Abstract

For patients who are candidates for surgical resection of the liver, advanced age has, for many years, been considered to be a limiting factor or has precluded intervention. More recently, improvements in diagnostic, surgical and anaesthetic techniques and the increase in the average age of the population have gradually broadened the indications for hepatic resection in elderly patients. The factors for reappraisal of the surgical risk of liver resection in elderly patients are discussed here. Comparative data are also presented on the mortality, morbidity and post-operative changes in blood chemistry parameters in 90 patients who underwent hepatic resection: 33 patients over 65 years of age (group A) and 57 under 65 years (group B). In group A, compared to group B, mortality (3% versus 5%) and the percentage of patients with post-operative complications (27% versus 37%) were not significantly different. The incidence of post-operative complications correlated more closely with specific risk factors (elevated pre-operative "ASA score" from associated disease) than with age itself. Analysis of the regressions did not reveal important relationships between age and changes in the blood chemistry parameters. These results help to support the idea that advanced age alone is not now an absolute contra-indication to major liver resection.
outcome of right hepatectomies in patients older than 70 years

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hypothesis: the increasing number of elderly patients undergoing liver resections mandates updating of clinical outcomes on this specific population.

design: case series.

setting: a tertiary care teaching hospital.

patients: twenty-three patients older than 70 years who underwent right hepatectomies (including 7 extended right hepatectomies) between january 1, 1995, and october 31, 2001 (group 1) and 99 patients younger than 70 years who underwent 64 right hepatectomies and 35 extended right hepatectomies during the same period (group 2) were included for a total sample population of 122.

main outcome measures: preoperative clinicopathological features, intraoperative factors, in-hospital mortality, postoperative complications, intensive care unit requirement, hospital stay, and course of main biochemical liver function test results of groups 1 and 2 were analyzed and compared.

results: the 2 groups were similar for indications for surgery and the presence of underlying liver disease. group 1 had a higher incidence of associated pulmonary diseases (21.7% vs 5%, p = .02) and patients with an american society of anesthesiologists score of iii (ie, a patient with severe systemic disease limiting activity, but not incapacitating) (56.5% vs 26.3% of cases, p = .01). there were no differences in intraoperative requirement of packed red blood cells and in operation time. there were no in-hospital deaths in group 1; there were 2 deaths (2%) in group 2. nine patients (39.1%) in group 1 and 32 patients (32.3%) in group 2 experienced postoperative complications (p = .53), of whom, respectively, 5 (21.7%) and 17 (17.2%) developed transient liver dysfunction (p = .56), and 4 (17.4%) and 5 (5.1%) required a supplementary intensive care unit stay (p = .06). the postoperative stay (mean [sd], 16 [14] days vs 13 [9] days, p = .88) and peak values of the aminotransferase level, total serum bilirubin level, and prothrombin time were similar in the 2 groups. the timing of the peak value of the total serum bilirubin level (mean [sd], 4.1 [4.8] days vs 2.5 [2.5] days, p = .28) and its period of normalization (mean [sd], 9.4 [10.8] days vs 6.7 [5.1] days, p = .67) were also similar for both groups. for patients with malignancies, the 3-year survival rate was 64.2% in group 1 and 53.9% in group 2 (p = .53).

conclusion: being older than 70 years should not be a contraindication for major hepatectomies, provided that liver cirrhosis and severe associated medical conditions are ruled out during the preoperative evaluation.

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for closer monitoring of respiratory and hemodynamic factors, depending on the preoperative ASA score, and/or on the length and complexity of the surgical procedure.

The rate of postoperative complications was 39.1% (9/23) in group 1 and 32.3% (32/99) in group 2, with an almost significantly greater number of group 1 patients requiring a supplementary ICU stay for early complications. Only one of these, however, was for causes determined by preoperative conditions (respiratory failure). Group 1 patients had a significantly longer postoperative ICU stay (for simple monitoring or owing to complications) compared with group 2 patients.

Five patients (21.7%) in group 1 and 17 (17.2%) in group 2 had various degrees of liver dysfunction; in most of them (4 and 14 patients, respectively), postoperative TSB value exceeded 5 mg/dL (>85 µmol/L). Liver dysfunction was the cause of death of 1 patient in group 2, whereas 2 patients in group 1 developed severe hepatic insufficiency requiring intensive medical treatment. One of them underwent RH (including the caudate lobe) for metastases from colorectal cancer, the liver function being apparently normal. An RH was performed, as the gross aspect of liver seemed to confirm preoperative findings, even though the resected specimen showed features of chronic hepatitis with initial fibrosis. His postoperative course was characterized by transitory hyperbilirubinemia, which resolved spontaneously.

A bile leakage was the most frequent among other complications in both groups (3 and 5 cases, respectively). Two patients (8.7%) in group 1 and 3 (3%) in group 2 were reoperated on owing to complications. In group 1, one patient required hemostasis because of bleeding and another biliostasis because of bile leakage from the cut surface of the liver. In group 2, one patient underwent thrombectomy for portal vein thrombosis (as described earlier), and 2 patients required delayed hepaticojejunostomy for accidental injury of the main hepatic duct during resection.

The mean hospital stay lasted around 2 weeks in the 2 study groups. (The analysis of postoperative liver function revealed almost equal peak values of all the factors examined (aspartate aminotransferase level, alanine aminotransferase level, TSB level, prothrombin activity, and activated partial thromboplastin time).
Postoperative TSB and prothrombin activity values peaked within similar intervals in the 2 groups (group 1, 4.1 and 2.5 days, respectively; and group 2, 3.1 and 2.9 days, respectively). The period required for normalization of postoperative TSB values, although slightly longer for patients in group 1 (9.4 vs 6.7 days), did not significantly differ.

All patients carrying benign liver diseases are alive. There were no significant differences in 1- and 3-year survival rates between patients of groups 1 and 2 with malignant tumors (84.4% vs 82.2%, and 64.2% vs 53.9%, respectively; P = .53).

**COMMENT**

The background allowing us to conduct the present study was the increasing age of patients undergoing liver resections for malignancies worldwide and the presumable high volume of elderly patients who will be evaluated for hepatectomies in our institution in the near future, given the progressive increase of age in recent years (Figure).

From our results, we could assume that advanced age itself should not be a contraindication for major hepatectomies, even in selected patients with hepatic alterations and/or carrying mild-degree-associated medical conditions. We demonstrated that the outcome of RHs and ERHs in patients older than 70 years was comparable to that of a younger population with similar indications for resection in the same period.

The 2 study groups were not different for any of the examined intraoperative factors, ie, blood and plasma consumption, duration of the operation, total clamping time, necessity of resecting the caval wall and/or a portion of the diaphragm, and intraoperative complications, which indicated a comparable complexity of the surgical procedure. The main issue, however, was the low perioperative mortality rate (1.6%), which was absent in elderly subjects and the reduced incidence of postoperative complications, similar to that reported in studies considering whichever type of resection and patients unsel ected for age.

Several groups have investigated the feasibility of liver resections in patients older than 65 years, but only very recently have some results proved satisfactory, with an operative mortality rate less than 5%. Indeed, the experience in the late 1980s and early 1990s showed an operative mortality for all types of hepatectomy ranging from 6% to 40% in elderly populations. Excellent results in terms of operative deaths (not exceeding 5%) and complications (<30%) have been described by some subsequent studies, but most of them included different surgical procedures (ie, minor and major hepatectomies) and different percentages of patients with cirrhosis. Only 1 study reported no operative mortality in a series of octogenarians who underwent liver resections for HCC. In fact, advanced age still represents a major negative factor for the early outcome, with an operative mortality rate of up to 42%, in most cases attributable to liver failure in patients with cirrhosis.

With the exception of 1 recent study, where 2 homogeneous groups of patients (>65 years or <40 years) with healthy livers undergoing RH were matched to define the selection criteria for elderly candidates for major hepatectomies, the previous reports were not comparable to the present one, solely addressing resections for HCC, or including all types of hepatectomies. None of them, in particular, specifically analyzed RHs or ERHs (ideally the least tissue-sparing procedures among major hepatectomies) in subjects older than 70 years.

The key points for referring aged subjects to major liver resections are a precise identification of associated medical diseases, a correct preoperative evaluation of the liver function, an accurate estimation of the residual functional hepatic mass, and a careful balancing of postoperative fluid infusion, but no limitations should be posed based exclusively on age. The first aspect has been widely investigated by others, focusing in particular on the ASA score. It has been found to not influence the postoperative mortality in 1 report, while advanced ASA score emerged as one of the most reliable predictors of postoperative complications and mortality in another study. Some authors have considered an ASA score higher than II (ie, a patient with mild to moderate systemic disease) as a contraindication for surgery for HCC or for major hepatectomies. We did not aim to weight the ASA score as an independent prognostic factor, even though older patients had a higher incidence of ASA III in our study. Despite the higher incidence of pulmonary and cardiovascular diseases, we did not indicate a routine admission to the ICU for them in the early postoperative period, although we observed a more frequent indication for ICU stay (precautionary or owing to complications) in elderly patients. However, only one among them was intensively treated for complications due to preoperative comorbidity.

The exact definition of the ASA is highly operator-dependent, and the already reported experience of postoperative deaths for causes unrelated to surgery (ie, myocardial infarction) in subjects with an unremarkable history of cardiac or pulmonary disease suggest that this score should be applied more selectively during the evaluation of elderly patients with underlying liver disease.
This latter element would lead to the exclusion of major hepatectomies in patients with cirrhosis, and the criteria for planning an adequate extent of the resection have already been reported. Together with the common tools used to exclude portal hypertension, we have adopted the lidocaine test for the assessment of functional reserve in subjects with cirrhosis, considering the value of 25 µg/mL as the lower limit to indicate a major resection. In fact, 3 older patients in this series had chronic hepatitis, but none had cirrhosis, while in the younger group 8 had chronic hepatitis and 6 had cirrhosis. Among patients with cirrhosis, 3 had an uneventful postoperative course, 2 developed temporary mild liver failure, and 1 died of myocardial infarction on the second postoperative day. In 2 recent French studies, the presence of underlying liver disease has been envisaged as one criterion contraindicating RH in elderly subjects, whereas grade IV fibrosis (ie, cirrhosis) has been identified as the leading cause of postoperative liver failure and mortality after major liver resection. We agree that aged patients with liver disease can undergo RH or ERH only when the liver function is fully preserved, thus ruling out overt cirrhosis, and when the ASA score is less than III. The rate of hepatic steatosis allowing safe liver surgery is not yet clearly defined, although a moderate value of 25 µg/mL as the lower limit to indicate a major resection. However, although it is impossible to exactly predict this feature before surgery without a liver biopsy specimen, this diagnostic tool should be considered when the presence of steatosis is suggested by imaging and a major resection is planned.

The adoption of techniques such as preoperative percutaneous biliary drainage to relieve jaundice, which has been envisaged as negatively affecting the postoperative outcome, or portal vein embolization to increase the volume of the remnant liver, led us to include 3 otherwise inoperable elderly patients, thus increasing the resectability rate.

Although the 2 groups of patients in our study were not categorized according to a marked difference in age, we concluded that the postoperative recovery of hepatic function, as assessed by common biochemical factors (ie, transaminase levels, TSB level, prothrombin activity, and activated partial thromboplastin time) is not strictly age related, in accord with what is expressed in previous studies. Factors other than age (ie, hepatic diseases, temporary ischemia, or remnant liver volume) play the main role, although the slightly later collocation of the postoperative peak of the level of TSB seems to support the fact that older livers probably react to injuries with a more prolonged cholestasis.

In summary, major hepatectomies are feasible procedures in patients older than 70 years who have preserved liver function and controllable medical conditions, yielding 0% operative mortality and low morbidity rates in specialized tertiary centers.

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REFERENCES

Outcomes after Major Hepatectomy in Elderly Patients

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BACKGROUND: We aimed to study the early and long-term outcomes of patients 70 years and older undergoing major liver resections and compare the results with patients below the age of 70 years.

STUDY DESIGN: All patients undergoing major liver resection (defined as three segments or more) from January 1993 to June 2004 were included. Patients were studied in two groups: 70 years of age and older (group E, elderly) and less than 70 years old (group Y, young). Early outcomes and long-term survival were analyzed.

RESULTS: A total of 517 patients underwent major liver resection: group E, n = 127; group Y, n = 390 patients. There was no difference in operative mortality (group E, 7.9%; group Y, 5.4%; p = 0.32) or postoperative morbidity (p = 0.22) between the groups. Overall and disease-free survivals were not notably different for all patients (59% versus 57%, p = 0.89; 60% versus 55%, p = 0.28, respectively) or for a subgroup of patients with colorectal liver metastases (61% versus 55%, p = 0.76; 60% versus 47%, p = 0.07) in groups E versus Y, respectively. In multivariable analysis, American Society of Anesthesiologists grade 3 (p = 0.024, hazard ratio [HR] = 1.59, versus grade 1, 95% CI = 1.06 to 2.39) and intraoperative transfusion > 3 U (p < 0.0005, HR = 2.56, 95% CI = 1.84 to 3.56) were predictors for overall survival. More than three tumors (p = 0.025, HR = 1.41, 95% CI = 1.04 to 1.90) and redo resection (p = 0.001, HR = 2.80, 95% CI = 1.51 to 5.19) were predictors of disease-free survival.

CONCLUSIONS: Major liver resections can be safely performed in patients 70 years of age or older, with early results and survival similar to those in the younger than 70 age group. American Society of Anesthesiologists grade 3 and intraoperative transfusions > 3 U were predictors for overall survival, and more than three tumors and redo resection were predictors for disease-free survival. (J Am Coll Surg 2006;203:677–683. © 2006 by the American College of Surgeons)
free survivals at 3 years for all patients were 60% and 55% for groups E and Y, respectively. There was also no pronounced difference in overall and disease-free survivals for the subgroup of patients with colorectal metastases in group E versus group Y (Fig. 3, 4). The overall survivals at 3 years for patients with colorectal metastases were 61% and 55% for groups E and Y, respectively; disease-free survivals at 3 years were 60% and 47% for groups E and Y, respectively. Univariate analysis was done for both groups looking at age, gender, ASA grade, preoperative serum bilirubin, intraoperative transfusion, tumor number, tumor size, redo liver resections, and quality of the liver (abnormal versus normal) as factors for overall and disease-free survival. On univariate analysis, ASA grade 3 and intraoperative blood transfusion were major predictors for overall survival (Table 3). On univariate analysis, redo liver resection and tumor number greater than three were important predictors of disease-free survival (Table 4). Age, ASA grade, and intraoperative blood transfusion were used as covariates in a multivariable analysis of predictors of overall survival after major hepatectomy. In Cox regression analysis, both ASA grade 3 and intraoperative blood transfusion > 3 U were found to be major predictors of overall survival (Table 5). Also, in multivariable analysis, tumor number greater than three and redo liver resections remained major predictors for disease-free survival (Table 6).

**DISCUSSION**

Elderly patients are more likely to have decreased life expectancy with comorbidity, so the decision to perform major hepatectomy has to be carefully balanced against the likelihood of benefit before undertaking such resections. But most studies have had small numbers or have not distinguished between major and minor resections, making interpretation of results difficult. This is the largest series of major hepatic resections in patients older than 70 years comparing the results with patients younger than 70 years. In this study, all liver resections in group E were major liver resections, and 37% of these were extended resections. Other studies, by Hanazaki and colleagues (n = 16, 15%) and Aldrighetti and associates (n = 11, 34%), which have analyzed liver resections in the elderly (older than 70 years), have reported both a smaller number and proportion of major resections.

In-hospital mortality after major hepatic resections in this study revealed no substantial difference for groups E and Y. Some early studies reported higher mortality rates of 11% to 30% after major hepatic resections in the elderly (65 to 70 years). Lower mortality rates of <
(older than 70 versus younger than 70 years) undergoing liver resection for colorectal metastases. Hanazaki and co-authors also reported no difference in overall and disease-free survival in a large series of elderly patients undergoing liver resection, although this was for hepatocellular carcinoma. But this study is the largest one that has assessed long-term outcomes after major liver resection for colorectal liver metastases and shown that the survival is no different than that for patients in the younger (less than 70 years) age group undergoing a similar resection.

ASA grade 3 and intraoperative blood transfusion were the only major predictors in univariate and multivariable analyses affecting overall survival. Fong and colleagues showed ASA grade to be a predictor of poor clinical outcomes, but this was looking at cardiopulmonary complications and not overall survival. Redo liver resections and more than three tumors were predictors for disease-free survival in both univariate and multivariable analyses. First and repeat hepatic resections for colorectal metastases have also been safely performed in elderly patients, and more patients in our unit are currently being assessed with view to a repeat resection.

In the current climate of scarce health care resources, treatment for elderly patients has been under close scrutiny. Although there have been several studies showing that elderly patients have benefited from liver resection for malignancy, most have reported small numbers, so they are a highly select group. This large comparative study looking at the elderly population over 70 years of age undergoing major hepatectomy has shown that they have similar early and long-term outcomes compared with patients younger than 70 years of age. Use of health care resources in terms of ICU and in-hospital stays is no different in the younger population, and some of this can be attributed to better support in terms of anesthesia and community nursing. ASA grade and need for intraoperative blood transfusion > 3 U are the only factors that were predictors for overall survival. So careful selection of patients using the ASA grade and minimalization of blood loss during liver resection are essential for better outcomes after major hepatic resection in patients over the age of 70 years.

**Author Contributions**

Study conception and design: Menon, Toogood

Acquisition of data: Al-Mukhtar, Aldouri

Analysis and interpretation of data: Menon, Aldouri

Drafting of manuscript: Menon, Toogood

Critical revision: Prasad, Lodge

**REFERENCES**


Surgery in Elderly People - Anesthetic Considerations And Operative Issues, Perioperative Pain Management, Delirium And Postoperative Cognitive Dysfunction, Other Complications

Surgery on elderly people was once uncommon, but as the population has aged it has become much more frequent. There has also been a change in who is thought of as old, and studies based on someone sixty-five years old provide incomplete insight into the issues surrounding appropriate therapies for the “new” geriatric patient.

The traditional view of risk for surgical procedures has focused more on chronological than biological age. Advanced age has generally been considered to carry a higher risk of illness and complications (morbidity), and of death (mortality). In consequence, life-saving procedures such as cardiac, vascular, or oncology procedures can be delayed or withheld. However, relying on age alone to determine a patient’s response to surgery can be inappropriate.

Chronological age can, of course, serve as a marker for increased physiological frailty. Frail older adults (the “new” geriatric patient) frequently suffer from multisystem disease, several comorbidities, and polypharmaceutic regimens (an excessive number of medications). Frailty implies not just lower reserve capacity, but also an interaction of social and medical problems. In consequence, the decision to perform surgery should be multidisciplinary in nature, encompassing not only the suitability to withstand the stress of surgery, but also the rehabilitation and social supports required for hospital discharge.

Read more: JRank Articles http://medicine.jrank.org/pages/1726/Surgery-in-Elderly-People.html#ixzz3pZz6wa7H
PERIOPERATIVE COMPLICATIONS OF LIVER RESECTION IN THE ELDERLY WITH HEPATOCellular CARCINOMA: A COMPARISON WITH YOUNGER PATIENTS

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SUMMARY

Background: Liver resection surgery in patients with hepatocellular carcinoma is a high-risk procedure with an in-hospital mortality rate around 5%. Patient age and volume of blood loss were found to be independent predictive factors of long-term outcomes in previous studies. We sought to clarify the age-related differences in the perioperative complications during the whole admission for liver resection surgery.

Methods: This retrospective study included 210 patients scheduled for elective liver resection from July 2006 to July 2008. The characteristics of the patients, intraoperative events, and postoperative complications were retrieved from medical charts, anesthesia records stored in a computer database, and the quality assurance system in our department. The patients were divided into two groups: Group A, aged 60 years or older (n = 91); and Group B, aged younger than 60 years (n = 119). Postoperative complications and intraoperative parameters were compared using the Student’s t test for continuous data, and χ² test for categorical data. Correlations of age with blood loss, operation time, urine output, length of intensive care unit stay, total admission time, and intubation time were examined with the Pearson’s correlation. Analysis of variance was used to investigate the endotracheal intubation time with different postoperative pain control methods.

Results: No differences in intraoperative blood loss, total operation time, urine output during surgery, in-hospital death, difficulty of operation, and incidence of massive blood loss and oliguria were found between the two groups. The length of intensive care unit stay and total admission time were significantly longer in the elderly group (p = 0.04 and 0.01, respectively). There was a higher incidence of postoperative respiratory complications in the elderly as revealed by a longer intubation time in Group A than in Group B (p = 0.03).

Conclusion: In contrast to some surgeries for emergency conditions such as long bone fracture or acute abdomen, the perioperative complications in the elderly receiving elective liver resection surgery did not differ markedly from those of younger patients. However, elderly patients would benefit even more if comprehensive postoperative care or newly improved therapies can be provided to lessen the incidence of perioperative respiratory complications. [International Journal of Gerontology 2009; 3(2): 101–107]

Key Words: general anesthesia, geriatrics, hepatocellular carcinoma, perioperative care, surgery

Introduction

Almost all elderly people have disabilities or disorders in more than one organ system when they present to hospital. Therefore, taking good care of these patients necessitates the cooperation of specialists from a variety of medical and paramedical fields. The elderly population is the most explicit target of so-called "total patient
Total vascular exclusion technique for resection of hepatocellular carcinoma

Zhen-Yu Yin, Xiao-Ming Wang, Ren-Xiang Yu, Bai-Meng Zhang, Ke-Ke Yu, Ning Li, Jie-Shou Li

AIM: To improve the low resection rate, poor prognosis and to control the massive hemorrhage during operation, total vascular exclusion (TVE) technique was used in hepatotomies of advanced and complicated hepatocellular carcinomas (HCCs).

METHODS: Five hundred and thirty patients with HCCs were admitted in our hospital. They were divided into TVE technique group (group A: n=276), Pringle maneuver method group (group B: n=176) and unresectable group (group C: n=276). The clinical, operative, pathological parameters and outcome of the patients were statistically evaluated.

RESULTS: Group A had a significantly higher resection rate than group B (accounting for 47.92 % and 33.21 % respectively). There was no significant difference in blood loss, blood transfusion and perioperative mortality between groups A and B. Both groups had the similar median disease free survival time (14.6 vs 16.3 months) and 1 year survival rate (92.9 % vs 95.5 %). The TVE group had a medial survival time of 40.5 months and its 5-year survival rate was 34.6 %. 

CONCLUSION: As compared with Pringle maneuver method, the total vascular exclusion is a safe and effective technique to increase the total resection rate of advanced and complicated HCCs.

INTRODUCTION

At present, operations including tumor resection and liver transplantation offer the only chance of cure for the patients with HCCs[5-7], and hepatectomy remains the normal choice when liver transplantation is not available. HCCs we met were mostly advanced with a low resection rate and had a high risk of lethal blood loss during operation as well as a high mortality after operation especially when the liver was affected by chronic hepatitis or cirrhosis[2-7]. To avoid excessive bleeding and blood transfusion, several methods to limit bleeding have been developed since hepatic portal clamping was successfully performed by Pringle in 1908, which led to the development of total vascular exclusion (TVE) of the liver by Heaney in 1966. Since then, Huguet and his colleagues have better characterized and widely advocated the use of TVE, which can greatly reduce the risk of massive hemorrhage and air embolism[9].

Pringle maneuver method is routinely used in hepatectomy to control blood loss during HCCs operation, TVE is there fore controversial. To the present, no study has documented its safety and efficacy as compared with Pringle maneuver method in resection of HCCs. This study was review our experiences with resection of HCCs by TVE and Pringle maneuver methods.

MATERIALS AND METHODS

Patients

From January 1994 to January 2002, 530 patients with HCCs were admitted in our hospital, they were divided into 3 groups. Group A: 78 patients with complicated HCCs underwent total vascular exclusive hepatotomies. Group B: 176 patients with HCCs underwent Pringle maneuver hepatotomies. Group C: 276 patients with unresectable HCCs underwent conservative treatments such as transhepatic artery embolization.

 Diagnosis and vascular exclusion selection

HCCs were diagnosed by examinations such as serum tumor marker α-fetal protein, B-type ultrasound, plain or enhanced spiral computed tomography, magnetic resonance imaging before operation. The diagnosis was confirmed by pathologic examination after operation.

Pringle maneuver method was routinely used in the hepatectomy in our center, and the TVE was only used in advanced and complicated HCC patients such as massive tumors needing major hepatectomy, tumor closing or invading the major blood vessels of liver, tumor in the caudate lobe and multiple tumors.

Perioperative care and treatment

Preoperative care: A venous catheter was introduced one week before operation for routine parenteral nutrition to improve the patient’s liver function, nutritional status and coagulation condition. During perioperative care period, frozen plasma should be infused and blood transfusion must be strictly controlled. Blood loss and ascites production during the operation were balanced by infusing fresh frozen plasma. Intraoperative blood transfusion was given only if the hematocrit value was below 0.30. To prevent bleeding, hemostatic drugs such as fibrinogen and thrombinogen were always intravenously given. The main aim during the first few postoperative days was to restore the liver function and prevent hepatic failure. We used 20 % human albumin 100-200 ml/day to maintain the serum protein level. Glucose solution was given for the energy, and short-term antibiotics, histamine blockers were also administrated. Appropriate oral intake was restored as soon as possible. The blood discharge from the drain was
carefully monitored. When bleeding exceeded 100 mL/h, an emergency laparotomy was performed. The patients were taken care of in an intensive care unit for the first 24 to 48 hrs with their the life signs inspected. Immediate postoperative treatments included hemostasis, prophylaxis antibiotic treatment and total parental nutritional support.

**Operative technique**

The surgical technique was described previously[2,8]. In general, a bilateral subcostal incision with or without an upward midline extension was used, and intraoperative ultrasound was routinely used to determine location of the tumor, or possible tumor modules in the contralateral lobe and the exact relationship between the tumor and the major liver blood vessels. In group A, all the hepatic ligaments were divided to allow complete mobilization of the liver and exposure of the whole retrohepatic vena cava. TVE was prepared by carefully dissecting the suprahepatic and infrahepatic vena cava, and right adrenal veins and accessory hepatic veins were ligated if necessary to allow complete venous control during clamping. Clamps were always applied in the following sequence: hepatoduodenal ligament, infrahepatic vena cava and suprahepatic vena cava. During transection of the liver, 5 min interval was always allowed in every 15-20 min TVE until the transection was over. After the resection was completed, the clamps were removed in reverse order of their application. Pringle maneuver method was applied in group B at the time of liver transection and consisted of cross-clamping the hepatoduodenal ligament until the liver transection was completed. If the time was more than 20 min, the clamp was released for about 5 min until the operation was completed. Hemostasis of the raw surface of the liver was assured by biological fibrin glue and exact suture. Closed drainage was routinely used before closure of the incision.

**Data collection and analysis**

All medical records of the patients of the three groups were reviewed retrospectively. Major hepatectomy was defined as resection of two or more liver segments according to Goldsmith and Woodburne, while minor hepatectomy was defined as resection of only one segment[2]. Tumor closing or invading the major liver blood vessels was defined as the distance between them which was less than 1 cm.

The values were expressed as median (range) and cases (percent). The overall survival after hepatic resection was calculated by the Kaplan-Meier method. Statistical evaluations were performed by using unpaired Student t test and chi-square analysis, and comparison was made by log rank analysis. Statistical significance was determined by a P value of less than 0.05. Calculations were made with SPSS computer software (Chicago, IL).

**RESULTS**

As shown in Table 1, the two groups (groups A and B) of patients were similar in terms of age, sex. Both groups had similar high HBV infectious rate. Although the operative time and blood exclusive time were long in TVE group, no significant difference was found in blood loss and blood transfusion between groups A and B. More major hepatectomies and caudate lobe hepatectomies were performed in group A than in group B. Although higher cirrhosis rate, multiple tumor possibility, more caudate lobe location and higher risk of tumor rupture were found during operation in group A than in group B, the possibilities of tumor free resection margin in the two groups were similar.

**Table 1 General clinical data**

<table>
<thead>
<tr>
<th>Clinical parameters</th>
<th>Group A (n=78)</th>
<th>Group B (n=176)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yr)</td>
<td>51.72 (36-71)</td>
<td>49.66 (14-74)</td>
</tr>
<tr>
<td>Male</td>
<td>69 (88.64 %)</td>
<td>147 (83.52 %)</td>
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<tr>
<td>HbsAg (+)</td>
<td>67 (85.89 %)</td>
<td>151 (85.79 %)</td>
</tr>
<tr>
<td>Child-Push grade</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grade A</td>
<td>41 (52.54 %)*</td>
<td>124 (70.45 %)</td>
</tr>
<tr>
<td>Grade B</td>
<td>28 (35.90 %)*</td>
<td>38 (21.59 %)</td>
</tr>
<tr>
<td>Grade C</td>
<td>9 (11.53 %)</td>
<td>14 (8.0 %)</td>
</tr>
<tr>
<td>Total resection rate</td>
<td>47.92%(254/ 530)*</td>
<td>33.21 %(176/ 530)</td>
</tr>
<tr>
<td>Procedure time (min)</td>
<td>268 (150-325)*</td>
<td>178 (128-356)</td>
</tr>
<tr>
<td>Blood exclusion time (min)</td>
<td>25.4 (12-55)*</td>
<td>14 (28-28)</td>
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<tr>
<td>Blood loss (ml)</td>
<td>818 (250-2800)</td>
<td>725 (180-2400)</td>
</tr>
<tr>
<td>Blood transfusion (ml)</td>
<td>690 (0-2400)</td>
<td>620 (0-2600)</td>
</tr>
<tr>
<td>Total hospital stay time (d)</td>
<td>29.4 (12-35)</td>
<td>19.8 (10-39)</td>
</tr>
<tr>
<td>Re-operation</td>
<td>11 (14.10 %)</td>
<td>16 (9.09 %)</td>
</tr>
<tr>
<td>Emergency operation</td>
<td>5 (6.41 %)</td>
<td>9 (5.11 %)</td>
</tr>
<tr>
<td>Local hepatectomy</td>
<td>12 (15.38 %)*</td>
<td>48 (27.28 %)</td>
</tr>
<tr>
<td>Minor hepatectomy</td>
<td>21 (26.92 %)*</td>
<td>96 (54.55 %)</td>
</tr>
<tr>
<td>Major hepatectomy</td>
<td>45 (57.69 %)*</td>
<td>32 (18.19 %)</td>
</tr>
<tr>
<td>Caudate lobe hepatectomy</td>
<td>4 (5.13 %)*</td>
<td>0 (0)</td>
</tr>
</tbody>
</table>

*P <0.05 vs statistically significant when compared with group B.

**Table 2 Pathologic data**

<table>
<thead>
<tr>
<th>Clinical parameters</th>
<th>Group A (n=78)</th>
<th>Group B (n=176)</th>
</tr>
</thead>
<tbody>
<tr>
<td>The mass</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Median diameter (cm)</td>
<td>11.58 (6.2-24.6)*</td>
<td>6.25 (1.8-12.7)</td>
</tr>
<tr>
<td>&gt;or =5 cm</td>
<td>72 (92.30 %)*</td>
<td>118 (67.05 %)</td>
</tr>
<tr>
<td>&gt;or =10 cm</td>
<td>53 (67.95 %)*</td>
<td>28 (15.90 %)</td>
</tr>
<tr>
<td>Close or invade vana cana</td>
<td>23 (29.49 %)*</td>
<td>17 (9.65 %)</td>
</tr>
<tr>
<td>Close or invade major hepatic vein</td>
<td>21 (26.92 %)*</td>
<td>13 (7.39 %)</td>
</tr>
<tr>
<td>Close or invade major bile duct</td>
<td>11 (14.10 %)*</td>
<td>8 (4.55 %)</td>
</tr>
<tr>
<td>Close or invade major port vein</td>
<td>32 (41.03 %)*</td>
<td>22 (12.5 %)</td>
</tr>
<tr>
<td>TNM tumor stage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stage 1</td>
<td>6 (7.69 %)*</td>
<td>49 (27.84 %)</td>
</tr>
<tr>
<td>Stage 2</td>
<td>12 (15.38 %)*</td>
<td>71 (40.34 %)</td>
</tr>
<tr>
<td>Stage 3</td>
<td>36 (46.15 %)*</td>
<td>32 (18.19 %)</td>
</tr>
<tr>
<td>Stage 4a</td>
<td>20 (25.64 %)*</td>
<td>22 (12.5 %)</td>
</tr>
<tr>
<td>Stage 4b</td>
<td>4 (5.13 %)*</td>
<td>2 (1.14 %)</td>
</tr>
<tr>
<td>Cirrhosis</td>
<td>59 (75.64 %)</td>
<td>120 (68.18 %)</td>
</tr>
<tr>
<td>Multiple tumor</td>
<td>8 (10.25 %)*</td>
<td>6 (3.41 %)</td>
</tr>
<tr>
<td>Caudate lobe tumor</td>
<td>4 (5.13 %)*</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Tumor free resection margin</td>
<td>74 (94.87 %)</td>
<td>173 (96.3 %)</td>
</tr>
<tr>
<td>Tumor rupture during operation</td>
<td>11 (14.10 %)*</td>
<td>13 (7.39 %)</td>
</tr>
</tbody>
</table>

*P <0.05 vs statistically significant when compared with group B.

Bleeding was most common short-term complication after hepatectomy, but there was no significant difference between the two groups, accounting for 20.5 % and 16.48 %, respectively. Although the complications in group A including bile leakage, ascites, pleural effusion, jaundice, hepatic failure were significantly higher than those in group B, the reoperation