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# High Preoperative Serum Alanine Transferase Levels: Effect on the Risk of Liver Resection in Child Grade A Cirrhotic Patients

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**Abstract. Despite careful selection of cirrhotic patients with hepatocellular carcinoma (HCC), liver resection remains associated with a greater risk than in patients without underlying liver disease. In this study we assessed by multivariate analysis parameters associated with in-hospital mortality and morbidity in a selected group of 108 Childs-Pugh A cirrhotic patients undergoing liver resection of HCC. The overall incidences of in-hospital deaths and postoperative complications were 8.3% and 48.1%, respectively. By univariate analysis, the preoperative serum alanine transferase (ALT) level ($p = 0.001$) and intraoperative transfusions ($p = 0.01$) were significantly associated with in-hospital death; however, only the serum ALT concentration was an independent risk factor. In-hospital mortality rates in patients whose serum ALT was below 2N (twofold the upper limit of the normal value), between 2N and 4N, and more than 4N were 3.9%, 13.0%, and 37.5%, respectively. An ALT level greater than 2N was predominantly observed in patients with a hepatitis C virus infection and significantly associated with histologic features of superimposed active hepatitis. Patients with an ALT level greater than 2N experienced an increased incidence of postoperative ascites (58% versus 32%, $p = 0.01$), kidney failure (16% versus 0%, $p = 0.0003$), and upper gastrointestinal bleeding (6.4% versus 0%, $p = 0.02$). These results indicate that the preoperative ALT level is a reliable predictor of in-hospital mortality and morbidity following liver resection in Child-Pugh A cirrhotic patients. Cirrhotic patients with ALT > 2N should undergo only a limited resection; if a larger resection is required, those patients should be considered for nonsurgical therapy or liver transplantation.**

In patients with localized hepatocellular carcinoma (HCC), liver resection is currently the only therapeutic option that could offer a chance of long-term survival [1]. However, most HCCs are associated with chronic liver disease and in particular liver cirrhosis [2]. Liver resection in this setting is associated with a high risk of postoperative complications due to the poor functional reserve of the liver or impaired and delayed ability of the liver to regenerate [3–7]. Improvement of operative results of resection of HCC in patients with cirrhosis were due to technical advancements and careful selection of candidates [5, 8, 9]. Although several models, including assessment of hepatic blood flow and dynamic determinations of metabolic function, have retrospectively been developed to assess the extent of a safe resection [10–13]. Child-Pugh classification correlates significantly with patient survival and is widely accepted [14–17]. The presence of ascites, hypoalbuminemia, hyperbilirubinemia, and prolonged prothrombin time are classically associated with poor outcome and preclude extensive liver resection [18]. Despite the careful selection of patients according to these criteria and the adjustment of the extent of resection to the liver functional reserve, postoperative complications leading to death may still occur [6, 19]. To predict who in a cirrhotic population with preserved liver function will develop complications after hepatic resection, we selected 108 clinical charts for inclusion in this study, representing Child-Pugh class A cirrhotic patients who underwent resection of HCC.

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## Mterials and Methods

### *Study Population*

Between 1989 and 1994, among 137 consecutive cirrhotic patients who underwent resection of an HCC, 108 (79%) were Child-Pugh class A and were selected for analysis. The diagnosis of cirrhosis and HCC were confirmed in each patient upon pathologic analysis of the removed specimen. Preoperative data of these 108 patients are summarized in Table 1. At the time of surgery, the prothrombin time (PT) and serum bilirubin and albumin concentrations were within the normal range in each patient, and none had clinical ascites. The maximum diameter of the HCC ranged between 1.5 and 20.0 cm (mean 7.1 ± 4.9 cm). Liver resections were performed to achieve clear margins based on preoperative morphologic exploration and intraoperative ultrasonography. Major liver resections (defined by the resection of three segments or more) were performed in 43 patients (40%) including 29 right and 14 left hepatectomies. All major and 42 of 65 minor resections were performed under continuous portal triad clamping (30 ± 14 minutes duration). Patients with blood losses over 500 ml were transfused. The mean (± SD) units of packed red blood cells (RBCs) transfused in the 43 patients requiring transfusion was 2.7 ± 4.1.

### *Design of the Study*

The outcome after liver resection was assessed in terms of in-hospital mortality and morbidity. In-hospital deaths were de-

**Table 1.** Clinical, biochemical, pathologic, and operative characteristics of 108 Child-Pugh class A cirrhotic patients undergoing liver resection for an HCC.

| Variable | No. of patients |
|---|---|
| Age (years) | 58 ± 12 |
| Male | 88 (81%) |
| Risk factors for cirrhosis | |
| Alcohol abuse | 30 (28%) |
| HBV | 33 (30%) |
| HCV[a] | 41/82 (50%) |
| Hemochromatosis | 8 (7%) |
| Laboratory data | |
| Prothrombin time (% control) | 81 ± 14 |
| Total bilirubin (μmol/L) | 15 ± 9 |
| Albumin (g/L) | 43 ± 7 |
| ALT (IU/L) | 68 ± 53 |
| AST (IU/L) | 78 ± 63 |
| GGT (IU/L) | 70 ± 68 |
| Associated active hepatitis | 53 (49%) |
| Operative procedures | |
| Major resection[b] | 43 (40%) |
| Bisegmentectomy | 23 (21%) |
| Unisegmentectomy | 20 (18%) |
| Subsegmentectomy | 22 (20%) |
| Intraoperative blood transfusion | 43 (40%) |

Data are expressed as the mean ± SD.

HBV: hepatitis B virus; HCV: hepatitis C virus; ALT: serum alanine aminotransferase; AST: serum aspartate aminotransferase; GGT: γ-glutamyl transpeptidase.

[a]Eighty-two patients were tested for hepatitis C virus infection.

[b]Major resection defined by the resection of three or more segments.

fined as any death that occurred within the same hospital admission as the liver resection. Postoperative complications included liver failure (defined by a fall in PT below 40% or an increase in serum bilirubin greater than 80 μmol/L in the absence of hemolysis or biliary obstruction that persisted beyond the third postoperative day), massive ascites, intraabdominal sepsis, upper gastrointestinal bleeding, and kidney failure. For the purpose of this study, deaths and complications were in addition stratified into those that were and those that were not related to postoperative liver failure.

Prediction of outcome after liver resection was performed by univariate and multivariate analyses. Preoperative information included the age and gender of the patients, the etiology of cirrhosis, and its severity, as assessed by serum bilirubin, aspartate aminotransferase (AST), alanine aminotransferase (ALT), γ-glutamyl transpeptidase, albumin, and creatinine levels as well as the PT at the time of the procedure. The presence or absence of pathologic features of active hepatitis (defined by portal and periportal inflammation with erosion of the limiting plate and piecemeal necrosis and fibrosis) was sought by examining the nontumorous tissue within the resected specimen. Intraoperative variables included the extent of resection (as defined by the number of liver segments resected), type and duration of vascular clamping, and amount of blood loss (as assessed by the units of packed RBCs transfused intraoperatively).

**Table 2.** Postoperative complications in 108 Child-Pugh class A cirrhotic patients undergoing liver resection of an HCC and associated mortality.

| Complications | No. of patients with complications | No. of patients dying if complications are present |
|---|---|---|
| Massive ascites | 43 (39.8%) | 7 (16.2%) |
| Liver failure[a] | 22 (20.3%) | 6 (27.2%) |
| Kidney failure | 5 (4.6%) | 4 (80.0%) |
| Septic complications | | |
| Overall | 11 (10.2%) | 5 (45.5%) |
| Ascites superinfection | 8 (7.4%) | 4 (50.0%) |
| Intra-abdominal abscess | 5 (4.6%) | 3 (60.0%) |
| Lung infection | 3 (2.8%) | 1 (33.3%) |
| Portal vein thrombosis | 2 (1.9%) | 1 (50.0%) |
| Gastrointestinal bleeding | 2 (1.9%) | 2 (100%) |
| Intra-abdominal bleeding | 1 (0.9%) | 1 (100%) |
| Myocardial infarction | 1 (0.9%) | 1 (100%) |

[a]As defined in the Materials and Methods section.

### *Statistical Analysis*

Data were gathered from an ongoing computerized database that was checked and completed for the purpose of this study. Comparison between means was performed using Student's *t*-test or the Mann-Whitney U-test. Comparison of frequencies was performed by the chi-square test or Fisher exact test. Prediction of in-hospital death was performed by univariate and multivariate analyses (logistic regression). Noncategorical variables (e.g., age, serum creatinine and bilirubin levels, PT) were entered as continuous variables (with or without logarithm transformations to fulfill the assumption of proportional hazards) or as categorical variables (e.g., age >50 or <50 years) after defining cutoff values by discriminant function analysis. Categorical variables were coded as 0 (absence) or 1 (presence).

## Results

### *In-hospital Mortality and Morbidity*

In-hospital death and postoperative complications occurred in 9 patients (8.3%) and 52 patients (48.1%), respectively. Death was frequently related to liver failure ($n = 6$), massive ascites ($n = 7$), severe sepsis ($n = 5$), or kidney failure ($n = 4$). One patient died from gastrointestinal bleeding associated with portal vein thrombosis. One other patient died from myocardial infarction without evidence of liver failure.

Postoperative complications are listed in Table 2. Among the 52 patients experiencing such complications, 43 (83%) had some evidence of ascites and 22 (42%) postoperative liver failure. Three patients required reoperation due to intraabdominal sepsis ($n = 2$) or bleeding ($n = 1$).

### *Variables Associated with Mortality and Morbidity*

By univariate analysis (Table 3), two variables were significantly associated with in-hospital death: preoperative serum ALT level and intraoperative transfusion. However, when both variables were entered into a multivariate analysis, only serum ALT concentrations was an independent risk factor ($p = 0.005$). In-

**Table 3.** Variables differentiating patients undergoing liver resection for an HCC who died in hospital and those who did not ($n = 108$).

| Variable | Mortality present ($n = 9$) | Mortality absent ($n = 99$) | $p$ |
|---|---|---|---|
| Age (mean ± SD, years) | 58 ± 12 | 63 ± 9 | NS |
| Risk factors for cirrhosis | | | |
| Alcohol abuse | 2 (22.2%) | 28 (28.2%) | NS |
| HBV | 3 (33.3%) | 30 (30.3%) | NS |
| HCV | 4 (44.4%) | 37 (37.3%) | NS |
| Preoperative biologic data | | | |
| Prothrombin time (% control) | 78 ± 12 | 81 ± 15 | NS |
| Total bilirubin (μmol/L) | 17 ± 10 | 15 ± 9 | NS |
| Albumin (g/L) | 41 ± 9 | 43 ± 7 | NS |
| ALT (IU/L) | 126 ± 78 | 63 ± 49 | 0.001 |
| AST (IU/L) | 109 ± 70 | 74 ± 66 | NS |
| GGT (IU/L) | 92 ± 75 | 78 ± 64 | NS |
| Associated active hepatitis | 6 (66.6%) | 47 (47.4%) | NS |
| Operative procedures | | | |
| Major resection | 6 (66.6%) | 37 (37.3%) | NS |
| No. segments resected | 3 ± 2 | 2 ± 2 | NS |
| Pringle maneuver | 6 (66.6%) | 79 (79.8%) | NS |
| Ischemia duration (min) | 35 ± 13 | 30 ± 12 | NS |
| Patients transfused | 6 (66.6%) | 37 (38.3%) | NS |
| PRBC transfused (units) | 5.4 ± 7.3 | 2.4 ± 3.7 | 0.001 |

Results are given as either the mean ± SD or the number and percent of patients.

PRBC: packed red blood cells.

**Table 4.** Characteristics and incidence of postoperative complications in patients with and without high preoperative ALT serum level undergoing liver resection for HCC.

| Characteristic | ALT ≤ 2N ($n = 77$) | ALT > 2N ($n = 31$) | $p$ |
|---|---|---|---|
| Age (years) | 58 ± 11 | 59 ± 11 | NS |
| Risk factors for cirrhosis | | | |
| Alcohol abuse | 23 (29.8%) | 7 (22.5%) | NS |
| HBV | 27 (35%) | 6 (19%) | NS |
| HCV | 17 (22.1%) | 24 (77.4%) | 0.00001 |
| Associated active hepatitis | 28 (36.3%) | 25 (80.6%) | 0.00001 |
| Resection of three segments or more | 29 (37.6%) | 14 (45.1%) | NS |
| Duration of vascular occlusion (min) | 33 ± 13 | 31 ± 16 | NS |
| Intraop. blood transfusion | 28 (36.4%) | 15 (48.4%) | NS |
| No. complications/patient | 0.75 | 1.48 | |
| Individual complications | | | |
| Massive ascites | 25 (32.4%) | 18 (58.0%) | 0.01 |
| Liver failure[a] | 14 (18.2%) | 8 (25.8%) | NS |
| Kidney failure | 0 | 5 (16.1%) | 0.0003 |
| Septic complications | | | |
| Overall | 7 (9.1%) | 4 (12.9%) | NS |
| Ascites superinfection | 4 (5.2%) | 4 (12.9%) | NS |
| Intra-abdominal abscess | 3 (3.8%) | 2 (6.4%) | NS |
| Lung infection | 2 (2.6%) | 1 (3.2%) | NS |
| Portal vein thrombosis | 1 (1.3%) | 1 (3.2%) | NS |
| Gastrointestinal bleeding | 0 | 2 (6.4%) | 0.02 |
| Intra-abdominal bleeding | 1 (1.2%) | 0 | NS |
| Myocardial infarction | 1 (1.2%) | 0 | NS |
| In-hospital death | 3 (3.8%) | 6 (19.3%) | 0.008 |

Results are given as either the mean ± SD or the number of patients.

Intraop., intraoperative.

[a]As defined in the Materials and Methods section.

hospital mortality for patients whose preoperative serum ALT values were less than twofold the upper limit of the normal value (2N) ($n = 77$), between 2N and 4N ($n = 23$), and more than 2N ($n = 8$) were 3.9%, 13.0%, and 37.5%, respectively ($p = 0.003$).

Increased preoperative serum ALT was associated with an increased incidence of postoperative complications (Table 4). Among the individual complications, kidney failure, massive ascites, and gastrointestinal bleeding were significantly more frequent in patients with serum ALT greater than 2N than in patients with serum ALT lower than 2N. A high preoperative ALT level was observed predominantly in patients with a hepatitis C virus (HCV) infection and was more frequently associated with features of active hepatitis within the cirrhotic liver (Table 4). Although the extent and technique of resection were comparable in patients with high (>2N) and low (≤2N) ALT levels, intraoperative blood loss was greater in the former than in the latter.

### *Extent of Safe Resection as a Function of Preoperative Serum ALT*

The incidences of in-hospital death and complications as a function of preoperative serum ALT level and extent of resection are shown in Table 5. A safe resection (null mortality) was achieved through the resection of up to one segment in patients with preoperative serum ALT lower than 2N but only through the resection of less than one segment in patients whose preoperative serum ALT was more than 2N. Increasing the extent of resection beyond these threshold values was not associated with a further increase in in-hospital mortality.

## Discussion

In this selected group of Child-Pugh A cirrhotic patients we readdressed the value of several simple pre- and intraoperative variables on the risk of postoperative mortality and morbidity. We have found that liver resection in this group of patients is associated with an in-hospital mortality of 8.3%. This risk appears to be unequal among patients, however, being predominantly influenced by the preoperative serum ALT level.

Our results apparently differ from those of several previous studies that have failed to identify preoperative ALT level as an independent prognosis factor of in-hospital mortality and morbidity [3, 4, 11, 20, 21]. This discrepancy is not surprising considering that the patients in the other studies and in our study differ in several respects. First, all our patients had biopsy-proved cirrhosis, whereas most of the other studies included patients with and without cirrhosis [3, 11, 20, 21]. The significance of increased ALT levels in patients with or without cirrhosis is probably different, and this difference suggests that our results may not be applicable to patients with noncirrhotic livers. Second, the range of distribution of ALT among normal and abnormal levels in our study appears wider and the proportion of patients with high ALT level greater than in the other studies. Finally, the proportion of

**Table 5.** In-hospital mortality and morbidity as a function of preoperative serum ALT level and extent of resection.

| | Extent of resection | | | |
|---|---|---|---|---|
| Preoperative ALT | <1 Segment ($n$ = 22) | 1 Segment ($n$ = 22) | 2 Segments ($n$ = 21) | ≥3 Segments ($n$ = 43) |
| ALT ≤ 2N | | | | |
| Patients (no.) | 13 | 18 | 17 | 29 |
| In-hospital deaths (%) | 0 | 0 | 5.8 | 6.8 |
| ALT > 2N | | | | |
| Patients (no.) | 9 | 4 | 4 | 14 |
| In-hospital deaths (%) | 0 | 25.0 | 25.0 | 28.5 |

patients undergoing a limited liver resection (one segment or less) was much lower in our study (39%) than in the previous studies (78–82%) [3, 4, 21]; indeed high preoperative serum ALT levels were, in our experience, associated with a poorer outcome only in patients undergoing large liver resections.

The incidence of HCC has regularly increased over the past decade in Japan and the West due to the emergence of HCV infections [2, 22, 23], and there is epidemiologic evidence that this trend is likely to become even more obvious in the near future. It underlines the need for research programs aiming at defining the benefits and limits of liver resection in these patients. The current study demonstrated the deleterious effect of high preoperative ALT levels in patients with hepatitis C, which could be related to a poorer functional reserve of livers with active hepatitis, to a postoperative flare in superimposed hepatitis, or to a hyperkinetic state as suggested by the higher incidence of postoperative ascites, kidney failure, and upper gastrointestinal bleeding [24, 25].

The preoperative AST level and presence of active hepatitis within the nontumorous liver seem in our experience to be less reliable predictors of early postoperative outcome than the preoperative ALT level. Indeed, ALT is a more specific marker of liver damage than is AST [26]. Also, 20% of our patients with a transaminase level more than twice the normal upper range did not have evidence of superimposed hepatitis upon pathologic examination of the resected specimen. This discrepancy may be accounted for by a sparse distribution of pathologic features of hepatitis or to a difference between the kinetics and specificity of biologic and pathologic features of cytolysis [27]. Although patients undergoing major liver resections were at increased risk of postoperative complications, the extent of resection per se had no significant impact on outcome in this group of cirrhotic patients with preserved liver function, an observation previously suggested by other groups [5, 15]. Similarly we have, like others [3, 5, 19, 21], found that the amount of intraoperative blood loss was associated with an unfavorable outcome.

Special considerations therefore seem necessary when liver resection is considered in Child-Pugh A cirrhotic patients with high preoperative ALT levels. The first possibility is to postpone surgery until the ALT level has normalized, which may be anticipated to be achieved within a reasonably short time when cytolysis is related to a superimposed alcoholic hepatitis. In patients with HCV infection, spontaneous fluctuations of transaminase levels are often observed [28], but the decreased transaminase levels occurred with an unpredictable delay. An attractive possibility in these patients would be to institute, prior to resection, an antiviral therapy that has been shown to induce normalization of the transaminase levels [29]. Such a policy may prove effective in reducing the risk of liver resection and may at the same time be anticipated to reduce the risk of intrahepatic recurrence of HCC [30]. An alternative possibility would be to consider other therapeutic modalities, especially in patients in whom limited resection is not feasible, such as arterial chemoembolization, percutaneous alcoholization, or liver transplantation.

**Résumé**

Malgré une sélection des patients cirrhotiques ayant un carcinome hépatocellulaire (CIIC), la résection hépatique reste plus risquée chez le cirrhotique que chez le patient sans maladie hépatique sous jacente. Nous avons étudié, par analyse multifactorielle, les paramètres associés à une mortalité et une morbidité hospitalières chez un groupe sélectionné de 108 patients ayant une cirrhose de Child-Pugh A et un CHC. L'incidence globale de mortalité hospitalière et celle des complications postopératoires étaient respectivement de 8,3% et de 48,1%. En analyse univariée, les facteurs significatifs de mortalité étaient le taux préopératoire des alanines aminotransférases sériques (ALAT) (p = 0,001) et le taux de transfusion sanguine peropératoire (p = 0,01). La mortalité hospitalière des patients dont le taux d'ALAT était inférieur à 2 fois la normale (XN), entre 2XN et 4XN, et supérieur à 4XN était respectivement de 3,9%, de 13% et de 37,5%. Un taux d'ALAT supérieur à 2XN était observé principalement chez les patients ayant une infection IICV et ayant une histologie d'hépatite active surajoutée. Les patients ayant un taux d'ALAT supérieur à 2XN avaient plus souvent une ascite postopératoire (58% vs 32%, p = 0,01), une insuffisance rénale (16% vs 0%, p = 0,0003), et une hémorragie digestive haute (6,4% vs 0%, p = 0,02). Ces résultats indiquent que le taux préopératoire d'ALAT est un facteur prédictif de mortalité et de morbidité après résection hépatique chez le cirrhotique Child-Pugh A. Chez les patients cirrhotiques ayant un taux d'ALAT > 2XN, une résection hépatique limitée est indiquée. Si une résection plus importante est nécessaire, un traitement non chirurgical ou une transplantation hépatique doivent être proposés.

**Resumen**

A pesar de una cuidadosa selección de los pacientes cirróticos con carcinoma hepatocelular (CHC), la resección hepática continua asociada con un mayor riesgo que en los pacientes libres de enfermedad hepática subyacente. En el presente estudio hemos evaluado mediante análisis multivariable los parámetros que se asocian con mortalidad y morbilidad intrahospitalarias en un selecto grupo de 108 pacientes clasificados como Child-Pugh A sometidos a resección del CHC. Las tasas globales de muerte intrahospitalaria y de complicaciones postoperatorias fueron 8.3% y 48.1%, respectivamente. En el análisis univariable, el nivel preoperatorio de alanina-transferasa (ALT) sérica (p = 0.001) y de transfusiones intraoperatorias (p = 0.01) aparecieron significativamente asociados con la mortalidad intraoperatoria; sin embargo, sólo las concentraciones séricas de ALT aparecieron como un factor de riesgo independiente. Las tasas de mortalidad intraoperatoria en los pacientes en quienes la ALT sérica era menor de 2N, en los que tenían valores entre 2 y 4N y en los mayores de 4N, fueron 3.9%, 13% y 37.5%, respectivamente. Un

nivel de ALT mayor de 2N se observó principalmente en pacientes con infección HCV y apareció significativamente asociado con las características histológicas de una hepatitis activa superpuesta. Los pacientes con nivel de ALT mayor de 2N experimentaron una incidencia aumentada de ascitis postoperatoria (58 vs. 32%, $p = 0.01$), falla renal (16 vs. 0%, $p = 0.0003$) y sangrado del tracto gastrointestinal superior (6.4 vs. 0%, $p = 0.02$). Estos resultados indican que el nivel preoperatorio de ALT es un factor confiable de predicción de la mortalidad y la morbilidad intraoperatorias después de resección hepática en pacientes cirróticos clase Child-Pugh A. Los pacientes cirróticos con ALT $>$ 2N deben ser sometidos a una resección limitada; si se requiere una resección más amplia, ellos deben ser considerados para terapia no quirúrgica o para trasplante de hígado.

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# Invited Commentary

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Dr. Belghiti and his associates are to be commended for defining a simple method to assess the risk of hepatectomy in patients with hepatocellular carcinoma (HCC). Their study is unique in that the patients included in the study were all Child's A cirrhotic patients. It is well recognized that even among cirrhotic patients with preserved liver function postoperative mortality is high. Defining ALT of more than 2N of the normal value as a risk factor represents a step forward in selecting patients with Child's A liver function for hepatectomy. However, because the postoperative mortality of patients with ALT more than 2N was about 20%, selection of patients based on the preoperative ALT value alone may disallow the benefit of hepatectomy in 70% to 80% of patients who may survive the procedure. A better criterion, if available, would be the indocyanine green clearance test, which was shown on discriminate analysis to be superior to routine liver biochemistry and Child's grading [1, 2]. Whichever criterion or combinations of criteria are used, however, they should be viewed as guidelines only because the survival of patients after hepatectomy depends on many other factors as well.

Not mentioned in the study is the influence of continuous portal clamping on the liver with active hepatitis. Although the value of vascular inflow occlusion during hepatectomy for cirrhotic patients has not been documented by prospective randomized trials, the influence of continuous (rather than intermittent) portal clamping on metabolic function of the liver with concurrent liver cell death should not be underestimated. Another point not detailed is the volume of intraoperative blood loss, which has been shown to be an important determinant of survival in many studies; in this report, only the volume of blood transfusion was given. Blood volume transfusion could not be equated to the volume of blood loss, as nowadays many anesthetists and surgeons tend to minimize blood transfusion. As stated in the manuscript, the intraoperative blood loss was greater in patients with a high ($> 2N$) ALT level than that in patients with low ($< 2N$) ALT level. Although the exact volume of blood loss was not given, the effect of bleeding on the liver (i.e., hepatic hypoperfusion) might have been substantial if there is already existing liver cell necrosis. If the volume of blood loss could be accurately documented, blood loss may turn out to be the significant or equally important determinant of survival.

It is true that the immediate postoperative outcome depends on preoperative liver function; but once patients are selected on the basis of various criteria the outcome depends on the performance of the surgeon and the perioperative care [3]. In this regard, a keen awareness of hypoxic injury to the liver, avoidance of massive blood loss, and preservation of liver function are the keys to success. Such principles apply particularly to patients with marginal liver function.

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