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Hepatic surgery at a VA tertiary medical center: lessons learned

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Abstract

BACKGROUND: The development of a hepatic surgery center within a US Department of Veterans Affairs hospital is dependent on proper training and institutional support, which can translate into low operative morbidity and mortality rates.

METHODS: Patients who underwent hepatic procedures between 2003 and 2009 were retrospectively reviewed. A subset analysis of laparoscopic liver resections for patients with hepatocellular cancer (HCC) was performed. One hundred twenty-six patients underwent 130 hepatic procedures, 65% of which were hepatic resections. Ninety-seven percent of cases were for malignant disease, including HCC (70%).

RESULTS: The morbidity and mortality rates were 15.5% and 2.4%, respectively. For patients with HCC there was no difference in operative outcomes or overall survival when procedures were performed laparoscopically.

CONCLUSIONS: A Veterans Affairs (VA) hospital specializing in hepatic surgery can achieve low complication rates comparable with those of high-volume centers. The numbers of patient referrals and hepatic resections and the proportion of laparoscopic operations increased after the creation of a dedicated hepatic surgery center within a single VA hospital.

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Hepatic surgery requires specialized training. There have been many advances in liver surgery over the past 2 decades that have led to significant improvements in patient safety and overall outcomes. The most commonly recognized advances include improved perioperative care and anesthesia, new hemostatic technologies, better understanding of intrahepatic anatomy, and the establishment of high-volume centers. One important factor that has received less attention is the recent sharp increase in fellowship positions that now provide focused training in liver surgery at academic and nonacademic high-volume centers. These fellowships include advanced gastrointestinal surgery, surgical oncology, and liver transplantation. It is predictable that appropriate fellowship training in liver surgery can lead to equivalent outcomes similar to those achieved by the major training programs. Indeed, the increased number of specialty-trained liver surgeons probably accounts for the vast proliferation of not only safe techniques in liver surgery but also detailed

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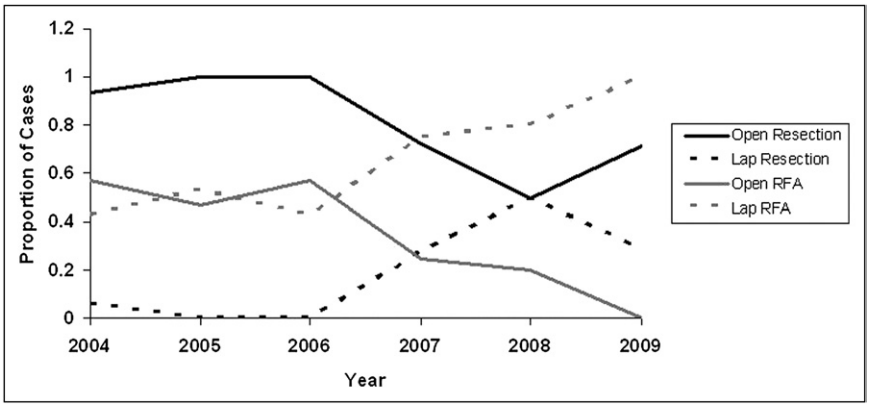

Figure 1 Annual proportion of liver procedures done by either laparoscopy or open technique from 2003 to 2009. The proportion of open (solid lines) hepatic resections and radiofrequency ablation (RFA) procedures declined starting in 2006. In contrast, the numbers of laparoscopic (dashed line) resections and RFA procedures increased.

knowledge and understanding of liver-related diseases that are important aspects for patient selection. Therefore, we hypothesize that appropriate fellowship training combined with a supportive hospital environment can translate into low operative morbidity and mortality rates even at low-volume medical centers.

Herein, we report the early experience in hepatic surgery and outcomes of a single surgeon, previously trained at a high-volume liver surgery center, who significantly increased the volume of liver surgery at a US Department of Veterans Affairs (VA) medical center over a relatively brief time interval. The purpose of our study was to examine trends in patient referral patterns, perioperative outcomes, long-term outcomes, and changes in treatment modality over the study period. We review the spectrum of liver disease treated by surgery and then focus our analysis on the most common hepatic malignancy (ie, primary liver cancer) in the veteran population. In particular, we describe our experience managing patients with chronic hepatitis C virus–related hepatocellular cancer (HCC) and liver cirrhosis.

We found that over a 6-year time interval, the number of patient referrals increased significantly, and while the total number of hepatic resections steadily increased, the proportion of operations done open was reduced by the introduction of the laparoscopic technique.

Methods

A retrospective analysis of a prospectively maintained database identified 126 patients who underwent liver-related procedures between November 2003 and June 2009. Patients were typically referred after undergoing preliminary workup at other VA medical center–affiliated institutions, and yearly referral patterns were analyzed. Data for analysis included demographics, clinical histories, imaging results, laboratory values, operative findings, and clinical follow-up information. Complications were graded according to the Clavien-Dindo classification system.[1] In a subset analysis, 28 laparoscopic liver resections in cirrhotic patients with HCC were compared with open operations in 25 consecutive patients. Data analyzed included patient demographics, resection type, and survival outcomes.

Statistical analysis

Two-tailed Student's t tests were used for statistical analysis of intraoperative and postoperative metrics. Statistical significance was considered at $P < .05$. A Kaplan-Meier outcome analysis was performed to analyze survival outcomes. The study was approved by the San Francisco VA Medical Center and the University of California, San Francisco, Committee on Human Research in accordance with all guidelines.

Results

Patient referral patterns

One hundred twenty-six patients underwent 130 liver procedures between November 2003 and June 2009. Patients were referred from 5 different Veterans Integrated Service Networks, and 79% of patients were from outside the San Francisco VA Medical Center. Yearly referrals from health care systems outside San Francisco increased progressively from 2003 (data not shown). Additionally, the proportion of liver procedures performed laparoscopically, including resections and radiofrequency ablations, has generally increased since 2004 (Fig. 1).

Demographics

Analysis of population demographics revealed a preponderance of elderly male patients. Operative risk was assessed by American Society of Anesthesiologists risk assessment scale, and a minority of patients were identified as

Table 1 Patient demographics and procedures (n = 126)

Variable	Value
Sex	
Male	123 (98%)
Female	3 (2%)
Mean age (y) (range)	62.3 (37–91)
Preoperative risk (ASA class)	
I	0 (0%)
II	4 (3%)
III	91 (72%)
IV	31 (25%)
Disease	
Benign	4 (3%)
Malignant	122 (97%)
Primary liver	91 (72%)
Extrahepatic	6 (5%)
Metastatic liver	25 (20%)
Intervention	
Resections	84 (65%)
Right hepatectomy	16 (12%)
Extended right hepatectomy	6 (5%)
Left hepatectomy	10 (8%)
Extended left hepatectomy	3 (2%)
Central hepatectomy	3 (2%)
Segmentectomy/wedge	46 (35%)
Radiofrequency ablation	46 (35%)

ASA = American Society of Anesthesiologists.

in class II (mild systemic disease), whereas the majority were deemed in class III (severe systemic disease) or class IV (severe systemic disease that is a constant threat to life). Nearly all procedures were done for the treatment of malignant disease, with only 3% representing benign disease. Primary liver cancer was the most common malignant disease, with HCC constituting the majority. Unlike most contemporary series, metastatic liver cancer (melanoma, renal cell carcinoma, neuroendocrine tumors, and colorectal carcinoma) represented a minority our patient population (Table 1).

Type of liver procedure

A total of 84 resections were done, of which 29 (34.5%) were completed laparoscopically. Radiofrequency ablation was done in 46 patients, with 33 procedures (71.7%) completed laparoscopically. Of patients who underwent resection for malignant disease, operations performed included formal and extended right and left hepatectomies, central hepatectomies, segmental resections, and wedge resections (Table 1). Overall tumor size averaged 4.96 cm. Median overall operative time was 390 minutes, and median estimated blood loss was 700 mL. Postoperatively, median hospitalization was 10 days, and overall major morbidity (Clavien-Dindo class III–V) was 15.5%. Complications included biloma (n = 1), renal failure requiring dialysis (n = 5), hepatic insufficiency (n = 4), and pulmonary embolism (n = 1). There were 2 deaths within 30 days of operative intervention, for an overall mortality of 2.4%.

Comparison of open versus laparoscopic liver resection for HCC

Twenty-eight laparoscopic liver resections were done in cirrhotic patients with HCC. Results from these patients were compared with those from 25 consecutive patients with similar demographics who underwent open resections (Table 2). At the time of surgery, the average age for patients in the laparoscopic group was 61 years, whereas in the open group, it was 65 years. There was 1 woman in each group. Hepatic reserve was measured by Child-Pugh classification and Model for End-Stage Liver Disease score. Nearly all patients were in class A, though there were 2 patients in class B and 1 patient in class C in the laparoscopic group. The mean Model for End-Stage Liver Disease scores were 9.4 in the laparoscopic group and 8.6 in the open group.

Mean tumor size in the laparoscopic patients was 4.0 cm, compared with 5.2 cm in the open group. There were no significant differences between measurable preoperative demographic or health metrics between the 2 groups. There were more left lateral segmentectomies and anatomic segmental resections (n = 8 vs n = 0 and n = 12 vs n = 6, respectively) in the laparoscopic group compared with the open group. As expected, there were more formal anatomic right and left hepatectomies in the open group (n = 9 vs n = 5 and n = 6 vs n = 0, respectively). There was no statistical difference in median operative time between the laparoscopic and open groups (317 vs 379 min, respectively, P = .33). There was a statistically significant lower median estimated blood loss when procedures were done by laparoscopy (200 vs 825 mL, P = .003). Thus, fewer patients required intraoperative blood transfusions (4 vs 9) when resections were done laparoscopically. In terms of perioperative outcomes, there was no difference in median hospital stay between the laparoscopic and open groups (7 vs 9 days, P = .71). The major morbidity rate was higher in the open group (20%) compared with the laparoscopic group (10.7%). There were no deaths in either group. Importantly, evaluation of overall survival by Kaplan-Meier analysis at 39 months showed no difference between laparoscopic and open resections (66% vs 63%, respectively, P = .65; Fig. 2). Similarly, disease-free survival probability showed no difference at 32 months (47% vs 35%, P = .34). Median follow-up was 24 months for laparoscopic resections and 28 months for open resections.

Discussion

Historically, hepatic resections were regarded as technically difficult and hazardous operations associated with high perioperative morbidity and mortality rates.[2] Fortunately, over the past 2 decades, significant strides have been made in hepatic resectional surgery, with many factors contributing to the current safety of even more complex procedures.

Table 2 Laparoscopic versus open liver resection in cirrhotic patients with HCC

Variable	Laparoscopic (n = 28)	Open (n = 25)	*P*
Mean age (y) (range)	61.4 (37–81)	65.1 (49–88)	.19
Men/women	27/1	24/1	
Hepatic reserve (Child-Pugh class)			
A	25	25	
B	2	0	
C	1	0	
Hepatic reserve (MELD score)	9.4	8.6	.20
Operative risk (ASA class)			
II	4	6	
III	20	17	
IV	4	2	
Mean tumor size (cm)	4.0	5.2	.12
Limited resections (<3 segments)			
Left lateral	8	0	
Anatomic segmental	12	6	
Wedge	3	4	
Major resections (≥3 segments)			
Right hepatectomy	4	5	
Extended right hepatectomy	1	4	
Left hepatectomy	0	4	
Extended left hepatectomy	0	2	
Median operative time (min)	317	379	.33
Median estimated blood loss (mL)	200	825	.003
Number of intraoperative transfusions	4	9	
Median length of stay (days)	7	9	.71
Complications (grade)			
I	6 (ileus, wound infection)	2 (wound infection)	
II	3 (ascites, line infection)	5 (ascites, line infection)	
III	1 (biloma)	3 (biloma)	
IV	2 (renal failure)	2 (renal failure, pulmonary embolism)	
V	0 (death)	0 (death)	

ASA = American Society of Anesthesiologists; MELD = Model for End-Stage Liver Disease.

No single factor accounts for the marked improvement in the safety of liver surgery; however, the emergence of hepatobiliary surgery as a distinct area of specialization may emerge as the most important factor.[3] In the present study, we examined consecutive unselected patients undergoing liver operations from 2003 to 2009 by a single fellowship-trained hepatobiliary surgeon in the first few years of practice at a tertiary VA medical center. We determined perioperative outcomes of the entire cohort of patients and focused the analysis on patients with primary liver cancer, the most common liver disease among veterans. Overall, our data show acceptable perioperative and long-term outcomes comparable with those obtained at high-volume hepatobiliary training centers.[4]

Indeed, the practice of liver surgery continues to evolve, as exemplified by our results. During the study period, we experienced a steady annual increase in patient referrals. We also document a significant change in the method of treatment over time. Although a few laparoscopic cases were done in 2004, it was not until 2006 that the laparoscopic approach for hepatic resection was formally adopted. The motivation to adopt laparoscopy for the treatment of HCC was due partly to improved vessel-sealing technologies, permitting the safe transection of the hepatic parenchyma,[5] but more importantly the desire to transfer the well-established benefits of laparoscopy to our challenging veteran population suffering from cirrhosis and hepatitis C virus–related HCC.[6,7] Although the safety of laparoscopy in malignancy has been documented, data regarding laparoscopic resection for HCC are only now beginning to emerge.[8] Nevertheless, the number of laparoscopic resections increased significantly, along with an increase in the proportion of patients treated by laparoscopic radiofrequency ablation.

The most significant finding of our study relates to overall outcomes following resection for HCC in cirrhotic patients. Although a carefully selected case-matched control group would have been ideal, we were limited by our small sample size; we therefore compared 25 consecutive cirrhotic HCC patients treated by open resection before the adoption of laparoscopy with 28 patients who underwent laparoscopic resection. As might be predicted, patients selected to undergo the laparoscopic resections were treated more often by either wedge resection or segmental resection compared with patients treated by the open technique. An important result was the significantly lower intraoperative

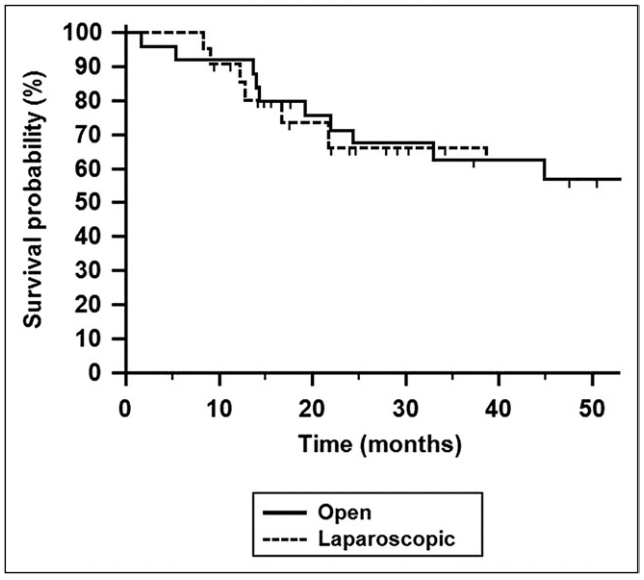

Figure 2 Probability of overall survival. There was no difference in survival outcomes between patients treated laparoscopically and with open procedures. Overall survival probability was 66% and 63% at 39 months between patients resected laparoscopically and with open procedures, respectively ($P = .65$).

blood loss and need for transfusion. Admittedly, this is almost certainly a reflection of patient selection bias. Likewise, our data showed no significant difference in hospital stay between the laparoscopic and open groups, most likely because of factors related to underlying liver dysfunction rather than tumor-related factors. Although the complication rates were comparable in both groups, the laparoscopic group tended to have less severe wound complications and leakage of ascites that are difficult to quantify in this limited retrospective study.

Although these results certainly imply that the introduction of specialty-trained surgeons from high-volume centers can bring about changes in patient referral patterns and perioperative outcomes, one can argue that other influences can similarly account for these observations. These factors include increased familiarity with this unique patient population by medical and ancillary staff (the so-called learning curve) as well as surgeon-independent shifts in demographic referrals driven by the consolidation of VA medical center resources. Nonetheless, these changes rarely occur in a vacuum and are usually driven by the impetus of either institutional expertise or aspiration, both of which are strongly affected by specialty-trained staff.

In conclusion, hepatic resections can be done safely even in a challenging cirrhotic veteran population with HCC. Moreover, our results support the notion that appropriate training in hepatobiliary surgery can translate into acceptable perioperative outcomes that rival those obtained at high-volume training academic and nonacademic medical centers.

References

1. Dindo D, Demartines N, Clavien P-A. Classification of surgical complications: a new proposal with evaluation in a cohort of 6336 patients and results of a survey. Ann Surg 2004;240:205–13.
2. Foster JH, Berman MM. Solid liver tumors. Major Probl Clin Surg 1977;22:1–342.
3. Dixon E, Vollmer CM Jr, Bathe O, et al. Training, practice, and referral patterns in hepatobiliary and pancreatic surgery: survey of general surgeons. J Gastrointest Surg 2005;9:109–14.
4. Asiyanbola B, Chang D, Gleisner AL, et al. Operative mortality after hepatic resection: are literature-based rates broadly applicable? J Gastrointest Surg 2008;12:842–51.
5. Corvera CU, Dada SA, Kirkland JG, et al. Bipolar pulse coagulation for resection of the cirrhotic liver. J Surg Res 2006;136:182–6.
6. Viganò L, Tayar C, Laurent A, et al. Laparoscopic liver resection: a systematic review J Hepatoabiliary Pancreat Surg 2009;16:410–21.
7. Chen HY, Juan CC, Ker CG. Laparoscopic liver surgery for patients with hepatocellular carcinoma. Ann Surg Oncol 2008;15:800–6.
8. Nguyen KT, Gamblin TC, Geller DA. World review of laparoscopic liver resection—2,804 patients. Ann Surg 2009;250:831–41.