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ORIGINAL ARTICLE

Observational Study

Pure laparoscopic hepatectomy as repeat surgery and repeat hepatectomy

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Abstract

AIM: To assess clinical outcomes of laparoscopic hepatectomy (LH) in patients with a history of upper abdominal surgery and repeat hepatectomy.

METHODS: This study compared the perioperative courses of patients receiving LH at our institution that had or had not previously undergone upper abdominal surgery. Of the 80 patients who underwent LH, 22 had prior abdominal surgeries, including hepatectomy (n = 12), pancreatectomy (n = 3), cholecystectomy and common bile duct excision (n = 1), splenectomy (n = 1), total gastrectomy (n = 1), colectomy with the involvement of transverse colon (n = 3), and extended hysterectomy with extensive lymph-node dissection up to the upper abdomen (n = 1). Clinical indicators including operating time, blood loss, hospital stay, and morbidity were compared among the groups.

RESULTS: Eighteen of the 22 patients who had undergone previous surgery had severe adhesions in the area around the liver. However, there were no conversions to laparotomy in this group. In the 58 patients without a history of upper abdominal surgery, the median operative time was 301 min and blood loss was 150 mL. In patients with upper abdominal surgical history or repeat hepatectomy, the operative times were 351 and 301 min, and blood loss was 100 and 50 mL, respectively. The median postoperative stay was 17, 13 and 12 d for patients with no history of upper abdominal surgery, patients with a history, and patients with repeat hepatectomy, respectively. There were five cases with complications in the group with no surgical history, compared to only one case in the group with a prior history. There were no statistically significant differences in the perioperative results between the groups with and without upper abdominal surgical history, or with repeat hepatectomy.

CONCLUSION: LH is feasible and safe in patients with a history of upper abdominal surgery or repeat hepatectomy.

Key words: Chronic liver disease; Laparoscopic hepatectomy; Liver tumor; Repeat hepatectomy; Surgical history

Core tip: The clinical outcomes of laparoscopic hepatectomy (LH) in patients with a history of upper abdominal surgery and repeat hepatectomy were evaluated. Of 80 patients who underwent pure LH, 22 had prior upper abdominal surgeries, and 12 underwent repeat hepatectomy. There were no conversions to laparotomy. There were no significant differences in operative time, blood loss, morbidity, or postoperative hospital stay between patients with and without prior abdominal surgery. LH with upper abdominal surgical history and repeat hepatectomy is feasible and safe for select patients.

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INTRODUCTION

The liver is the organ where most tumors metastasize, including colorectal, lung, breast, and ovarian cancers. Hepatic recurrence after previous resection of hepatocellular carcinoma (HCC) can also occur[1-3]. Therefore, conventional open surgery for hepatic resection is frequently performed in patients with a history of abdominal surgery[1-5]. Recently, laparoscopic procedures have been widely applied in various fields of surgery, and the number of favorable reports on laparoscopic hepatectomy (LH) is increasing[6-11]. However, there are still technical difficulties with LH related to liver mobilization, control of hemorrhaging, avoiding or repairing bile duct injuries, and vascular control. Moreover, surgeons need to contend with restricted manipulation, the lack of manual sensation, and disorientation from the lack of an overview[12,13]. Therefore, LH is typically only indicated for small and easily accessible lesions[7,14]. Indications for pure LH include HCC when there is an adequate hepatic reserve, metastatic liver tumors when there is no evidence of uncontrollable extrahepatic metastasis, and benign tumors when the diagnosis is uncertain or there are obvious symptoms.

An additional complication for LH is the presence of postoperative adhesions around the liver in patients who have had previous upper abdominal surgery. These adhesions and other postoperative changes can increase the risk of intraoperative bleeding and injury to vascular or biliary structures. Despite the increasing frequency of hepatectomy for patients with a history of abdominal surgical procedures, only a few reports of LH procedures for these patients are available[15-17]. Therefore, the purpose of this study was to assess the outcomes of LH for the patients with prior upper abdominal surgery and repeat hepatectomies.

MATERIALS AND METHODS

Patients and categorization

A total of 80 patients who underwent pure LH procedures at our hospital were included in this study. Patients undergoing hybrid procedures (LH combined with manipulation through a mini-laparotomy for reconstruction and other complicated procedures) for resection of hilar carcinoma, gallbladder carcinoma, or liver tumors with hepatic vein root involvement were excluded from this study. Lesions in all segments of the liver (segments 1-8) were included.

Patients were divided into groups based on the presence or absence of prior surgical history: no history (NH; $n = 58$) or upper abdominal surgical history (UASH; $n = 22$). Within the UASH group, a subgroup of patients was identified who had repeat hepatectomy (RH; $n = 12$). For these groups of patients, clinical indicators of perioperative course were retrospectively examined from medical records, including operative time, intraoperative blood loss, conversion to laparotomy, morbidity, and postoperative hospital stay. For patients in the UASH group, adhesions from previous surgery were evaluated by reviewing recorded video and graded according to Beck *et al*[18] mild adhesions were considered grade 1 (thin, filmy, and divided by blunt dissection) or grade 2 (thin, vascular, and easily divided by sharp dissection); severe adhesions were considered grade 3 (extensive, thick, and vascular, requiring division by sharp dissection) or grade 4 (dense, and the bowel is at risk of injury with division).

LH procedure

Patients were put in a supine to lateral position depending on the location of the tumor (left lateral position for tumors in the right dorsal liver). The first trocar was inserted at the umbilicus with an open method when the patient had no previous operative scar, otherwise the trocar was placed where adhesions were expected to be absent or minimal, while avoiding the previous incision site. After pneumoperitoneum (8 mmHg, occasionally increased up to 12 mmHg) was established through a 12-mm-port, a flexible laparoscope was introduced and then 3 to 4 additional trocars were inserted. When encountering adhesions that prevented adequate visualization, access to the operative field, and insertion of additional trocars, adhesiolysis was carefully performed with an electrocautery pen and ultrasonic shears. Intraoperative ultrasonography was routinely performed to assess the tumor conditions and determine the transection line. For the cases requiring anatomical

Table 1 Upper abdominal surgical histories

Surgical history		Procedure type	Adhesion
Hepatectomy (n = 12)	S4a56a resection, lymph node dissection	Laparoscopic	Severe
	Central bisectorectomy	Open	Severe
	S3 segmentectomy	Laparoscopic	Mild
	(3rd resection) S3 segmentectomy, Pt S5-6	Laparoscopic	Severe
	Pt S5 (severe cholecystitis)	Laparoscopic	Severe
	Extended posterior sectorectomy	Open	Severe
	(3rd resection) Lateral sectorectomy, S4b-8a resection	Open	Severe
	Pt S4 and S3	Open	Severe
	Anterior sectorectomy (distal gastrectomy)	Open	Severe
	Pt S6	Open	Severe
	Pt S6	Open	Severe
	S5 segmentectomy	Open	Severe
Pancreatectomy (n = 3)	Pancreatoduodenectomy	Open	Severe
	Distal pancreatectomy	Open	Severe
	Distal pancreatectomy	Open	Severe
Colectomy (involving transverse colon) (n = 3)		Open	Severe
		Laparoscopic	Mild
		Open	Severe
Common bile duct excision (n = 1)		Open	Severe
Splenectomy (n = 1)		Laparoscopic	Mild
Total gastrectomy (n = 1)		Laparoscopic	Mild
Extended hysterectomy[1] (n = 1)		Open	Severe

[1]Extended hysterectomy with extensive lymph node dissection up to the upper abdomen. The degree of adhesions was classified according to Beck *et al*[18] (mild = grade 1-2, severe = grade 3-4). Pt: Partial resection; S: Segment.

resection of one or more sectors, extrahepatic Glissonian pedicle encirclement/control and Pringle maneuvers were applied. The superficial hepatic parenchyma was transected using ultrasonic shears and the deeper portion of the parenchyma was transected using irrigation monopolar/bipolar cautery and a bipolar sealing device (BiClamp forceps, ERBE VIO System 200D, ERBE Elektromedizin GmbH, Tuebingen, Germany). A laparoscopic cavitron ultrasonic surgical aspirator was used for the portion of the parenchyma near the major vessels. After completing resection of the liver, the specimen was inserted into a protective plastic bag and extracted through the incision created by extending the port site. In the cases with an uncertain tumor location or uncontrollable bleeding, the operation was converted to a hand-assisted laparoscopic surgery or conventional open surgery.

Terminology

An upper abdominal surgery was defined as a distinct scar above the umbilicus[19] from which the operative procedure involved the subphrenic and subcostal area around the liver. If a laparoscopic procedure involved this area, it was defined as upper abdominal surgery regardless of port placements, including hepatectomy, biliary and pancreatic surgery, splenectomy, radical gastrectomy, colectomy with the involvement of transverse colon, and extended hysterectomy with extensive lymph node dissection up to upper abdomen. However, the patients with laparoscopic cholecystectomy were excluded due to mild adhesions that are usually observed. Colorectal cancer surgery was only included when the transverse colon was involved in the procedure.

Anatomical resection of the liver was defined as the procedure in which the Glissonian pedicle was divided at the root bifurcation and all the parenchyma related to the pedicle was resected. The nomenclature from the Brisbane 2000 Guidelines for liver anatomy and resection was used to describe the extent of the hepatic resection: major resection = hemihepatectomy and central bisectionectomy, as well as right posterior, anterior, and left median sectorectomies, which have cutting surfaces that are larger than that of a hemihepatectomy[11,20].

Statistical analysis

Groups were compared using Student's t, Fisher's exact and χ^2 tests with SPSS, version 11 statistical software (SPSS Inc., Chicago, IL, United States), with $P < 0.05$ indicating significance.

RESULTS

Characteristics of patients who underwent LH

The types of previous upper abdominal surgical procedures and extent of adhesions for each patient in the UASH group are given in Table 1. A subgroup of these patients underwent repeat hepatectomies, the details of which are presented in Table 2. Analysis of the three groups revealed that there were no differences with respect to age, sex, disease, tumor characteristics, or type of hepatectomy (Table 3).

Perioperative outcome

Although 81.8% (18/22) of UASH and 91.7% (11/12)

Table 2 Characteristics of the patients with repeat hepatectomies

Sex	Age	Cause for Hx	Method for diagnosis	Hx procedures	No. of tumors	Size of tumors (mm)	Child-Pugh class	Surgery interval (mo)	Adhesion grade	Operating time (min)	Bleeding (mL)	Hospital stay (d)
M	63	IPT	CT with contrast	Pt S4a5	1	20	A	12	3	540	100	30
F	71	HCC	CT with contrast	Pt S1 (3rd Hx)	1	8	A	22	4	216	0	9
M	74	Met	CT with contrast	Pt S5, S7	4	28	A	70	4	570	840	21
F	81	HCC	CT with contrast	Pt S2-3	1	18	A	87	4	104	5	12
F	69	HCC	CT with contrast	Pt S5-6	2	30	A	28	2	168	30	9
M	65	HCC	CT with contrast	Pt S1l	1	23	A	16	4	165	50	10
F	80	HCC	CT with contrast	S3 resection	1	18	B	46	4	224	50	13
M	60	HCC	CT with contrast	Pt S4	1	35	A	16	3	286	50	14
M	77	Met	CT with contrast	Pt S4 - 8	1	20	A	15	4	245	21	9
M	72	GBCa	Pathology from 1st Hx for IPT	S4a56a resection	1	60	A	0.5	4	488	143	24
M	57	HCC	CT with contrast	Pt S7, S2	2	21	A	32	4	388	50	10
M	67	HCC	CT with contrast	PtS8	1	11	A	97	3	432	365	14

Adhesion grades according to Beck *et al*[18]. CT: Computed tomography; GBCa: Gall bladder carcinoma; HCC: Hepatocellular carcinoma; Hx: Hepatectomy; IPT: Inflammatory pseudo-tumor; Met: Metastasis; Pt: Partial resection; S: Segment.

Table 3 Demographic factors and background diseases of the patients

Factor	NH (*n* = 58)	UASH (*n* = 22)	RH (*n* = 12)
Age, yr	70 (48-82)	68 (57-81)	70 (57-81)
Sex, male/female	34/24	12/10	8/4
Chronic liver disease, yes/no	37/21	11/11	7/5
Cause for hepatectomy			
Hepatocellular carcinoma	38	12	8
Metastasis	11	8	2
Others	9	2	2
Tumor			
n	1 (1-4)	1 (1-6)	1 (1-4)
Size (mm)	24 (7-107)	23 (8-60)	21 (8-60)
Type of LH procedure			
Major/minor	11/47	1/21	0/12
Anatomical/non-anatomical	23/35	6/16	2/10

Twelve patients in the RH group are also included in the UASH group. Values are expressed as median (range). Major resection: hemihepatectomy, central bisectionectomy, right posterior sectorectomy, right anterior sectorectomy and left median sectorectomy. Anatomical resection: the procedures in which the Glissonian pedicle was divided at the root in bifurcation and all the parenchyma related to the pedicle was resected. LH: Laparoscopic hepatectomy; NH: No history of upper abdominal surgery; RH: Repeat hepatectomy; UASH: Upper abdominal surgery history.

of RH patients had severe adhesions, there were no conversions to a laparotomy. However, there were two cases of conversion among the NH patients due to massive hemorrhage or difficulty of tumor identification. The median operative times did not differ among the groups (Table 4). Although the blood loss was reduced in the RH group, the difference was not statistically different. Seven patients in the NH group had complications, leading to a median hospital stay of 17 d, whereas only one UASH patient had leakage of pancreatic juice from the area around the pancreatico-jejunostomy, which recovered conservatively. However,

Table 4 Perioperative courses of the patients with laparoscopic liver resection

	NH (*n* = 58)	UASH (*n* = 22)	RH (*n* = 12)
Operative time (min)	301 (112-710)	351 (104-848)	301 (104-570)
Blood loss (mL)	150 (NC-3270)	100 (NC-3569)	50 (NC-840)
Conversion to laparotomy (*n*)	2	0	0
Morbidity (*n*)	7	1	0
Postoperative hospital stay (d)	17 (5-254[1])	14 (8-52)	12 (9-30)

Twelve patients in the RH group are also included in the group of UASH. Values are expressed as median (range). [1]Although this patient developed no complication directly related to operative manipulation during and immediately after surgery, her postoperative stay was extended due to uncontrollable massive ascites. NC: Small and non-countable; NH: No history of upper abdominal surgery; RH: Repeat hepatectomy; UASH: Upper abdominal surgery history.

Table 5 Perioperative courses of the patients with laparoscopic liver resection (excluding those with major hepatectomy)

	NH (*n* = 47)	UASH (*n* = 21)	RH (*n* = 12)
Operative time (min)	287 (112-696)	334 (104-682)	301 (104-570)
Blood loss (mL)	100 (NC-3270)	100 (NC-850)	50 (NC-840)
Conversion to laparotomy (*n*)	2	0	0
Morbidity (*n*)	5	1	0
Postoperative hospital stay (d)	17 (5-254[1])	13 (8-52)	12 (9-30)

Twelve patients in the RH group are also included in the group of UASH. Values are expressed as median (range). [1]Although this patient developed no complication related directly to operative manipulation during and immediately after surgery, her postoperative stay was extended due to uncontrollable massive ascites. NC: Small and non-countable; NH: No history of upper abdominal surgery; RH: Repeat hepatectomy; UASH: Upper abdominal surgery history.

Table 6 Summary of previous reports of laparoscopic repeat hepatectomy

Ref.	*n*	Age (yr)	Disease	First Hx (open/lap)	Procedure	Bleeding (mL)	Operating time (min)	Con. (*n*)	POHS (d)	Morbidity	Mortality
Nguyen *et al*[16]	2		Met								
Belli[1] *et al*[15]	12	69 (58-75)	HCC	4:8	LLS (*n* = 5), Pt (*n* = 4), Seg (*n* = 3)	297 ± 134 272.2 ± 120	114.4 ± 11.0 63.9 ± 13.3	1	7.4 ± 2.5 6.2 ± 3.0	26.6%	0%
Hu *et al*[28]	6	49 (46-61)	HCC	3:3 (Lap RFA, *n* = 2)	LLS (*n* = 2), Pt (*n* = 4)	283.3 ± 256.3	140.8 ± 35.7	0	5.67 ± 1.63	16.7%	0%
Shafaee *et al*[27]	76	61 (29-82)	Met (*n* = 63), HCC (*n* = 3), others (*n* = 10)	28:44	LLS (*n* = 4), Pt seg (*n* = 53), above-seg (*n* = 19)	300 (0-5000)	180 (80-570)	8	6 (2-42)	26%	0%
Ahn *et al*[17]	4	57 (54-60)	HCC (*n* = 3), Met (*n* =1)	0:4	LLS (*n* = 1), Pt (*n* = 3)	481.7 ± 449.5	312.3 ± 158.4	1	10.6 ± 7.4	23.4%	0%
Cannon *et al*[29]	17										
Tsuchiya *et al*[30]	3	73 (52-79)	HCC	0:3		281.3 (mean)	264.6 (mean)	0	8.6 (mean)		0%
Kanazawa *et al*[31]	20	70 (46-83)	HCC	15:5	Pt	78 (1-1500)	239 (69-658)	2 (HALS)	9 (5-22)	5%	0%
Montalti *et al*[32]	9		Met								
Present article	12	70 (57-81)	HCC (*n* = 8), Met (*n* = 2), others (*n* = 2)	8:4	Pt (*n* = 10), Subseg (*n* = 2)	50 (NC-840)	301 (104-570)	0	12 (9-30)	0%	0%

Data are expressed as median (range) or mean ± SD, unless stated otherwise. [1]In the paper from Belli, operating time, bleeding and POHS are described separately for patients whose previous hepatectomy was open (upper) or laparoscopic (lower). Con: Conversion to laparotomy; HALS: Hand-assisted laparoscopic surgery; HCC: Hepatocellular carcinoma; Hx: Hepatectomy; LAP: Laparoscopic; LLS: Left lateral sectorectomy; Met: Metastasis, NC: Small and non-countable; POHS: Postoperative hospital stay; Pt: Partial resection; RFA: Radiofrequency ablation; Seg: Segmentectomy; Subseg: Subsegmentectomy.

the morbidity and hospital durations did not differ among the groups, and there were no postoperative deaths.

Because the number of major hepatectomies in the UASH and RH groups was small, and these procedures often entail longer operative times, larger blood loss, and longer postoperative hospital stays, the results were re-analyzed after excluding these patients. No differences were observed in any of the parameters tested (Table 5).

DISCUSSION

Postoperative adhesions are known to increase the operative time of subsequent surgeries, due to the need for adhesiolysis and the risk of bowel injury[18]. Furthermore, there is an increased risk of intraoperative complications and conversion from laparoscopic procedures to laparotomy in patients with postoperative adhesions[21]. Indeed, a history of abdominal surgery was once considered a contraindication for laparoscopic surgery, though technical and instrumental improvements have allowed for laparoscopic procedures such as cholecystectomy, appendectomy, colectomy, and gastrectomy to be safely applied in these patients[18,22-25]. However, LH remains a technically demanding procedure. Resection of the liver parenchyma can be performed after completing adequate adhesiolysis and mobilization of the involved liver area. Fibrotic adhesions can hinder the visualization and dissection of the hepatoduodenal ligament and hilar area, which are often crucial steps in LH procedures. The liver capsule bleeds easily during adhesiolysis and mobilization, thus increasing blood loss and creating a suboptimal operative field[26].

The results of perioperative indicators are similar to previous reports[15-17,27-32], which are summarized in Table 6. However, patients in the present study had longer postoperative hospital stays, which was likely due to the higher age and poorer liver function of our patients, in addition to cultural and healthcare management differences. Importantly, the perioperative results were not significantly different between the groups with and without an upper abdominal surgical history, despite the high incidence of severe postoperative adhesions. The prevalence of severe adhesions in patients in the UASH group is consistent with the report by Ahn *et al*[17]. In their study, patients without a surgical history frequently had chronic liver disease, which can make transection of the liver parenchyma more difficult. Therefore, these challenges offset the complications caused by adhesions in the group with a surgical history, resulting in a lack of perioperative differences between the groups. In comparison, a larger proportion of our patients had chronic liver disease compared to their study, both in the NH group (60% *vs* 45%) and the UASH group (50% *vs* 9%). On the other hand, our study had a smaller proportion of patients who had undergone

major hepatectomy (15% *vs* 39%), with more anatomical resections (36%, mostly minor) due to chronic liver disease.

We previously reported that pure LH is useful for patients with severe liver dysfunction, as it minimizes the disturbance in liver-cirrhotic collateral blood/lymphatic flow caused by laparotomy and liver mobilization, as well as the mesenchymal injury caused by compression of the liver[33,34]. Pure LH, therefore, limits complications, such as massive ascites, which can lead to severe postoperative liver failure. In the present series, we found that the smaller working space required by LH allowed for minimal adhesion dissections and a direct tumor approach. We believe that this is one of the reasons why our patients with a surgical history, and with repeat hepatectomy, had similar perioperative results to the patients without a history. Although perioperative results are different with major hepatectomies (longer operative time and postoperative hospital stay, larger blood loss), inclusion of these few cases did not significantly alter the results between the groups. The majority of cases in previous reports and in the present series underwent partial hepatectomy as a repeat procedure, therefore alterations of hepatic parenchyma and intrahepatic anatomy from the first hepatectomy should be relatively small. Since alterations of hilar and intrahepatic vascular structures should greatly impact the second hepatectomy, further examination of major or anatomical repeat hepatectomies is needed. However, the results of the present study suggest that an advantage of pure laparoscopy for smaller repeat resections of impaired liver is the fact that the hepatectomy is facilitated by the minimal adhesiolysis required with a laparoscopic view and manipulation.

The perioperative morbidity and mortality with conventional open repeat hepatectomy are comparable to those with the first hepatectomy[2,35]. However, repeat LH has recently been safely applied to patients with recurrent HCC, and is recommended as a good alternative treatment option[15,27]. In our series, 12 repeat LH procedures, two of which were third hepatectomies, were performed for recurrent liver tumors without morbidity. Another treatment option involves a hybrid procedure with adhesiolysis through a previous mini-laparotomy, which may be effective for patients with massive adhesions and without any free space in the abdomen. We experienced one such case in our series in a patient with a history of severe acute pancreatitis caused by main pancreatic duct tumor embolus. He underwent adhesiolysis through a previous mini-laparotomy followed by the pure LH. In this operation, the magnified laparoscopic view facilitated the hepatectomy with minimal adhesiolysis and in the small working space.

In conclusion, this study demonstrates that pure LH in patients with a history of upper abdominal surgery is feasible and safe in select patients. Moreover, repeat hepatectomy can be facilitated with a laparoscopic approach, especially in patients with impaired liver function.

COMMENTS

Background

The liver is the most common site for tumor metastases from colorectal, lung, breast, and ovarian cancers, in addition to recurrence of hepatocellular carcinoma. Thus, hepatic resection is frequently performed in patients with a history of abdominal surgery. Recently, laparoscopic procedures have been widely applied in various surgical fields. However, despite the favorable results reported from laparoscopic hepatectomy (LH), technical difficulties still remain with this procedure. In addition, this procedure is complicated by adhesions at the area around the liver that occur in patients who have previously undergone upper abdominal surgery.

Research frontiers

Although the importance and application of hepatectomy for patients with a history of abdominal surgical procedures have increased, reports of the use of LH in such cases are limited. In this study, the outcomes of LH for the patients with prior upper abdominal surgery and of repeat hepatectomy in our series were evaluated and compared to those from patients without prior surgical histories.

Innovations and breakthroughs

This study demonstrates that pure LH as a repeat surgery and repeat hepatectomy is feasible and safe in select patients. Furthermore, this procedure facilitates repeat hepatectomy in patients with impaired liver function.

Applications

Pure LH as a repeat surgery and repeat hepatectomy is safely applicable to patients with liver metastasis from intra-abdominal organ malignancies, metachronous repeat hepatic tumors, or impaired liver function.

Terminology

Upper abdominal surgery was defined as an operative procedure involving the subphrenic and subcostal area around the liver, including hepatectomy, biliary and pancreatic surgery, splenectomy, radical gastrectomy, colectomy with the involvement of transverse colon, and extended hysterectomy with extensive lymph node dissection up to upper abdomen. Anatomical resection of the liver was defined as the procedure in which the Glissonian pedicle was divided at the root bifurcation and all the parenchyma related to the pedicle was resected. A major resection referred to hemihepatectomy, central bisectionectomy, and right posterior, anterior, and left median sectorectomies.

Peer review

The article is useful for surgeons, gastroenterologists, and oncologists and confirms the safety of laparoscopic hepatectomies in patients with previous abdominal surgeries. The number of analyzed patients was sufficient to allow a statistical analysis and to draw conclusions. The surgical technique, the results, and the statistical analysis are well presented.

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