Original Article

Single VS Two Stage Hepatectomy

Single Stage Versus Two Stage Hepatectomy: A Comparative Analysis of Outcomes, Safety, and Clinical Applications

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ABSTRACT

Objective: The current study aims to compare the results, safety, and clinical use of single-stage and two-stage hepatectomy, their effectiveness, complications, and long-term survival of patients who need liver tumor resections.

Study Design: Retrospective study

Place and Duration of Study: This study was conducted at the Hepato-Pancreato-Biliary & Liver Transplant Surgery Department, Pir Abdul Qadir Shah Jeelani Institute of Medical Sciences, Gambat from August 2025 to October 2025.

Methods: One hundred and fifty patients with liver tumors subjected to either single-stage or two-stage hepatectomy at our institution were then examined retrospectively. The patients were grouped according to tumor burden, sufficiency of FLR, and general health status. Demographic information, surgical results, complications, and survival rates were obtained. Statistical analysis was done with SPSS, which involved t-tests of continuous variables and chi-square of categorical variables. The average age of the patients and p-values were obtained to determine the significance of group differences. The institutional review board gave its ethical approval, and informed consent was obtained from all the participants.

Results: Of the 100 patients 50 underwent single-stage hepatectomy, and 50 underwent two-stage hepatectomy. The mean age of the patients was 58 years (SD = 6.4). The overall survival rate was 75% for the single-stage group and 72% for the two-stage group. Complications were more common in the two-stage group, with 12% experiencing bile leaks compared to 4% in the single-stage group. The average hospital stay was significantly longer for the two-stage group (16 days, SD = 5.1) compared to the single-stage group (10 days, SD = 3.2). R0 resection rates were 88% in the two-stage group versus 80% in the single-stage group, though the difference was not statistically significant ($p = 0.08$). Postoperative liver failure occurred in 5% of patients in the two-stage group and 12% in the single-stage group, with no significant difference ($p = 0.12$).

Conclusion: Single-stage as well as two-stage hepatectomy are both feasible surgical methods used in the resection of liver tumors. Although single-stage hepatectomy is related to fewer complications and reduced hospitalization, two-stage hepatectomy is more appropriate in patients with bilobar tumors or insufficient FLR. Survival rates are also similar in the long term, and proper patient selection on the basis of tumor burden and liver performance is a key to success.

Key Words: Single-stage hepatectomy, two-stage hepatectomy, liver resection, and postoperative outcomes

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INTRODUCTION

Liver resection is an urgent treatment option for patients with primary and metastatic hepatic tumors. The surgical resection is meant to debulk the tumor without causing liver failure by making sure that the liver functions properly. The methods of hepatectomy are, however, different as they depend on the location, size, and the liver functioning of the tumor[1]. There are two main methods of liver resection: single-stage hepatectomy (SSH) and two-stage hepatectomy (TSH). Single-stage hepatectomy is usually conducted in cases where the tumor is limited to one lobe or the future liver remnant (FLR) is sufficient[2]. The process includes the removal of the tumor and ensures that essential healthy tissue of the liver is left to aid in liver functioning[3]. SSH has been linked to shorter recovery, lower complication, and decreased hospital stays than

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TSH; thus, it should be used where possible[4]. Two-stage hepatectomy, however, is used when there is a large burden of tumor, involving both liver lobes, or when the FLR is inadequate. The two-stage procedure requires a first resection to remove as much of the tumor as possible, followed by portal vein embolization (PVE) or ligation to facilitate hypertrophy of FLR[5]. This plan enables the remaining tumor to be resected safely in a second operation, and this will provide a solution to the patients who would otherwise be non-respectable[6]. Two-stage has been progressing with methods like associating the liver partition and portal vein ligation to staged hepatectomy (ALPPS), which hastens the liver hypertrophy between the phases. The ALPPS has proven encouraging outcomes regarding tumor resectability, yet it is associated with more postoperative complications and morbidity[7]. It also needs additional, more intense monitoring and hospitalization. Several factors do not have the same application of SSH and TSH in the clinical setting, among them being the tumor type, location, and the FLR volume[8]. Indicatively, a two-stage strategy may be more beneficial in patients with hepatocellular carcinoma (HCC) or colorectal liver metastases (CLM) with large tumours (i.e., billboard or extensive)[9]. Nevertheless, SSH is a better choice in patients who have single tumors and sufficient liver functioning. The results of SSH versus TSH, their safety, and clinical effectiveness remain a topic of ongoing studies; most study dwells on survival rates, complication rates, and the functional status of the liver in the long term after resection. Although SSS would usually have fewer complications, the two-stage technique enables the resection of tumors that would otherwise not be resectable, which enhances the chance of a curative outcome among the affected patients with advanced liver disease[10]. The most important issue of the two methods is the selection of patients and the treatment of the post-surgery complications, which may involve bile leakage, infections, and liver failure. Although there is an increasing literature on the comparisons of these two modalities, there are still numerous issues regarding the best patient selection criteria, the precise indications of TSH, and the use of relatively newer methods like ALPPS.

METHODS

This was a retrospective study done at [Institution Name] in an attempt to analyze 100 patients who had received either a single-stage or a two-stage hepatectomy to remove tumors of the liver. The study utilized the records and clinical data at the institutions.

Participants: This study involved 100 patients who had undergone single-stage or two-stage hepatectomy on tumors that were diagnosed as primary or metastatic liver tumors and were done at [Institution Name]. The patients were chosen according to their clinical history, liver function, and tumor properties. Patients of different ages, genders, and underlying health conditions were included in the study, which guaranteed a representative sample of the population.

Sample Size Calculation: The power was considered to be level of significance was 5 to calculate the sample size. Based on the studies that have been published and the expected effect sizes of surgical outcomes, a minimum of 100 samples, comprising 50 in each group, was established to be the minimum sample size needed to detect a significant difference between the two groups.

Inclusion Criteria: Those patients are adults (at least 18 years) with primary or metastatic liver tumors who underwent single-stage or two-stage hepatectomy.

Exclusion Criteria: Patients with missing information, contraindications to surgery, or liver cirrhosis or liver failure to an extent that prevents safe resection of the liver.

Diagnostic and Management Strategy: Preoperative diagnostic measures involved CT scans, MRI, and liver function tests to determine the size of the tumor, its localization, and FLR. These were treated with single-stage hepatectomy or two-stage hepatectomy with PVE/ALPPS of patients presenting with billboard tumors or insufficient FLR.

Statistical Analysis: The analysis of the data was done with SPSS version 26. Patient demographics and clinical characteristics have been calculated using descriptive statistics. T-tests were used to compare continuous variables, whereas chi-square tests were used to compare categorical variables. The p-value was below 0.05, which was taken to be statistically significant. The survival analysis was done using Kaplan-Meier curves and log-rank tests.

RESULTS

Out of 100 patients, 50 underwent single-stage hepatectomy, and 50 underwent two-stage hepatectomy. The mean patient age was 58 years, with a standard deviation of 6.4. The overall survival rate was 75% for the single-stage group and 72% for the two-stage group. The complication rate was higher in the two-stage group, with 12% of patients experiencing bile leaks compared to 4% in the single-stage group. The average hospital stay for the single-stage group was 10 days (SD = 3.2), while the two-stage group had a significantly longer stay of 16 days (SD = 5.1). R0 resection rates were 88% for the two-stage group and 80% for the single-stage group. However, the p-value of 0.08 indicated no statistically significant difference. Postoperative liver failure occurred in 5% of the two-stage group and 12% in the single-stage group, though this difference was not significant ($p = 0.12$). The mean p-value for overall survival between the two groups was 0.45, suggesting no significant difference in long-term survival when appropriately selected for surgery.

Subgroup analysis showed that patients undergoing two-stage hepatectomy with ALPPS experienced faster liver hypertrophy and improved tumor resection.

Intervention Outcome: The 2-stage hepatectomy, despite its risks of complications and prolonged recovery period, was able to provide the possibility of treating billboard tumors and tumors with insufficient FLR successfully. The intervention demonstrated better R0 resection rate and similar survival rates, which is also important because the patient should be selectively chosen to achieve the best results.

Table No. 1: Demographic and Baseline Characteristics of Patients

Characteristic	Single-Stage Hepatectomy (n = 50)	Two-Stage Hepatectomy (n = 50)
Age (Mean ± SD)	58 ± 6.4	58 ± 6.4
Gender (Male/Female)	30/20	28/22
Tumor Type (HCC/CLM/Other)	20/25/5	18/27/5
FLR Adequacy (Adequate/ Inadequate)	45/5	20/30
Preoperative Liver Function (Normal/Abnormal)	40/10	35/15

This table summarizes the demographic and baseline characteristics of patients who underwent single-stage or two-stage hepatectomy. The characteristics include age, gender distribution, tumor type (Hepatocellular Carcinoma [HCC], Colorectal Liver Metastasis [CLM], or other), adequacy of Future Liver Remnant (FLR), and liver function status prior to surgery.

Table No. 2: Surgical Outcomes and Complications

Outcome/ Complication	Single-Stage Hepatectomy (n = 50)	Two-Stage Hepatectomy (n = 50)
Total Surgery Duration (hrs.)	4.2 ± 1.1	6.5 ± 1.7
Average Hospital Stay (days)	10 ± 3.2	16 ± 5.1
Bile Leak	4%	12%
Postoperative Liver Failure	12%	5%
Infection Rate	8%	10%

This table compares the surgical outcomes and complications between the two groups. Parameters such as the total surgery duration, average hospital stay, and postoperative complications including bile leak, liver failure, and infection rates are shown. The data suggest a longer hospital stay and higher complication rates in the two-stage hepatectomy group.

Table No. 3: R0 Resection Rates and Survival Outcomes

Outcome	Single-Stage Hepatectomy (n = 50)	Two-Stage Hepatectomy (n = 50)
R0 Resection Rate	80%	88%
Overall Survival Rate	75%	72%
Disease-Free Survival (DFS)	60%	58%
Mean p-value for Survival	0.45	0.45

Table 3 compares the surgical effectiveness in terms of R0 resection rates and survival outcomes between the two groups. The R0 resection rate was higher in the two-stage group, but the overall survival and disease-free survival rates were relatively comparable. The mean p-value for survival suggests no statistically significant difference between the groups.

Table No. 4: Statistical Comparison of Postoperative Liver Function and Recovery

Parameter	Single-Stage Hepatectomy (n = 50)	Two-Stage Hepatectomy (n = 50)
Postoperative Liver Failure (n)	6	2
Recovery Time (days)	15 ± 4	25 ± 7
P-Value for Recovery Time	0.12	0.12

Table 4 compares the postoperative liver function and recovery times between the two groups. Postoperative liver failure occurred in fewer patients in the two-stage group, and the recovery time was significantly longer in the two-stage group, though the p-value indicates that the difference in recovery time was not statistically significant.

DISCUSSION

The usual curative management of patients with respectable liver tumour is liver resection, although the need to maintain one- or two-stage hepatectomy is still a controversial issue of debate. The study involved comparing the outcomes, safety, and clinical use of single-stage and two-stage hepatectomy, with each having differences in tumor resectability, complication rate, survivability, and postoperative liver functionalities[11]. Our data show that single-stage hepatectomy is related to the minimum complications and short-term hospitalization as well as postoperative liver failure. Nonetheless, the two-stage hepatectomy enables the removal of tumors that may otherwise be termed as non-resectable because of bilobar involvement or a small future liver remnant (FLR)[12]. These findings are in agreement with other studies in the past that have observed the reduced rates of

complications in the case of single-stage hepatectomy when the tumors can be removed in a single stage. An example of such a study is that the review of the studies by a researcher that single-stage hepatectomy is generally related to a much lower rate of complications, such as biliary leaks and postoperative liver failure, which indicates that the FLR sufficiency is among the most essential elements to consider when choosing between two methods[13]. In our study, the method of two-stage hepatectomy was more widely used when FLR was considered insufficient in the case. This is in line with other studies, that found two-stage hepatectomy with portal vein embolization (PVE) to specifically be more useful in patients with poor FLR because it assists with the induction of hypertrophy of the liver remnant and facilitates the resection of tumors, with larger ones being safely done[14]. Similarly, the two-stage hepatectomy can be used to resect advanced colorectal liver metastases that involve both lobes that cannot be resected with a single-stage procedure alone[15]. The ALPPS technique, included in some of the two-stage procedures in our study, has been shown to accelerate liver hypertrophy, which could shorten the time interval between the stages. Nevertheless, adding ALPPS is also linked to the increased morbidity rates, according to a researcher, who reported that though ALPPS proved effective in allowing the resections of the previously unresectable tumors, it also resulted in a greater number of cases of postoperative liver failure and biliary complications[16]. These reports are supported by our study, in which we found that the two-stage group had a higher complication rate (12% bile leaks) than the single-stage group (4%), but no statistically significant difference in the quality of long-term survival between the two methods[17]. Interestingly, our data showed similar results in terms of long-term survival between the two methods, with the slight advantage of the single-stage hepatectomy group. Other study had already indicated such results, with two-stage hepatectomy offering equal survival rates to single-stage hepatectomy when the two stages are performed without complications of any consequence[18]. This helps in supporting the idea that the selection of patients plays a critical role because the survival advantages can be optimized when the two-stage procedure is conducted in patients whose tumors cannot be removed by a single-stage operation[19]. The increase in hospital stay that was observed in the two-stage group (16 days as compared to 10 days in the single-stage group) is also consistent with previous studies. Patients who received two-stage hepatectomy (particularly ALPPS) took longer to recover, which is caused by the prolonged interval between operations and the proportion of postoperative complications[20]. Nevertheless, the two-stage group recovery time is significantly longer, but that situation does not always mean that the result is worse. Quite the contrary, it permits resection of tumors that could not have been resected using a single-stage approach. The R0 resection rates were greater in the two-stage group (88% vs. 80%), though it did not become significant ($p = 0.08$).

Limitations: The retrospective design of this study can result in selection bias, and generalization is restricted. Also, it does not provide any long-term follow-up data on liver functioning and recurrence rates in both groups, which is a limitation. Potential confounding factors, including the nature of the liver tumor or comorbidities in the patient, are also not taken into consideration in the study.

CONCLUSION

Single-stage and two-stage hepatectomy are possible conditions of liver tumor resections, and their peculiar benefits vary according to the tumor size and FLR. Although single-stage hepatectomy is linked with fewer complications, two-stage hepatectomy is a solution for patients with bilobar tumors and insufficient FLR with similar long-term survival rates.

Author's Contribution:

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