Evaluation of Surgical Site Infection Rate Following Hepatectomy at the 108 Military Central Hospital

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Summary

Objective: To evaluate the incidence of surgical site infection (SSI) following hepatectomy at the 108 Military Central Hospital and identify associated risk factors. *Subject and method:* A retrospective study was conducted on 372 patients who underwent hepatectomy in 2024. Patients were classified into laparoscopic and open surgery groups. Data collected included clinical characteristics, surgical type, blood transfusion, drain placement, length of hospital stay, and postoperative complications. Statistical analyses, including logistic regression, were performed to identify independent risk factors for SSI. *Result:* The overall SSI rate was 3.5%. The laparoscopic group had a significantly lower SSI rate compared to the open group (1.9% vs. 5.7%; $p<0.05$). Multivariate logistic regression revealed that open surgery (OR = 2.9; $p=0.021$), postoperative blood transfusion (OR = 4.5; $p=0.008$), and drain placement (OR = 2.6; $p=0.037$) were independent risk factors for SSI. *Conclusion:* Laparoscopic hepatectomy was associated with a lower risk of SSI, reduced transfusion rates, and shorter postoperative hospitalization. Broader application of this technique should be considered. Further prospective multicenter studies are needed to validate these findings.

Keywords: laparoscopic hepatectomy, open surgery, surgical site infection, drain placement, blood transfusion.

I. BACKGROUND

Liver resection is a primary treatment modality for various hepatic diseases such as hepatocellular carcinoma, liver metastases, cholangiocarcinoma, and certain complex benign liver lesions. In the context of increasing liver cancer incidence in Asia especially in countries with high hepatitis virus prevalence like Vietnam the role of liver surgery is increasingly recognized as part of a curative treatment strategy [1,2].

However, due to the liver's complex anatomy, including an intricate vascular and biliary network, along with underlying liver conditions such as cirrhosis, postoperative complication rates remain high. Among these, surgical site infection (SSI) is a common complication that prolongs hospital stay, increases treatment costs, and elevates early postoperative mortality risk [3,4].

With advancements in imaging technology and surgical instrumentation, laparoscopic liver resection (LLR) has significantly progressed since the 1990s. According to the 2nd International Consensus Conference on Laparoscopic Liver Surgery (ICLLS 2014), LLR is considered safe and feasible, even in complex cases [2]. Several studies from Japan, South Korea, and Europe have demonstrated the advantages of LLR in reducing pain, blood loss, and hospital stay, and particularly in lowering SSI rates compared to open liver resection (OLR) [3-5].

In Vietnam, studies evaluating the role of LLR in preventing SSIs are still limited. The clinical practice context, surgical indications, and infection control conditions in local hospitals may differ from those in

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international centers. Therefore, this study was conducted to assess the rate of SSI following hepatectomy at the 108 Military Central Hospital and to identify related risk factors in clinical practice, thereby proposing solutions to improve the safety and effectiveness of liver resection.

II. SUBJECTS AND METHOD

2.1. Study Population

This retrospective study included 372 patients who underwent hepatectomy at the 108 Military Central Hospital from January to December 2024. Patients were divided into two groups: the laparoscopic surgery group (n = 215) and the open surgery group (n = 157). Data were collected from electronic medical records.

2.2. Inclusion and Exclusion Criteria

Inclusion criteria: Patients over 18 years of age with an indication for hepatectomy.

Exclusion criteria: Patients who underwent combined multiorgan resection or had incomplete postoperative data.

2.3. Study Variables

Primary outcome (dependent variable): Surgical site infection (SSI), defined according to the United States Centers for Disease Control and Prevention (CDC/NHSN 2021) [5], including superficial incisional SSI, deep incisional SSI, and organ/space SSI.

Independent variables: Gender, age, body mass index (BMI), comorbidities (e.g., cirrhosis, diabetes mellitus, hypertension), type of surgery (laparoscopic/open; major/minor hepatectomy), operative time, intraoperative blood loss, blood transfusion (intra- and postoperative), use of abdominal drainage, length of hospital stay, duration of drain placement, and other postoperative complications. Major hepatectomy was defined as resection of three or more liver segments according to Couinaud's classification [12].

2.4. Data Analysis

Data were analyzed using SPSS statistical software. Categorical variables were compared using the Chi-square test, and continuous variables were compared using the Mann-Whitney U test. Multivariate logistic regression analysis was performed to identify independent risk factors for SSI. Variables with $p<0.1$ in univariate analysis were selected for inclusion in the multivariate model. A p-value of < 0.05 was considered statistically significant.

III. RESULT

3.1. Patient Characteristics

Table 1. Patient Characteristics

Characteristic	Value
Number of patients (n)	372
Mean age (± SD)	58.6 ± 11.3 years
Gender (Male/Female) (n, %)	267 (71.8%) 105 (28.2%)
Underweight (BMI) (n, %)	20 (5.4%)
Normal BMI (n, %)	212 (57%)
Overweight (BMI) (n, %)	140 (37.6%)
Cirrhosis (n, %)	181 (48.7%)
Hypertension (n, %)	79 (21.2%)
Diabetes mellitus (n, %)	52 (14%)
Hepatitis B (HBV) infection	193 (51.9%)
Postoperative mortality (n, %)	3 (0.8%)

The study cohort was predominantly male (71.8%) with a mean age of 58.6 ± 11.3 years. Nearly half of the patients had cirrhosis (48.7%), and more than 50% were positive for hepatitis B. The postoperative mortality rate was very low (0.8%).

3.2. Surgical Group Characteristics

Table 2. Comparison Between Laparoscopic (LLR) and Open (OLR) Groups

Variable	LLR (n = 215)	OLR (n = 157)	p-value
Major hepatectomy rate (%)	33.3%	41.4%	0.12
Operative time (min ± SD)	215 ± 47	198 ± 53	0.03*
Postoperative transfusion (%)	1.9%	4.5%	0.018*
Drain placement (%)	42.3%	47.8%	0.22

The LLR group had a longer operative time but significantly lower postoperative transfusion rate compared to the OLR group. There were no significant differences in major hepatectomy rate or drain placement between the two groups.

3.3. Surgical Site Infection (SSI)

Table 3. Categorical Risk Factors for SSI

Risk Factor	SSI Rate	p-value
Surgical approach (n, %)		
Open	9 (5.7%)	0.045
Laparoscopic	4 (1.9%)	
Diagnosis (n,%)		0.01
Hepatocellular carcinoma	4 (2.5%)	
Benign liver disease	3 (1.9%)	
Cholangiocarcinoma	4 (0.6%)	
Liver metastases	2 (0.6%)	
Gallbladder cancer	0 (0%)	
Surgical history (n, %)		0.02
Yes	9 (7.9%)	
No	4 (1.6%)	
Postoperative transfusion (n, %)		0.005
Yes	3 (27.3%)	
No	10 (2.8%)	
Drain placement (n, %)		0.06
Yes	9 (5.5%)	
No	4 (1.9%)	

Open surgery, prior abdominal surgery, postoperative transfusion, and drain placement were associated with increased risk of SSI. Notably, the infection rate was 27.3% among those who received postoperative transfusions.

Table 4. Quantitative Factors Associated with SSI

Variable	No SSI (n = 359)	SSI (n = 13)	Total (n = 372)	p-value
Preoperative hospital days	3.6 ± 2.9	5.4 ± 4	3.7 ± 3	0.031
Postoperative hospital days	7.6 ± 3.1	18.9 ± 10.7	8 ± 4.2	<0.001
Intraoperative blood loss (mL)	195.5 ± 152.3	239.8 ± 189.5	197 ± 153.7	0.308
Operative time (min)	138.9 ± 34	160 ± 45.3	139.6 ± 34.6	0.031
Drain duration (days)	5.5 ± 2.6 (n=135)	11.2 ± 8.5 (n=5)	5.7 ± 3.1 (n=140)	<0.001

The SSI group had longer operative times, prolonged drain duration, and longer hospital stays both before and after surgery. This indicates that SSIs significantly delay recovery and increase treatment burden.

Table 5. Classification of SSIs (CDC Guidelines)

Type of SSI	Number of Patients (n)
Superficial incisional	10 (76.9%)
Deep incisional	2 (15.4%)
Organ/space	1 (7.7%)
Total	***13 (100%)***

The majority of SSIs were superficial (76.9%), while deep and organ/space infections were less common. This suggests that most infections can be managed effectively with early detection and appropriate treatment.

IV. DISCUSSION

This study involving 372 patients demonstrated that laparoscopic liver resection (LLR) significantly reduces the incidence of surgical site infections (SSIs) compared to open liver resection (OLR), with a statistically significant difference (1.9% vs. 5.7%; p=0.045). Additionally, other independent risk factors such as postoperative blood transfusion and abdominal drain placement were also significantly associated with an increased risk of SSI. These findings are not only clinically relevant but also add further evidence supporting the global trend toward wider adoption of LLR.

The results are consistent with those reported by other authors. For example, Maeda et al (2025) in Japan reported SSI rates of 1.1% in the LLR group and 7.4% in the OLR group [1]. Similarly, a study by Montalti et al. (2020) involving 1,282 patients in Europe also showed significantly lower SSI rates with LLR [6]. Lee et al (2019) in Korea reported SSI rates of 2.1% with LLR and 6.8% with OLR [7]. A meta-analysis by Ciria et al. (2016) including over 9,000 cases from 245 studies confirmed the advantages of LLR in reducing SSIs, blood loss, and hospital stay duration [8].

Several mechanisms may explain the reduced SSI rate with LLR: Smaller incisions, minimal soft tissue manipulation, preservation of liver microcirculation, limited exposure to ambient air, and a reduced need for drain placement. The minimization of unnecessary drains during LLR, as emphasized by Sugimoto et al (2022), plays a key role in reducing infection risks [9]. In our study, abdominal drainage approached statistical significance as a risk factor for SSI (p=0.06), suggesting that its routine use should be carefully reconsidered. Based on our findings, we recommend that abdominal drainage should not be used routinely after hepatectomy. Instead, it should be selectively applied in patients at high risk of postoperative bleeding or bile leakage, such as those with cirrhosis, difficult resections, or intraoperative complications. This approach may help reduce unnecessary SSI risks while ensuring patient safety.

Regarding postoperative transfusion, multivariate analysis identified it as an independent risk factor for SSI (p=0.005). The underlying mechanism may involve transient immunosuppression and altered inflammatory responses following transfusion, as described by Beretvas and Takahashi [4,5]. The LLR group had a significantly lower transfusion rate than the OLR group (1.9% vs. 4.5%, p=0.018), highlighting another physiological advantage of laparoscopic techniques.

The study also found that longer operative times were associated with increased SSI risk (p=0.031), consistent with previous studies [1,9]. Prolonged surgeries may increase infection risk due to longer tissue exposure to air, surgical stress, and the likelihood of hypothermia. Additionally, the SSI group had significantly longer drain duration (11.2 ± 8.5 days vs. 5.5 ± 2.6 days; p<0.001), emphasizing the importance of careful drain management in preventing postoperative complications.

Although the mean intraoperative blood loss was higher in the SSI group (239.8 ± 189.5mL) compared to the non-SSI group (195.5 ± 152.3mL), the difference was not statistically significant (p=0.308). This aligns with the findings of Tzeng et al (2015), who noted that blood loss alone is not a decisive factor for SSI risk [3]. These findings reinforce the importance of a multifactorial approach rather than focusing on a single parameter.

Postoperative hospital stay was nearly twice as long in the SSI group compared to the non-SSI group (18.9 ± 10.7 vs. 7.6 ± 3.1 days; p<0.001). Preoperative hospitalization was also longer among patients who developed SSI (5.4 ± 4 vs. 3.6 ± 2.9 days; p=0.031), suggesting that infection risk may already be elevated due to pre-existing conditions or more complex surgical indications. Factors such as cirrhosis, high BMI, or prior surgeries may contribute to these extended stays. Although cirrhosis is a known risk factor for postoperative complications as shown by Lim et al. (2018) [11] our study did not find a significant association with SSI, possibly due to the small number of SSI cases (n = 13).

According to CDC classifications, 76.9% of SSIs were superficial, 15.4% were deep, and 7.7% involved organ/space infections. The predominance of superficial infections suggests that most SSIs can be effectively managed with proper wound care and early antibiotic treatment, with minimal long-term consequences if detected early.

The postoperative mortality rate in this study was very low (0.8%), reflecting global improvements in the safety of liver surgery. This success likely results from a combination of appropriate patient selection, modern surgical techniques, effective anesthesia protocols, and strict infection control practices. Guidelines from the CDC and WHO such as prophylactic antibiotic use, glucose control, core temperature maintenance, and hand hygiene have been strictly applied in our surgical protocols.

In our study, most SSIs after hepatectomy were superficial (76.9%), while deep and organ/space infections accounted for 15.4% and 7.7%, respectively. This distribution is consistent with previous studies, where superficial SSIs were the most common type after major hepatobiliary procedures. Takahashi et al (2018) reported that superficial SSIs were the predominant form among 2,300 patients in Japan, reflecting similar trends in Asian practice [4]. Likewise, the multicenter study by Lee et al (2019) in Korea found that organ/space SSIs, although less frequent, were more strongly associated with severe complications and prolonged hospitalization [7]. Notably, our study had only one case of organ/space SSI (7.7% of all SSIs), suggesting a low rate of severe infection an encouraging sign of effective surgical technique, infection control, and postoperative care at the 108 Military Central Hospital. In comparison, Tzeng et al (2015) reported that organ/space SSIs in OLR can be as high as 11% without proper infection control strategies [3]. This distribution highlights that most infections in our cohort were manageable with conservative treatment (e.g., wound care, antibiotics), and early recognition of superficial inflammation is crucial in preventing progression to more severe forms.

One key point is that postoperative complications are not solely dependent on surgical technique but are also heavily influenced by perioperative quality control systems. Studies from Japan and South Korea emphasize that collaboration among surgical teams, anesthesiologists, infection control staff, and nursing personnel plays a vital role in preventing and managing SSIs [2,7]. Therefore, alongside technical advances, workforce training and standardized perioperative protocols are essential to ensure long-term surgical success.

Although this study did not assess postoperative quality of life in detail, it opens several future research directions: the role of routine vs. selective drain use, blood transfusion minimization strategies, and multicenter comparisons among various hospitals in Vietnam. Furthermore, the application of artificial intelligence in infection risk assessment and clinical decision-making is a promising approach for optimizing liver resection outcomes.

However, the study has limitations: its retrospective, single-center design and the small number of SSI cases (n = 13) limit the statistical power and generalizability of multivariate analysis. Additionally, treatment cost and quality of life were not assessed factors that are increasingly important in modern clinical practice. With only 13 events, the risk of overfitting and unstable estimates increases, and the findings should therefore be interpreted with caution.

V. CONCLUSION

This study involving 372 cases of liver resection at the 108 Military Central Hospital showed that laparoscopic liver resection (LLR) was more effective in reducing the rate of surgical site infections (SSIs) compared to open liver resection (OLR) (1.9% vs. 5.7%), with a statistically significant difference. Independent risk factors associated with SSIs included open surgery, postoperative blood transfusion, and abdominal drain placement.

LLR not only reduces infectious complications but also shortens hospital stays, decreases the need for blood transfusion, and enhances postoperative safety. In the context of rising antibiotic resistance, expanding the indications for LLR is a reasonable strategy and should be considered for implementation in major liver surgery centers.

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