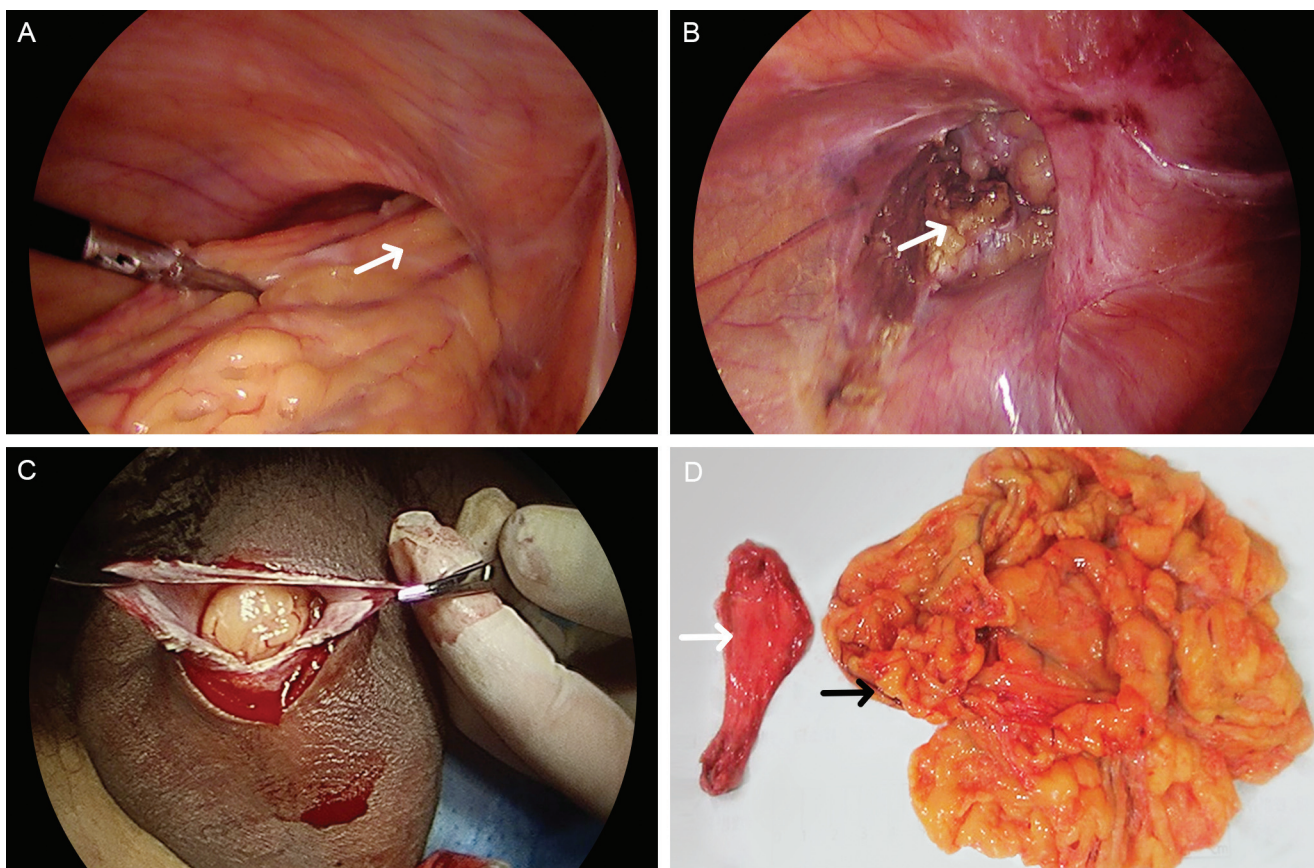


Figure 4. Partial omentectomy through a paramedian scrotal incision. (A) Laparoscopic view of incarcerated omentum (white arrow) in a patient with indirect chronic incarcerated inguinal hernia. (B) Omental excision (white arrow) at the level of the deep inguinal ring. (C) Scrotal paramedian incision. (D) Resected omentum (black arrow) and distal hernial sac (white arrow).

Statistical Analysis

All statistical analyses were performed using R software, version 30.60.1 (R Development Core Team, Vienna, Austria; <http://www.R-project.org>). Continuous variables are presented as mean \pm standard deviation (range), whereas categorical variables are presented as number and percentage. Wilcoxon's rank-sum test was used to examine the normality of the distribution of continuous variables. Fisher's exact test or the χ^2 test was used for categorical variables. Any univariate p value of ≤ 0.05 was considered statistically significant.

RESULTS

Among all patients treated for inguinal hernias during the study period, the prevalence of IncIH was 5.7% (154 of 2,536). **Table 1** shows the characteristics of the patients in the acute and chronic IncIH groups. The type

of incarcerated organ differed between the two groups; the most frequently incarcerated organ was the intestine in the acute IncIH group and the omentum in the chronic IncIH group ($P < .000$). Pre-operative inguinal pain was more common in the acute IncIH group than in the chronic IncIH group ($P < .000$). Adhesion between the incarcerated organ and hernial sac was more common in the chronic IncIH group than in the acute IncIH group ($P = .011$). Operation time was the duration from skin incision to skin closure (35.8 ± 10.5 minutes in the acute incarceration group and 46.9 ± 12.5 minutes in the chronic incarceration group). The mean follow-up period was 41.7 ± 19.4 months in the acute incarceration group and 42.8 ± 23.5 months in the chronic incarceration group. There was no recurrence in either group. A metachronous hernia occurred in two patients in the chronic IncIH group. The incidence of postoperative complications did not differ between the two groups.

Table 1.
Patients' Characteristics

	Acute Incarceration (n = 20 patients)	Chronic Incarceration (n = 134 Patients)	<i>p</i> -Value*
Age (year)	39.1 ± 14.3 (20 – 74)	37.8 ± 11.7 (20 – 69)	0.749
Sex			0.840
Male	20 (100%)	129 (96.3%)	
Female	0 (0.0%)	5 (3.7%)	
BMI	24.0 ± 2.7 (20.3 – 29.0)	23.5 ± 3.0 (19.8 – 39.3)	0.316
Laterality of symptom			0.774
Right	10 (50.0%)	76 (56.7%)	
Left	10 (50.0%)	57 (42.6%)	
Bilateral	0 (0.0%)	1 (0.7%)	
Hernia type			0.250
Indirect	18 (90.0%)	131 (97.8%)	
Direct	2 (10.0%)	3 (2.2%)	
Duration of hernia symptoms (year)	1.7 ± 0.9 (0.1 – 3.0)	5.4 ± 6.2 (1.2 – 30.0)	< 0.001
Duration of incarceration (month)	0.1 ± 0.4 (0.0 – 2.0)	8.5 ± 21.4 (3.0 – 240.0)	< 0.001
Preoperative inguinal pain	17 (85.0%)	4 (3.0%)	< 0.001
Incarcerated Organ			< 0.001
Intestine	17 (85.0%)	3 (2.2%)	
Omentum	3 (15.0%)	131 (97.8%)	
Adhesion between Incarcerated organ and hernial sac	1 (5.0%)	49 (36.6%)	0.011
Organ resection	1 (5.0%)	19 (14.2%)	0.434
Intestine	0	0	
Omentum	1	19	
Removal pathway of the transected omentum			
Port site	1	10	
Scrotal incision	0	9	
Operation time (min)	35.8 ± 10.5 (27 – 65)	46.9 ± 12.5 (30 – 80)	0.001
Intraoperative Complications	0 (0.0%)	2 (1.5%)	0.860
Bladder injury	0	0	
Injury of vas deferens or gonadal vessel	0	1	
Injury of inferior epigastric vessel	0	1	
Postoperative Complications	1 (5.0%)	5 (3.7%)	0.696
Hematoma	0	1	
Seroma	1	1	
Port site infection	0	1	
Mesh infection	0	0	
Atrophic testis	0	1	
Inguinodynia	0	1	

Table 1. Continued

	Acute Incarceration (n = 20 patients)	Chronic Incarceration (n = 134 Patients)	<i>p</i> -Value*
Recurrence	0 (0.0%)	0 (0.0%)	N/A
Metachronous contralateral hernia	0 (0.0%)	2 (1.5%)	1.000
F/U period (month)	41.7 ± 19.4 (8 – 71)	42.8 ± 23.5 (6 – 75)	0.755

Data are presented as mean (range), n (%), or n.

BMI, body mass index; F/U, follow-up.

*Most of the *p*-values represent comparisons of categorical variables, which were tested using the χ^2 test.

Continuous variables were tested using the Wilcoxon rank-sum test or t test.

Table 2 shows the operative outcomes of the patients in whom IAR was successful (IAR subgroup) and the patients who required omentectomy (omentectomy subgroup) within the chronic IncIH group. IAR was impossible in 19 of 134 patients. In 10 of 19 patients, the resected omentum was removed through the port site. In patients in whom hernial sac stretched to the scrotum and in whom there was omentum adhesion, a scrotal incision was performed because the resected omentum could not be reduced into the abdominal cavity. All male patients with an indirect hernia underwent partial omentectomy. The mean body mass index was higher in the omentectomy subgroup than in the IAR subgroup ($P = .003$). The mean duration of incarceration was longer in the omentectomy subgroup than in the IAR subgroup ($P < .000$). The resected omentum was edematous and congested in 17 patients and strangulated in 2 patients. Operative complications were more common in the omentectomy subgroup than in the IAR subgroup ($P < .000$).

DISCUSSION

Pain is probably the most common reason that patients seek medical consultation. Diseases that rapidly manifest as pain are treated in a timely fashion and often achieve good treatment results. In contrast, treatment is postponed for diseases that cause delayed pain, which may result in poor treatment results. An inguinal hernia has a risk of incarceration, and guidelines generally recommend surgical treatment as soon as possible.^{14,15} Many patients with acute IncIH who feel pain seek medical care immediately; however, if the pain is not severe, many patients do not seek medical treatment until after their condition has progressed to chronic IncIH with severe bulging. Therefore, compared with patients with acute IncIH, patients with chronic IncIH may have more severe adhesion between the incarcerated organ and

the hernial sac⁵ and more severe edema of the incarcerated organ, making reduction difficult.

An important point in the treatment of IncIH is to minimize organ resection by reducing the incarcerated organ. However, in the treatment of chronic IncIH, the two problems that must be resolved are the adhesion and the increased volume of the incarcerated organ caused by edema. In the present study, use of the TAPP approach reduced the need for organ resection by resolving these two problems in many patients with chronic IncIH. When adhesion was present in the proximal hernial sac, adhesiolysis was performed using an electrocautery device. In patients with edematous organs stuck in the narrow internal inguinal ring, reduction was often possible by partially pulling the organ into the abdominal cavity or by manipulating the organ via a peritoneal incision.

In the treatment of chronic IncIH, organ resection is considered when severe scrotal or labial enlargement is present. Therefore, it is considered necessary to perform surgery using an inguinal open approach that enables the surgeon to perform organ resection and hernial repair through the same incision.^{3,16} The reported incidence of reduction failure in laparoscopic surgery for hernial and organ resection ranges from 0% to 20%.¹⁷ In the present study, organ resection was performed in 14.2% (19/134) of patients with chronic IncIH and 5.0% (1/20) of patients with acute IncIH. A previous study showed that omental resection was required in 30% (6/20) of patients with chronic IncIH.¹³ Intra-abdominal anastomosis is possible in patients requiring bowel resection,^{18,19} and the resected omentum is easily removed through a scrotal incision in patients requiring omental resection.¹³ In the present study, all resected omentum was removed through a scrotal incision. No patient required conversion to an inguinal open approach. In other words, there was no need to use

Table 2.

Comparison of Characteristics and Operative Outcomes between the Intraabdominal Reduction Group and Organ Resection Group in 134 Chronic Incarcerated Inguinal Hernia Patients

	Intraabdominal Reduction (n = 115 patients)	Omentectomy (n = 19 patients)	<i>p</i> -Value*
Age (year)	37.8 ± 12.1 (20 – 69)	38.3 ± 8.7 (30 – 56)	0.519
Sex			0.785
Male	110 (95.7%)	19 (100.0%)	
Female	5 (4.3%)	0 (0.0%)	
BMI	23.2 ± 3.0 (19.7 – 39.3)	25.3 ± 2.3 (22.5 – 30.2)	0.003
Laterality of symptom			0.516
Right	63 (54.8%)	13 (68.4%)	
Left	51 (44.3%)	6 (31.6%)	
Bilateral	1 (0.9%)	0 (0.0%)	
Hernia type			1.000
Indirect	112 (97.4%)	19 (100.0%)	
Direct	3 (2.6%)	0 (0.0%)	
Duration of Incarceration (month)	5.7 ± 5.0 (3.0 – 24.0)	25.5 ± 53.5 (3.0 – 240.0)	< 0.001
Incarcerated Organ			1.000
Intestine	3 (2.6%)	0 (0.0%)	
Omentum	112 (97.4%)	19 (100.0%)	
Adhesion between Incarcerated organ and hernial sac	40 (34.8%)	9 (47.4%)	0.425
State of prolapsed organ			0.013
Edema and congestion	115 (100%)	17 (89.5%)	
Strangulation	0 (0.0%)	2 (10.5%)	
Operation time (min)	44.9 ± 11.8 (30 – 80)	58.8 ± 9.5 (42 – 70)	< 0.001
Complications	2 (1.7%)	5 (26.3%)	< 0.001
Injury of vas deferens or gonadal vessel	1	0	
Injury of inferior epigastric vessel	1	0	
Hematoma	0	1	
Seroma	0	1	
Port site infection	0	1	
Atrophic testis	0	1	
Inguinodynia	0	1	
F/U period (month)	42.8 ± 24.2 (6 – 75)	42.9 ± 19.0 (6 – 64)	0.826

Data are presented as mean (range), n (%), or n.

BMI, body mass index; F/U, follow-up.

*Most of the *p*-values represent comparisons of categorical variables, which were tested using the χ^2 test.

Continuous variables were tested using the Wilcoxon rank-sum test or t test.

the open approach for patients with chronic IncIH who required organ resection. Most previous studies have shown that bowel resection is commonly required in acute IncIH;^{9,20} however, in the present study, all organ resections were omentectomies, with no bowel

resections. We believe that successful IAR through adhesiolysis and organ pulling reduced the need for organ resection. That is, in the treatment of chronic IncIH, the important points are adhesiolysis and omental reduction rather than bowel resection.

In the present study, elective surgery was performed for patients with chronic IncIH without pain. IncIH with chronic symptoms is associated with increased risks of strangulation, organ edema, and adhesion between the hernial sac and incarcerated organs. Therefore, in patients with chronic omental incarceration, omentectomy may be necessary because of severe edema and adhesion to the distal end of the hernial sac caused by long-term incarceration. Many studies have focused on the treatment of acute IncIH, but few have focused on the treatment of chronic IncIH.

The risk of organ resection is lower in children because these cases are identified by parents who bring their children to the hospital immediately when critical organs, bowel, or ovaries are incarcerated.²¹ In adults, bowel-incarcerated inguinal hernias often cause pain, but patients with chronic omentum-incarcerated inguinal hernias rarely experience pain even if they experience discomfort due to bulging. Thus, adults sometimes do not present to the hospital until some time has passed after the onset of symptoms. In the present study, the average interval from the onset of initial hernia symptoms to surgery was 5.4 years in the chronic IncIH group and 1.7 years in the acute IncIH group. Patients with acute IncIH with pain require emergency surgery because of the high risk of bowel strangulation.⁶ In the present study, the prevalence of pre-operative pain was higher in the acute IncIH group (85.0%) than in the chronic IncIH group (3.0%). Acute IncIH can be diagnosed based on clinical symptoms and imaging studies, including ultrasonography. In the present study, all patients with acute IncIH were accurately diagnosed and underwent emergency surgery; all incarcerated bowels were preserved, although one patient required omentectomy.

This study had some limitations. First, our hospital is not a tertiary-care center; therefore, the number of patients with acute IncIH is likely to be low. Second, patients with risk factors identified in the preoperative patient consultations were referred to a tertiary center, which may have artificially lowered the postoperative mortality or morbidity rates in our study. Third, because this was a single-center retrospective study, the present findings require confirmation in a multicenter randomized controlled study.

CONCLUSION

The most important point in the treatment of chronic IncIH is to minimize organ resection. Even if organ resection is necessary, postoperative complications should be

minimized. In patients with chronic IncIH, TAPP hernioplasty enabled removal of the adhesion between the incarcerated organ and hernial sac; it also reduced the incidence of organ resection by enabling IAR in many patients. In patients with IAR failure, the resected omentum was easily removed through a scrotal incision. TAPP hernioplasty was a feasible and safe method in the treatment of chronic IncIH. Of course, in patients with IncIH, the performance of surgery as soon as possible reduces the incidence of organ resection.

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