



# Predictors of incisional hernia in adult liver transplant recipients

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## Abstract

**Purpose** Incisional hernia is a complication following abdominal operation. Patients undergoing liver transplantation have a high risk of developing incisional hernia because of immunosuppression. The purpose of this study was to evaluate incisional hernia after liver transplantation and to identify risk factors for hernia formation in those patients.

**Methods** We retrospectively reviewed 1044 adult patients with more than 2 years of follow-up in patients who underwent liver transplantation from January 2000 to December 2015.

**Results** Incisional hernia was identified in 79 patients with more than 2 years of follow-up. The overall incisional hernia rate was 7.6%. The mean age and body mass index (BMI) of the patients with incisional hernia were  $55 \pm 9$  years and  $25.3 \pm 3.7$  kg/m<sup>2</sup>, respectively. No significant differences in gender, diagnosis, diabetes, Child–Pugh score, model for end-stage liver disease (MELD) score, donor type, hepatorenal syndrome, varix bleeding, ascites, hepatic encephalopathy, ventilator use, spontaneous bacterial peritonitis (SBP), or bile leakage were found between patients who did and did not develop incisional hernia. Patients with acute rejection before hernia development were more to have herniated patients hernia ( $p < 0.05$ ).

**Conclusion** Age greater than 55 years and high BMI were significant risk factors. We identified risk factors for the development of incisional hernia. Based on these risk factors, attention should be paid to incisional hernia in older and obese patients.

**Keywords** Wound complication · Acute rejection · Body mass index · Elderly

## Abbreviations

BMI	Body mass index
CT	Computed tomography
DM	Diabetes mellitus
ICU	Intensive care unit
MELD	Model for end-stage liver disease
SBP	Spontaneous bacterial peritonitis

## Introduction

Incisional hernia is a complication after abdominal surgery, with a reported incidence of 4 to 20%. Obesity, older age, male sex, wound infection, steroids, ascites, smoking, malnutrition, diabetes, previous operation, emergency surgical procedures, and chronic pulmonary disease have been

described as risk factors for incisional hernia [1–3]. Liver transplantation patients have several risk factors for incisional hernia. Incisional hernia has been reported to occur in 4.9 to 34.3% of liver transplantation patients [4–7]. Hernia in patients who have undergone liver transplantation is likely due to postoperative immunosuppressant [8, 9]. Immunosuppressive agents interfere with the wound healing process compared to other abdominal operations. A previous study reported that older age, male sex, and increased steroid use were closely associated with incisional hernia [10]. However, most studies of incisional hernia have been performed in patients from Western countries. No studies based on Asian patient populations have been reported.

We performed this study to identify risk factors for incisional hernia after adult liver transplantation in a Korean population.

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## Materials and methods

We retrospectively reviewed the medical records of patients after adult liver transplantation from January 2000 to December 2015 in Samsung Medical Center, Seoul, Korea. Patients who died within 2 years after transplantation, re-transplant patients, and foreigners were excluded. The following patient characteristics and clinical data were recorded to determine potential risk factors for the development of incisional hernia: demographics [i.e., age, sex, body mass index (BMI), and age], preoperative comorbidities associated with impaired wound healing or incisional hernia [i.e., diabetes mellitus (DM), preoperative immunosuppressive therapy, and smoking], and perioperative data [i.e., deceased or living donor, and model for end-stage liver disease (MELD) score]. Incisional hernias at any site other than the transplant incision, stoma hernia, internal hernias, and umbilical hernias were excluded. This study protocol was reviewed and approved by the Institution's Review Board of Samsung Medical Center, Sungkyunkwan University School of Medicine (IRB no. 2018-05-086).

All liver transplantations were performed through a bilateral subcostal incision with midline extension. The fascia was closed with a posterior and an anterior row of running sutures using 1–0 monofilament. And 1–0 polyfilament is used as an interrupted suture to prevent any loosening between 1 and 0 monofilament running sutures and to reinforce the incision end.

Maintenance immunosuppressive therapy was introduced in a prior study [11]. Methylprednisolone 500 mg was administered intravenously during surgery and withdrawn three months after transplantation. The optimal blood level of tacrolimus was adjusted to maintain a trough plasma concentration of 10 ng/mL during the first month (reduced to 5–8 ng/mL after the first month). 500–750 mg MMF was administered twice per day. No patients took sirolimus during this period.

After discharge, patients were regularly followed at the outpatient clinic. Post-transplant follow-up was continued for more 2 years until death or current status. Incisional hernias were identified by physical examination during clinic visits or occasionally by computed tomography (CT) scan.

Mann–Whitney U test was used to analyze continuous variables, and Chi square test or Fisher's exact test was used to analyze categorical variables. We analyzed the risk factors associated with incisional hernia by univariate and multivariate logistic regression analyses. Statistical analyses were performed using SPSS for Windows, version 22.0 software package (SPSS Inc, Chicago, IL, USA), and a *p* value less than 0.05 was considered statistically significant.

## Results

Liver transplantation was performed in 1,044 adult patients with more than 2 years of follow-up, 79 of who developed incisional hernia and were included in the analysis. Preoperative demographics are shown in Table 1. The rate of incisional hernia formation was 7.6% (*n* = 79). Mean age at transplantation for the incisional hernia group was  $55 \pm 9$  years and 78.5% were men. Mean BMI was  $25.3 \pm 3.7$  kg/m<sup>2</sup>. Of the total patients, 857 (82.1%) transplantations were living-related transplantations, whereas 187 (17.9%) grafts were from deceased donors. The incidence of incisional hernia among those patients who underwent living donor liver transplantation was not significantly different from patients who underwent deceased donor liver transplantation (8.2% vs. 4.8%, respectively; *p* = 0.116). Hepatocellular carcinoma was the main diagnosis for liver transplantation in both groups (48.8% vs. 53.2%). Age, BMI, and hypertension were associated with hernia formation in univariate analysis (*p* < 0.05). Sex, DM, etiology, Child–Pugh score, MELD score, donor type, hepatorenal syndrome, varix bleeding, ascites, hepatic encephalopathy, spontaneous bacterial peritonitis, and ventilator care in the pre-transplant were not predisposing factors for hernia formation.

Survival was 86.8% and mortality was 13.2% (906 vs. 138) among all patients. The mortality difference between the two groups was not statistically significant (13.3% vs. 12.7%, respectively; *p* = 0.878). Postoperative characteristics of patients with and without incisional hernia are provided in Table 2. Acute rejection before hernia was statistically significant for the development of incisional hernia after liver transplantation (*p* < 0.05). No significant differences in bile leakage, reoperation, post-transplant bleeding/hematoma, post-transplant fluid collection, hernia operation, post-transplant ICU stay, or hospitalization were observed between patients who did and did not develop incisional hernia. When we corrected for possible confounding variables on multivariate analysis, recipient age > 55 years [odds ratio (OR), 2.501; 95% confidence interval (CI) 1.515–4.128, *p* < 0.001] and high BMI (OR = 1.087, 95% CI 1.018–1.161, *p* = 0.013) were independent significant risk factors for incisional hernia after liver transplantation.

## Discussion

Incisional hernia is a potential complication associated with abdominal operation, and risk factors include patient- and surgeon-related variables. The incidence in the present study was 7.6% among the liver transplant recipients, which is similar to the incidence of hernia formation after laparotomy for other indications [2, 3].

**Table 1** Comparison of preoperative characteristics between liver transplant recipients who did and did not develop incisional hernia

	Without hernia ( <i>n</i> = 965, 92.4%)	With hernia ( <i>n</i> = 79, 7.6%)	<i>P</i> value
Age (years)	52 ± 9	55 ± 9	< 0.001
Sex ( <i>n</i> , %)			0.671
Male	737 (76.4)	62 (78.5)	
Female	228 (23.6)	17 (21.5)	
BMI (kg/m <sup>2</sup> )	24.3 ± 3.4	25.3 ± 3.7	0.016
Etiology ( <i>n</i> , %)			0.356
HCC	471 (48.8)	42 (53.2)	
HBV	308 (31.9)	26 (32.9)	
HCV	21 (2.2)	1 (1.3)	
NBNC	18 (1.9)	0 (0)	
HBV, HCV	6 (0.6)	0 (0)	
HAV	7 (0.7)	0 (0)	
Alcohol	65 (6.7)	8 (10.1)	
Toxic	25 (2.6)	0 (0)	
Autoimmune	29 (3.0)	0 (0)	
Wilson	6 (0.6)	0 (0)	
Others	9 (0.9)	2 (2.5)	
Child–Pugh class ( <i>n</i> , %)			0.728
A	157 (16.3)	12 (15.2)	
B	312 (32.3)	29 (36.7)	
C	496 (51.4)	38 (48.1)	
MELD score	20 ± 11	20 ± 11	0.938
Type ( <i>n</i> , %)			0.116
Living donor	787 (81.6)	70 (88.6)	
Deceased donor	178 (18.4)	9 (11.4)	
Hypertension ( <i>n</i> , %)	95 (9.8)	14 (17.7)	0.028
Diabetes ( <i>n</i> , %)	189 (19.6)	13 (16.5)	0.498
Ascites ( <i>n</i> , %)	656 (68.0)	51 (64.5)	0.070
Spontaneous bacterial peritonitis ( <i>n</i> , %)	133 (13.8)	6 (7.6)	0.120
Hepatorenal syndrome ( <i>n</i> , %)	61 (6.3)	4 (5.0)	0.738
Varix bleeding ( <i>n</i> , %)	226 (23.4)	11 (13.9)	0.146
Hepatic encephalopathy ( <i>n</i> , %)	255 (26.5)	19 (24.1)	0.526
Ventilator care pre-transplant ( <i>n</i> , %)	33 (3.4)	3 (3.8)	0.860

*BMI* body mass index, *MELD* model for end-stage liver disease, *ICU* intensive care unit

**Table 2** Comparison of postoperative outcomes and complications between liver transplant recipients who did and did not develop incisional hernia

	Without hernia ( <i>n</i> , %)	With hernia ( <i>n</i> , %)	<i>P</i> value
Bile leakage ( <i>n</i> , %)	57 (5.9)	8 (10.1)	0.136
Reoperation ( <i>n</i> , %)	31 (3.2)	5 (6.3)	0.144
Post-transplant ascites ( <i>n</i> , %)	48 (5.0)	0 (0)	0.042
Post-transplant bleeding/hematoma ( <i>n</i> , %)	30 (3.1)	5 (6.3)	0.126
Post-transplant fluid collection ( <i>n</i> , %)	10 (1.0)	1 (1.3)	0.848
Acute rejection before hernia ( <i>n</i> , %)	0 (0)	9 (11.4)	< 0.001
Hernia operation ( <i>n</i> , %)	14 (1.5)	3 (3.8)	0.113
Post-transplant ICU stay (day)	9 ± 7	10 ± 7	0.723
Hospitalization (day)	39 ± 27	42 ± 25	0.115
Follow-up period (month)	94 ± 50	82 ± 40	0.064
Mortality ( <i>n</i> , %)	128 (13.3)	10 (12.7)	0.878

Other studies have identified the following risk factors for incisional hernia after liver transplantation: acute rejection with steroid bolus therapy, low platelet count after transplantation, bilateral subcostal incision with midline extension, muscle wasting, virus-correlated cirrhosis, BMI > 25, severe ascites, wound infection, and possibly immunosuppression [6, 12, 13]. The present study describes risk factors for the development of incisional hernia after liver transplantation. Incisional hernia was more common in patients who were older than 55 years or had high BMI.

Life expectancy is increasing due to recent improvements in early diagnosis and a well-developed mass-screening program. There has been a steady increase in the age of potential recipients for liver transplantation and 75% of patients on the waiting list for liver transplantation in the United States are older than 50 years. Previous studies have shown that elderly people have more risk factors for incisional hernia [14]. Although the criteria for age are different, the average age of patients in one American center with an annual abdominal operation of total 5 million, incisional hernia rate of 11–23%, and annual incisional hernia treatment of 400,000 is 50 years. The risk factors they present are diabetes, obesity, lung disease, smoking, wound infections, and steroids treatment. In addition to age, many people with these risk factors are more likely to have liver transplant recipients, so more attention should be paid to the wound closure of elderly patients undergoing liver transplantation.

Our study suggests that the incidence of incisional hernia is associated with a low incidence in the range of incidence rates reported in previous studies. This is because the average BMI of Korea is lower than that of Western countries [15]. However, it was shown that incisional hernia is more common in high BMI as demonstrated in our study, and BMI should be noted as an independent risk factor for incisional hernia [16, 17]. As suggested by many previous studies, obesity is a risk factor for herniation. The relationship between obesity and hernia might be related to an increase in abdominal pressure that exerts mechanical stress on the incision site. In addition, patients who require liver transplantation often suffer from DM. If an obese diabetic patient receives liver transplantation, his or her risk of incisional hernia is much higher than that of a normal weight non-diabetic patient. Preoperative weight loss in obese patients can prevent diabetes and improve graft function, as well as prevent postoperative complications such as incisional hernias. These obese patients need a mid- to long-term strategy to survive and live with good results. As a surgical strategy, bariatric surgery may be considered at the same time. However, surgery alone can provide good results in the short term, but obesity may not improve in the long term. In our liver transplant center, we have a nutritional support team composed of surgeons, nutritionist, rehabilitation doctors, pharmacists and others.

When a transplant patient is registered, nutritional status is assessed and supported prior to liver transplantation, and nutrition and rehabilitation therapy are managed periodically until the first year after transplantation.

In our study, acute rejection was found to be associated only with incisional hernia on univariate analysis. However, a German study in 2002 identified acute rejection with affiliated steroid bolus therapy as a risk factor [12]. In other studies, steroids have been implicated as a risk factor for incisional herniation [10]. With further confirmatory studies of steroid therapy associated with acute rejection, an association with incisional hernia may be found.

The present study had some limitations, most of which are attributable to the retrospective design of the study. All data were from a single institution and might not be broadly generalizable. Although this study reports our experience with incisional hernia at a large transplant center, the true incidence of incisional hernia after liver transplantation is not known because some patients with incisional hernia remained undiagnosed during the study interval [7]. Because the diagnosis of incisional hernia is made clinically based on patient self-report, and radiography is not a standard procedure, the number of incisional hernias could have been underestimated. One study suggested that an independent risk factor for development of incisional hernia was surgical site infection [9]. However, we did not include surgical site infection as a wound complication because this cannot be distinguished from mild to fully infected abscess presentation, which could potentially have affected our findings. Although smoking may be important as a risk factor, we cannot analyze it because there is not enough data on smoking.

In conclusion, we found that incidence of incisional hernia was 7.6% in adult liver transplant recipients. We found that age greater than 55 and high BMI was significant risk factors for incisional hernia formation following liver transplantation on multivariate analysis. In elderly and obese patients, risk of incisional hernias should be considered during operation and careful observation is needed during the follow-up period. During the study period at our institution, incisional hernias were repaired using primary fascial closure or by mesh reinforcement with an open technique or laparoscopic herniorrhaphy. Based on experience with multiple institutions with incisional hernia repair after liver transplantation, further study is required to determine optimal hernia repair.

**Author contributions** JSL participated in the design of the study and drafting the manuscript. JMK participated in the design of the study and drafting the manuscript. KSK contributed to data acquisition and analysis. GSC contributed to data acquisition and analysis. JWJ contributed to the design of the study and the manuscript revision. SKL contributed to the design of the study and the manuscript revision.

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## Compliance with ethical standards

**Conflict of interest** JSL, JMK, KSK, GSC, JWJ and SKL declare that they have no conflict of interest.

**Ethical approval** This study protocol was reviewed and approved by the Institution's Review Board of Samsung Medical Center, Sungkyunkwan University School of Medicine (IRB no. 2018-05-086).

**Human and animal rights** This article is a review of database already collected and does not include research directly related to human or animal participation.

**Informed consent** For this study, formal consent was not necessary.

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