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ORIGINAL ARTICLE

Evaluation of stapler hepatectomy during a laparoscopic liver resection

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Abstract

Methods: An international database of 1499 laparoscopic liver resections was analysed using multivariate and Kaplan–Meier analysis.

Results: In total, 764 stapler hepatectomies (SH) were compared with 735 electrosurgical resections (ER). SH was employed in larger tumours (4.5 versus 3.8 cm; $P < 0.003$) with decreased operative times (2.6 versus 3.1 h; $P < 0.001$), blood loss (100 versus 200 cc; $P < 0.001$) and length of stay (3.0 versus 7.0 days; $P < 0.001$). SH incurred a trend towards higher complications (16% versus 13%; $P = 0.057$) including bile leaks (26/764, 3.4% versus 16/735, 2.2%: $P = 0.091$). To address group homogeneity, a subset analysis of lobar resections confirmed the benefits of SH. Kaplan–Meier analysis in non-cirrhotic and cirrhotic patients confirmed equivalent patient ($P = 0.290$ and 0.118) and disease-free survival ($P =$ 0.120 and 0.268). Multivariate analysis confirmed the parenchymal transection technique did not increase the risk of cancer recurrence, whereas tumour size, the presence of cirrhosis and concomitant operations did.

Conclusions: A SH provides several advantages including: diminished blood loss, transfusion requirements and shorter operative times. In spite of the smaller surgical margins in the SH group, equivalent recurrence and survival rates were observed when matched for parenchyma and extent of resection.

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Introduction

After five decades of innovation, a hepatic resection has become an accepted surgical procedure for the management of both benign and malignant tumours. Significant conceptual and technical changes have resulted in a dramatic improvement in patient survival. These changes included improved understanding of intrahepatic vascular and biliary anatomy, the use of hypovolemic fluid management, selective vascular control, the introduction of the laparoscopic approach and varied forms of hepatic parenchymal division. A stapler hepatectomy (SH) is one of these parenchymal dissection techniques that have found new utility in the expansion of a laparoscopic liver resection.[1–3] This technique was first described by Nagorney *et al*. over 20 years ago.[4] Buchler *et al*. subsequently popularized this technique in an open liver resection.[5,6]

Initial descriptions of a laparoscopic liver resection came from European centres.[7–9] These reports were limited to peripheral resections, and came with warnings of significant complications and requirements of expertise in laparoscopic as well as hepatobiliary surgery. Several early adopters of laparoscopic liver surgery pursued a SH as an alternative to clip directed dissection. A stapled right hepatectomy was first reported by O'Rourke *et al*. and was

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thought to be a safer alternative technique for parenchymal dissection.[10] Subsequently, several high volume groups adopted this technique. This study serves to evaluate the benefits and weaknesses of SH across a multi-institutional series of groups utilizing electrosurgery and SH for parenchymal dissection.

Methods

After institutional review board approval for a computerized, multi-institutional retrospective cohort study, de-identified data were merged into a central database and examined. An international database of 1499 laparoscopic liver resections was established and patient outcomes were analysed using univariate, and multivariate analysis. A 10 centre international cohort of laparoscopic liver resections was assembled. Two laparoscopic cohorts were created: the first cohort was constructed of centres performing a laparoscopic SH and the second cohort was comprised of centres performing an electrosurgical hepatectomy. The method of parenchymal transection was up to the surgeon's preference; patients entered in this study had their surgery either performed at centres using the stapler or an electrosurgical technique. Both techniques have been well described previously.[11–13] An electrosurgical resection (ER) included radiofrequency ablation, tissuelink, ligasure and ultrasonic dissection while for simplicity any patients that underwent pre-ablation followed by a stapled parenchymal transection were excluded. The Pringle manoeuvre was routinely employed in the electrosurgical group but not within the SH group. Stapled vascular inflow and/or outflow control was permitted in the electrosurgical group as long as staplers were not utilized for parenchymal transection.

Demographic data, pre-operative diagnoses, symptoms, intra-operative data, patient outcomes and tumour characteristics were examined. All data are presented as median with ranges. Patients were analysed on an intent-to-treat basis based on the parenchymal transection technique. Comparisons were performed between the SH and the electrosurgical hepatectomy group. Continuous covariates were analysed using the Student's *t*-test or the Wilcoxon–Mann–Whitney test, where appropriate. Categorical variables were analysed by the chi-squared or Fisher's exact test, where appropriate. A univariate analysis was performed to examine the homogeneity of the two resectional groups. Further analysis was performed to evaluate the surgical outcomes of each technique. Analyses included multivariate analysis, chi-square, Student's *t*-test and Mann–Whitney test as indicated. To adjust for malignant disease, the size of the resection and the incidence of cirrhosis several subset analyses were performed. Subset analysis was limited to major lobar resections defined as either formal lobectomies or a trisegmentectomy. Lobar resection data from the SH and ER group were analysed on the basis of the patients' underlying parenchyma: cirrhotic versus non-cirrhotic. To assess the oncological integrity of SH compared with the electrosurgical approach; Kaplan–Meier analysis was performed for patient and disease-free survival for all patients with cancer, with additional subset analysis performed between the cirrhotic and non-cirrhotic patients. A P-value of 0.05 was considered as statistically significant.

Cost analysis was performed for SH and ER. Owing to the international basis of this study, cultural variation is considerable and this could account for dramatic differences in the length of stay data. As a result of this confounding variable, it was elected to perform only an operative cost analysis. This was performed using cost data for disposable devices and calculated anaesthesia and operative room cost per unit time ($158 US dollars/minute) with the primary authors' expense data used as an index cost. In the SH group, the primary author's institutional price was used for the stapler handles, disposable load, tissuelink, ligasure, an ultrasonic dissector and hand assist devices; when used this expense was calculated as the disposable expense.

Results

Analysis of an international database comprised of 1499 laparoscopic liver resections identified 764 (51%) SH and 735 (49%) ER. Patient demographics, tumour characteristics, intra-operative and post-operative outcomes are presented and analysed for all patients in Table 1. The incidence of post-operative liver failure was equivalent between the SH and ER groups (7/764; 0.9% versus 7/735; 1.0%; $P = 0.942$). The most common complications in the SH and ER group were biliary (26/764; 3.4% versus 16/735; 2.2%; $P = 0.153$), pulmonary (20/764;2.6% versus 13/735; 1.8%; $P = 0.262$), abdominal fluid collections (8/764; 1.0% versus 8/735; 1.1%; $P = 0.937$), liver failure (8/764; 1.0% versus 7/735; 1.0%; $P = 0.853$), post-operative ileus (14/764; 1.8% versus 8/735; 1.1%; $P = 0.231$), ascites (4/764; 0.5% versus 16/735; 2.2%; $P = 0.005$), post-operative hernia (12/764; 1.6% versus 6/735; 0.8%; $P = 0.187$), post-operative bleed (8/764; 1.0% versus 4/735; 0.5%; $P = 0.274$), chronic pain (8/764; 1.0% versus 6/735; 0.8%; $P = 0.642$) and other (14/764; 1.8% versus 12/735; 1.6%; $P = 0.767$).

The non-cirrhotic group lobar resection group comprised of 269 (18%) patients with 165 (61%) being performed with SH and 104 (39%) ER. Forty (3%) cirrhotic patients undergoing lobar resections were also examined with 26 being SH and 14 ER. The results of this analysis are presented in Table 2. These data confirm when the extent of a resection is controlled. SH continues to demonstrate advantages in decreased operative time, lower blood loss and shorter hospital stay. Similar findings were present in the cirrhotic group with the exception of shorter length of stay. Further analysis of data did identify SH had a smaller pathological margin on explanation than an electrosurgical dissection. The incidence of recurrence between the SH and ER groups were not significantly different (21/81:25.9% versus 11/65: 16.9%; $P < 0.191$). The median (range) time to recurrence was 13.0 (3–36) versus 13.1 (5–55) months after a similar median follow-up period of all patients [62.8 (13–106) months versus 54.5 (5–55) months]. The most common site of cancer recurrence in the lobar resections between the SH and ER were a second liver site (10/21