Predictive factors for long-term survival after hepatic resection for hepatocellular carcinoma: a single-center experience

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Aim
To evaluate our center's experience of liver resection for hepatocellular carcinoma (HCC) to determine the predictive factors affecting tumor recurrence and long-term survival.
Patients and methods
We reviewed the data of all consecutive patients who underwent liver resection for pathologically confirmed HCC during the period between January 2010 and June 2018.
Results
A total of 230 consecutive patients were included in the study. Hepatitis C virus was the main underlying cause among our patients (214 patients – 93.04%). The median operation time was 180 min (70–420 min), and the median blood loss was 700 ml (100–6000 ml). Postoperative morbidities occurred in 138 (60%) patients. Internal hemorrhage occurred in six (2.6%) patients. A total of 12 (5.2%) patients experienced biliary complications. Liver dysfunction occurred in 126 (54.7%) cases, and most of them were only grade A liver dysfunction (70 patients – 55.5%).
The median follow-up duration was 22 months (4–110 months). Recurrence occurred in 132 (62.5%) patients. The 1-, 3-, and 5-year disease-free survival rates were 69.2, 35.4, and 17.6%, respectively. Late mortality occurred in 61 (26.5%) patients. The 1-, 3-, and 5-year overall survival rates were 78.2, 59.1, and 50%, respectively.
Predictive factors for recurrence included alpha-fetoprotein, tumor number, macrovascular invasion, tumor size, and microvascular invasion. Predictive factors for long-term survival included macrovascular invasion, vascular complications, tumor size, and microvascular invasion.
Conclusion
Liver resection is one of the curative treatment strategies for HCC; however, the long-term prognosis is disappointing owing to the high incidence of tumor recurrence.

Keywords:
hepatocellular carcinoma, liver resection, long-term survival, recurrence

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Introduction

Hepatocellular carcinoma (HCC) is the commonest primary liver malignancy, accounting for more than 90% of primary liver malignancies. The incidence of HCC continues to increase in the recent years. It is the sixth commonest neoplasm worldwide and is the third commonest etiology of cancer-associated death [1]. HCC usually occurs in a background of liver cirrhosis, which usually precedes its development in most cases. As a result of better medical management of liver cirrhosis, survival of cirrhotic patients has steadily increased in recent years, resulting in a greater risk of developing HCC [2].

Surgery is considered the backbone of curative treatment for patients with HCC. Liver resection and liver transplantation are considered the only curative treatment modalities. They could achieve the best clinical outcomes in carefully selected candidates [3,4].

Liver resection is generally acknowledged as the first-line treatment in noncirrhotic patients with HCC. Moreover, it is acknowledged as the first-line treatment in cirrhotic patients with preserved liver functions with absence of any signs of clinically important portal hypertension [4].

Although liver resection is a potentially curative treatment for HCC, long-term prognosis after

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curative liver resection is unsatisfactory, because of the high incidence of tumor recurrence, which affects the patient survival. Tumor recurrence is a major cause of death following liver resection of HCC in the cirrhotic patient. Its incidence is reported to be ~40% within the first year, 60% at 3 years, and ~80% at 5 years. Recurrence can occur early after liver resection because of multicentric carcinogenesis and intrahepatic metastasis or later after liver resection owing to the background of liver cirrhosis [5–7].

The current study is conducted to evaluate our center's experience of liver resection for HCC to assess the predictive factors affecting tumor recurrence and long-term survival after liver resection for HCC in a tertiary high-volume center.

Patients and methods

Study design

We retrospectively reviewed the data for all consecutive patients who underwent liver resection for pathologically confirmed HCC at Gastrointestinal Surgery Center, Mansoura University, Egypt, during the period between January 2010 and June 2018.

An informed consent was obtained from each patient before the surgical procedure. The study was approved by Institutional Review Board and Local Ethical Committee at College of Medicine, Mansoura University, Egypt.

Preoperative evaluation

Preoperative evaluation included detailed patient complaint evaluation, general and abdominal examination, laboratory investigations including serum alpha-fetoprotein, and radiological evaluation including abdominal ultrasonography and triphasic computed tomography or magnetic resonance imaging. Upper gastrointestinal endoscopy was done to rule out esophageal varices, and metastatic workup was performed to rule out distant metastasis.

Patients were discussed in multidisciplinary meetings to select the appropriate treatment strategy. Liver resection was applied for patients with adequate liver functions (Child A or early B) with sufficient future liver remnant.

Surgical technique

The surgical procedure had been described elsewhere [8,9]. Brisbane 2000 terminology was used to identify the different types of curative liver resection [10]. Categories of liver resection were subdivided into minor liver resection (≤2 contiguous segments) and major liver resection (>2 contiguous segments) depending on Couinaud classification. Parenchymatous dissection was done using harmonic scalpel (Ethicon, Cincinnati, Ohio, USA) and clamp crush technique with the aim of at least 2-cm safety margin. Pringle maneuver was used in some cases either elective or emergent to minimize the blood loss during parenchymal transection.

Postoperative care and follow-up

After surgery, patients were transferred to the ICU or to the ward for monitoring of vital signs and abdominal drains. All patients underwent daily laboratory evaluation including liver functions. Abdominal ultrasonography and chest radiographs were performed routinely in all patients. Oral fluids were started once intestinal sounds are restored. Abdominal drains were removed when daily output is less than 100 ml with absence of any abdominal collections.

After discharge, patients were followed-up in the outpatient clinic every 2 weeks in the first month, every month during the first 3 months, then every 3 months for the first year. Biannual visits were arranged later. Follow-up visit included physical examination, laboratory evaluation including alpha-fetoprotein, abdominal ultrasonography, and triphasic computed tomography when recurrence is suspected.

Clinical outcomes

Postoperative morbidity was demarcated as any deviation from the regular postoperative path. Postoperative morbidities were recorded and categorized depending on the Clavien–Dindo classification [11]. Severe postoperative morbidities included patients with complication grade III or more. Postoperative mortality was defined as death during the first 90 days following operation.

Postoperative biliary fistula and posthepatectomy liver failure were defined according to the International Study Group of Liver Surgery [12,13].

Overall survival (OS) was estimated from the surgery day to death or censored at the day of last follow-up visit. Disease-free survival (DFS) was estimated from the surgery day to confirmed tumor recurrence day.

Statistical analysis

Shapiro–Wilk test was used to assess the normality of the data. Categorical data are presented as number and percentage. Continuous data are presented as medians with range. Survival rates were calculated using the Kaplan–Meier method and compared by Log-rank

test. Univariate and multivariate analyses are done by Cox regression analysis. Significant factors determined in the univariate analysis are included in the subsequent multivariate analysis. Data management and statistical analyses were done using SPSS for Windows (IBM-SPSS, version 22). The citation of the IBM-SPSS version 20 will be (IBM Corp, Armonk, NY, USA). A *P* value less than 0.05 was considered statistically significant.

Results

During the study period, 230 patients underwent liver resection for pathologically confirmed HCC and were included in the current study.

Baseline characteristics

Baseline characteristics of the study patients are shown in Table 1. Most of the patients were Child–Pugh class A (227 cases – 98.7%), whereas Child–Pugh class B represented only three (1.3%) cases. HCV was the main underlying cause of liver cirrhosis among the study patients (214 patients – 93.04%).

Operative data

Operative data of the study patients are shown in Table 2. The median operation time was 180 min (70–420 min), and median blood loss was 700 ml (100–6000 ml). Blood transfusion was required in 117 (50.9%) patients.

Table 1 Baseline characteristics of the study patients

Variables	Data
Age (years)	59 (18–78)
Sex	
Male	182 (79.1)
Female	48 (20.9)
BMI (kg/m^2)	29.1 (17.3–42.7)
Albumin (g/dl)	3.8 (2.7–5)
Bilirubin (mg/dl)	0.7 (0.4–11.2)
International normalized ratio	1 (1.0–1.8)
Platelet (x10^3/mm)	145 (34–433)
Creatinine (mg/dl)	0.8 (0.5–1.8)
Alpha-fetoprotein (ng/ml)	31 (1–2000)
Model for end-stage liver disease	7 (6–16)
Child–Pugh classification	
A	227 (98.7)
B	3 (1.3)
Virology	
Hepatitis C virus positive	214 (93.1)
Hepatitis B virus positive	1 (0.4)
Both negative	15 (6.5)
Previous abdominal surgery	78 (33.9)
Preoperative transarterial chemoembolization	15 (6.52)
Preoperative radiofrequency ablation	3 (1.3)
Esophageal varices	44 (19.1)

Data are presented as median (range) and *n* (%).

Postoperative data

Postoperative data are shown in Table 3. Postoperative morbidities occurred in 138 (60%) patients, and severe postoperative morbidities occurred in 41 (17.8%) patients.

Internal hemorrhage occurred in six (2.6%) patients, which required surgical re-exploration in all patients.

A total of 12 (5.2%) patients experienced biliary complications. Three (1.3%) cases presented with abdominal bilomas. Two (0.9%) of them were managed conservatively with radiology guided tube drainage. The last patient (0.4%) required ERCP and stent after failure of conservation with tube

Table 2 Operative data of the study cases

Variables	Data
Liver status	
Cirrhosis	213 (92.6)
Normal	17 (7.4)
Lesion number	
Single	212 (92.2)
Multiple	18 (7.8)
Lesion site	
Right hemi-liver	124 (53.9)
Left hemi-liver	96 (41.7)
Caudate lobe	5 (2.2)
Bilobar	5 (2.2)
Resection category	
Minor	178 (77.4)
Major	52 (22.6)
Resection type	
Localized resection	112 (49)
Segmentectomy	5 (2.2)
Left lateral sectionectomy	50 (21.7)
Right anterior sectionectomy	1 (0.4)
Right posterior sectionectomy	1 (0.4)
Caudate lobectomy	5 (2.2)
Right hemi-hepatectomy	38 (16.5)
Left hemi-hepatectomy	7 (3)
Extended right hemi-hepatectomy	5 (2.2)
Extended left hemi-hepatectomy	1 (0.4)
Central hepatectomy	1 (0.4)
Multiple resections	4 (1.7)
Pringle maneuver	37 (16.1)
Pringle maneuver duration (min)	15 (10–45)
Operation time (min)	180 (70–420)
Blood loss (ml)	700 (100–6000)
Blood transfusion	
Yes	117 (50.9)
No	113 (49.1)
Number of RBCs units	2 (1–8)

Data are presented as median (range) and *n* (%).

Table 3 Postoperative data of the study cases

Variables	Data
Hospital stay (days)	5 (2–66)
Postoperative morbidities	138 (60)
Severe morbidities	41 (17.8)
Clavien–Dindo grades	
I	53 (23)
II	44 (19.1)
IIIa	11 (4.8)
IIIb	9 (3.9)
IVa	2 (0.9)
V	19 (8.3)
Internal hemorrhage	6 (2.6)
Biliary complications	12 (5.2)
Liver dysfunction	126 (54.7)
Vascular complications	
Portal vein thrombosis	5 (2.2)
Abdominal collection	14 (6.1)
Respiratory complications	17 (7.4)
Renal complications (HRS)	4 (1.7)
Reoperation	7 (3)
Early mortality	19 (8.3)

Data are presented as median (range) and *n* (%).

drains for 3 weeks. Nine (3.9%) patients manifested with bile leakage. Five (2.2%) patients were managed conservatively till stoppage of biliary fistula. Three (1.3%) patients required ERCP and stenting after failure of conservative treatment. The last case (0.4%) required operative repair after failure of endoscopic approach to restore continuity of biliary system 2 weeks after extended right hepatectomy.

Liver dysfunction occurred in 126 (54.7%) cases. Grade A dysfunction occurred in 70 (55.5%) cases, whereas grade B and grade C dysfunction occurred in 38 (30.2%) cases, and 18 (14.3%) cases, respectively.

Pathological data

Pathological data of the study patients are shown in Table 4. The median tumor size was 6 cm (1.5–20 cm). R0 was achieved in 199 (86.5%) patients, whereas 31 (13.5%) patients had R1 resection.

Survival outcomes

The median follow-up duration was 22 months (4–110 months). Recurrence occurred in 132 (62.5%) patients. Most of recurrences occurred in the remnant liver (100 patients – 75%). Most of recurrences were multifocal and were treated by palliative supportive care (77 patients – 58.3%). The 1-, 3-, and 5-year DFS rates were 69.2, 35.4, and 17.6%, respectively (Table 5 and Fig. 1).

Late mortality occurred in 61 (26.5%) patients. The 1-, 3-, and 5-year OS rates were 78.2, 59.1, and 50%, respectively (Table 5 and Fig. 2).

Table 4 Pathological data of the study patients

Variables	Data
Background liver status	
Cirrhosis	216 (93.9)
Normal	14 (6.08)
Number	
Single	202 (87.8)
Multiple	28 (12.1)
Size (cm)	6 (1.5–20)
Safety margin	
R0	199 (86.5)
R1	31 (13.5)
Microvascular invasion	
Yes	113 (49.1)
No	117 (50.9)
Grading	
I	45 (19.65)
II	127 (55.21)
III	51 (22.17)
IV	6 (2.6)
No viable tumor	1 (0.4)
Staging	
T1	43 (18.7)
T2	128 (55.7)
T3	22 (9.6)
T4	36 (15.7)
Tx	1 (0.4)

Data are presented as median (range) and *n* (%).

Table 5 Long-term survival outcomes of the study patients

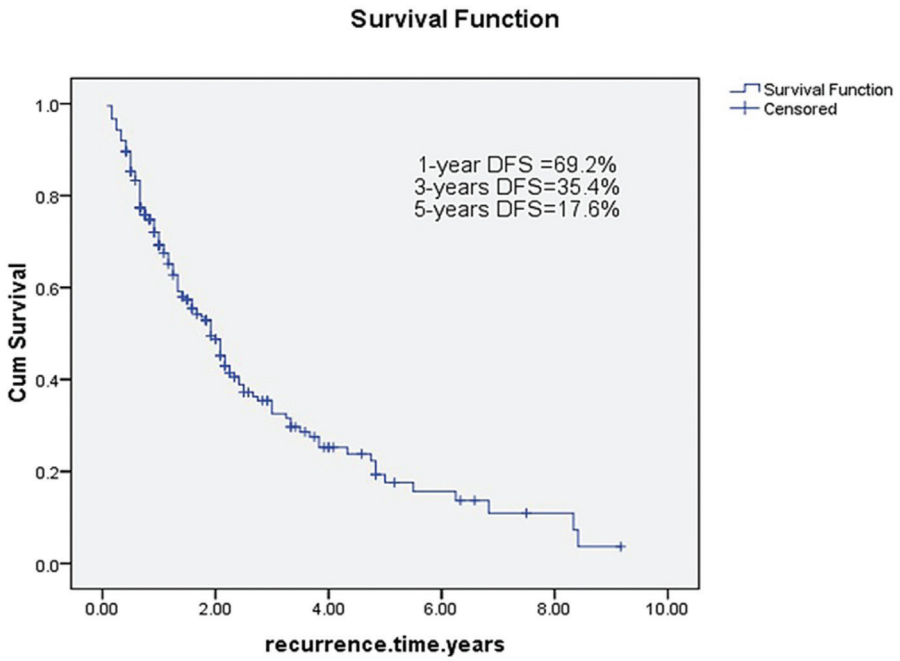
Variables	Data
Mortality	61 (26.5)
Recurrence	132 (62.5)
Recurrence time (months)	15 (4–110)
Recurrence site	
Intrahepatic	100 (75)
Extrahepatic	3 (2.3)
Both	29 (22)
Intrahepatic management	
Redo surgery	4 (3)
Transarterial chemoembolization	31 (23.5)
Radiofrequency ablation	9 (6.8)
Microwave ablation	3 (2.3)
Combined	7 (5.3)
Palliative	75 (58.1)
Extrahepatic location	
Lung	18 (56.3)
Bone	3 (9.4)
Adrenal	1 (3)
Abdominal wall	1 (3)
Peritoneum	5 (15.6)
Multi-site	4 (12.5)

Data are presented as median (range) and *n* (%).

Predictive factors for tumor recurrence

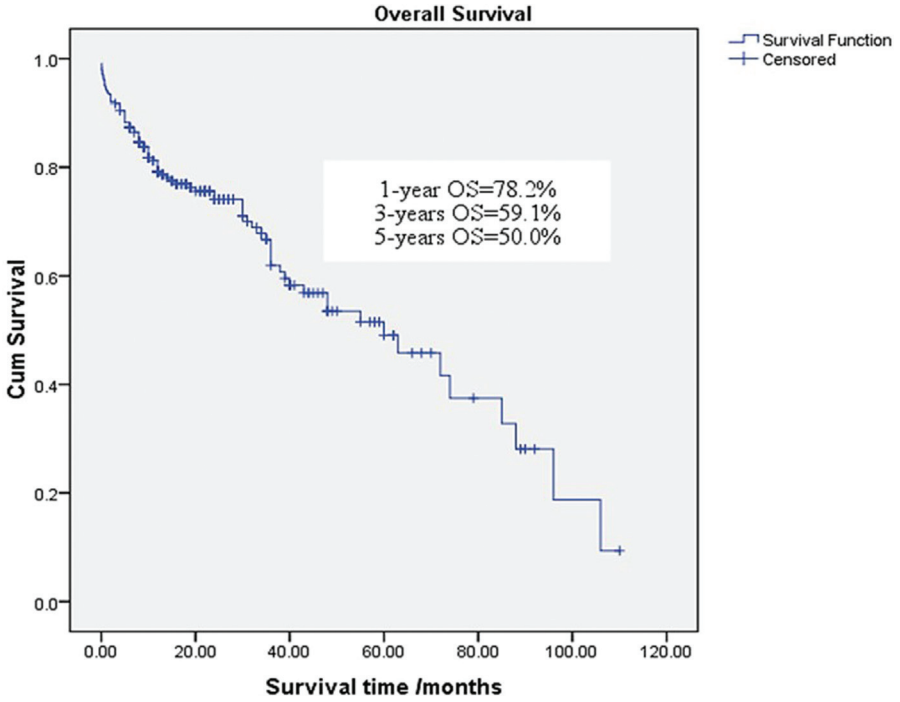
Several factors were analyzed to determine the predictive factors for tumor recurrence among our patients (Table 6). On univariate analysis,

Figure 1



Kaplan–Meier disease-free survival curve of all study patients.

Figure 2



Kaplan–Meier overall survival curve of all study patients.

preoperative alpha-fetoprotein, tumor number, presence of macrovascular invasion, tumor size, presence of microvascular invasion, and tumor stage were associated with tumor recurrence. On multivariate analysis, preoperative alpha-fetoprotein, tumor number, presence of macrovascular invasion, tumor size, and presence of microvascular invasion were significant predictors for tumor recurrence.

Predictive factors for long-term survival

Several factors were analyzed to determine the predictive factors for long-term survival among our patients (Table 7). On univariate analysis, preoperative

Table 6 Predictive factors for tumor recurrence among the study patients

Variables	Univariate analysis		Multivariate analysis	
	HR (95% CI)	*P* value	HR (95% CI)	*P* value
Alpha-fetoprotein	1 (1–1.001)	0.001	1 (1–1.001)	0.006
Lesion number (single/multiple)	2.738 (1.65–4.542)	0.001	1.954 (1.058–3.608)	0.032
Macrovascular invasion	2.147 (1.102–4.181)	0.002	2.084 (1.062–4.089)	0.008
Tumor size	1.079 (1.024–1.137)	0.004	1.074 (1.012–1.139)	0.018
Microvascular invasion	1.716 (1.042–2.826)	0.034	1.615 (1.32–2.457)	0.002
Tumor stage	1.487 (1.245–1.777)	0.001	0.916 (0.67–1.253)	0.584

CI, confidence interval; HR, hazard ratio.

Table 7 Predictive factors for long-term survival among the study patients

Variables	Univariate analysis		Multivariate analysis	
	HR (95% CI)	*P* value	HR (95% CI)	*P* value
Albumin	0.551 (0.301–1.006)	0.052	0.550 (0.76–1.097)	0.09
Alpha-fetoprotein	1 (1–1.001)	0.006	1 (1–1.001)	0.198
Macrovascular invasion	5.435 (2.609–11.32)	0.001	3.521 (1.321–9.387)	0.012
Portal thrombectomy	0.173 (0.053–0.568)	0.004	1.62 (0.381–6.889)	0.513
Vascular complications	0.196 (0.047–0.812)	0.025	0.196 (0.046–0.835)	0.028
Tumor size	3.801 (2.881–29.11)	0.002	3.987 (1.745–9.113)	0.001
Tumor number	2.115 (1.114–4.017)	0.022	1.023 (0.499–2.099)	0.95
Microvascular invasion	0.59 (0.35–0.995)	0.048	0.76 (0.435–0.866)	0.02
Tumor grade	1.795 (1.334–2.417)	0.001	0.999 (0.67–1.49)	0.996
Tumor stage	2.189 (1.632–2.934)	0.001	1.222 (0.813–1.836)	0.335

CI, confidence interval; HR, hazard ratio.

albumin, alpha-fetoprotein, presence of macrovascular invasion, associated portal thrombectomy, postoperative vascular complications, tumor size, tumor number, presence of microvascular invasion, tumor grade, and tumor stage were associated with long-term survival. On multivariate analysis, presence of macrovascular invasion, postoperative vascular complications, tumor size, and presence of microvascular invasion were significant predictors for long-term survival.

Discussion

HCC is one of the most common malignancies worldwide. Surgery is the mainstay of HCC curative treatment. Surgery is considered the backbone of curative treatment for patients with HCC. Liver resection and liver transplantation are considered the only curative treatment modalities. They could achieve the best clinical outcomes in carefully selected candidates [1,2,4]. Liver resection is generally acknowledged as the first-line treatment in noncirrhotic patients with HCC. Moreover, it is acknowledged as the first-line treatment in cirrhotic patients with preserved liver functions with absence of any signs of clinically important portal hypertension. Unfortunately, most patients with HCC cannot undergo curative liver resection owing to either impaired liver functions, presence of severe portal hypertension, or advanced tumor stage [4].

The current study included 230 consecutive patients with HCC who underwent surgical resection as the initial primary therapy for HCC from a tertiary referral hospital. Overall, 94.3% of our patients had underlying cirrhotic liver. We implemented a tailored approach dependent on the patients' clinical condition. Parenchymal-sparing liver resections such as nonanatomical resections were done in patients with liver cirrhosis and limited functional reserve. Patients without liver cirrhosis and good hepatic reserve were subjected for either anatomical or nonanatomical liver resection depending on tumor size and location [8].

Morbidity rate after liver resection remains high as reported in recent studies, with a varying incidence ranging between 32 and 55.5% [14,15]. This is attributed to heterogenicity on the underlying patients' demographics, liver resection extent, and different definitions of postoperative morbidities. Harimoto *et al.* [16] mentioned in their study including 966 patients that severe postoperative complications occurred in 17.1% of the patients after curative resection for HCC. Okamura *et al.* [17] mentioned in their study of 376 patients that postoperative complications were identified in 47.1% of patients after curative resection for HCC, whereas severe postoperative complications were identified in 28.5%. They concluded that postoperative complications were independent predictors of OS

and recurrence-free survival after curative hepatectomy in patients with HCC. In the current study, overall postoperative morbidities were identified in 138 (60%) patients, whereas severe postoperative morbidities were identified in 41 (17.8%) patients. The commonest complication among our patients was posthepatectomy liver dysfunction. Liver dysfunction occurred in 126 (54.7%) cases; however, most of them were just grade A dysfunction (70 cases – 55.5%) requiring no additional therapies. Grade B and grade C dysfunction occurred in 38 (30.2%) cases and 18 (14.3%) cases, respectively. The incidence of posthepatectomy liver dysfunction ranges from 1.2 to 37% in the published literature. This variation could be attributed to different patients and procedures performed in different studies beside the lack of the universally accepted definition [8,18].

Tumor recurrence is a major cause of death following liver resection of HCC in the cirrhotic patient. Its incidence is reported to be ~40% within the first year, 60% at 3 years, and ~80% at 5 years. Recurrence can occur early after liver resection because of multicentric carcinogenesis and intrahepatic metastasis or later after liver resection owing to de novo tumors developing on the background of liver cirrhosis [5–7].

Tabrizian *et al*. [19] in their study of 661 patients with HCC mentioned that the 5-year recurrence rate was 70% and that most recurrences were intrahepatic (66% of recurrences). Moreover, Ishizawa *et al*. [20] identified in their study on 434 patients with HCC that recurrence was encountered in 67% of patients 5 years after curative resection and the majority were also intrahepatic (61.5% of recurrences). In this study, recurrence was encountered in 132 (62.5%) cases, with median time for recurrence of 15 months. Most of the recurrences occurred in the remnant liver (100 patients – 75%). Most of the recurrences were multifocal and were treated by palliative supportive care (77 patients – 58.3%). The 1-, 3-, and 5-year DFS rates were 69.2, 35.4, and 17.6%, respectively. On the contrary, late mortality occurred in 61 (26.5%) patients. The 1-, 3-, and 5-year OS rates were 78.2, 59.1, and 50%, respectively.

Several risk factors for tumor recurrence after curative liver resection for HCC had been identified by different studies. In the current study, we found that preoperative alpha-fetoprotein, tumor number, presence of macrovascular invasion, tumor size, and presence of microvascular invasion were significant predictors for tumor recurrence. On the contrary, we found that presence of macrovascular invasion, postoperative vascular complications, tumor size, and presence of microvascular invasion were significant predictors for long-term survival.

It is recognized that there are no limitations for the tumor size that may prevent proceeding to liver resection [21]. The tumor size has been usually established as one of the most vital predictors of recurrence and survival after liver resection for HCC [22]. Hwang *et al*. [23] showed a stepwise worsening in HCC recurrence and survival outcomes with increased tumor size. They concluded that increased tumor size correlates with shorter OS and DFS periods. Moreover, Goh's study, which included 560 patients, emphasized on prognostic index of tumor size and also suggested refinement of the AJCC system [24]. In the current study, tumor size was a significant predictor of DFS and OS among our patients.

Tumor multifocality is well-known risk factor for tumor recurrence. It is usually associated with early relapse after curative resection for HCC [8,20]. Ishizawa *et al*. [20] identified in their study that tumor multiplicity is an independent predictor of postoperative recurrence, with 3- and 5-year cumulative recurrence rates of 73 and 75%, respectively, in the multiple tumor group versus 47 and 60%, respectively, in the single tumor group. These results are in agreement with our study, which identified that tumor multiplicity is an independent prognostic factor for tumor recurrence on multivariate analysis.

HCC displays a robust tendency for invasion of the hepatic vasculature. This is defined as macrovascular invasion. The prognosis of patients with HCC is dramatically worse in the presence of macroscopic vascular invasion. It is reported that the OS of those patients is almost 2–4 months with supportive care [25]. Kokudo *et al*. [26], in their study on 6474 patients with portal vein invasion identified that liver resection is associated with better outcomes regarding the OS when compared with other palliative procedures in patients with HCC with portal vein invasion. They concluded that as long as the invasion of portal venous system is only restricted to the first-order branch with preserved liver functions, curative liver resection should be applied as the treatment of choice [26]. In this study, macrovascular invasion was a significant prognostic factor regarding recurrence on both univariate and multivariate analyses.Alpha-fetoprotein is a well-known marker for HCC. More than 70% of patients with HCC have excessive alpha-fetoprotein secretion. A high preoperative level of serum alpha-fetoprotein (>400 ng/ml) represents an indirect indicator of the

burden or the behavior of the tumor [27]. The prognostic significance of alpha-fetoprotein also has been tested in multiple studies [8,9,28]. Ma *et al.* [29] found that patients with HCC associated with lower serum alpha-fetoprotein (≤20 ng/ml) had a lower 2-year recurrence rate and higher 2-year survival. This is in agreement with our results, which revealed a significant correlation between alpha-fetoprotein level and recurrence.

Several pathological characteristics of HCC are identified as prognostic factors for tumor recurrence and survival such as presence of capsule, microscopic vascular invasion, histological grading, and microscopic satellite nodules [8,27]. The existence of microscopic venous invasion is a commonly addressed predictive indicator of tumor recurrence following liver resection for HCC. Many studies have also suggested that poor HCC differentiation grade is associated with presence of microvascular invasion [30]. Interestingly, in this study, we found that there is a significant correlation between microscopic venous invasion with both tumor recurrence and long-term survival.

Our study had some limitation, including it is single-center retrospective study, which is liable to some selection bias. Moreover, some perioperative variables may not be included in our analysis. A future multicenter study among Egyptian centers including larger number of HCC patients is needed to confirm our findings.

Conclusion

In conclusion, surgery is a mainstay of HCC treatment. Liver resection is considered one of the potentially curative treatment strategies for HCC; however, the long-term prognosis is disappointing. This is attributed to the high incidence of tumor recurrence. In the current study, we found that alpha-fetoprotein, tumor number, macrovascular invasion, tumor size, and microvascular invasion were significant predictors for tumor recurrence. On the contrary, macrovascular invasion, vascular complications, tumor size, and microvascular invasion were significant predictors for long-term survival.

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Conflicts of interest
There are no conflicts of interest.

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