

# Evolution of laparoscopic liver resection

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The adoption of laparoscopic liver resection (LLR) has been much slower than for other laparoscopic procedures. This probably reflects perceived risks of uncontrollable bleeding, oncological inadequacy and a degree of scepticism regarding a major change in practice for unproven benefit. LLRs are difficult procedures requiring expertise in liver surgery and advanced laparoscopy. They demand the acquisition of new skills for efficient and safe performance<sup>1</sup>. Complex dissection and suturing techniques must be combined with mastery of various novel technologies, including enhanced video equipment, laparoscopic ultrasonography, energy devices, laparoscopic ultrasonic aspirators and staplers. Increasing numbers of hepatobiliary surgeons have explored the possibilities of LLR, resulting in two international consensus meetings and publications involving more than 9000 patients.

There are no published RCTs comparing open surgery with LLR. The variety of conditions where liver resection can be used, including benign disease, primary and secondary liver cancers, the state of the underlying liver, resection types based on the amount of parenchyma removed, and the location of lesions in the liver segments are all variables that potentially limit the accrual of large numbers of comparable patients in a reasonable length of time. Despite these difficulties, two RCTs are currently under way. The Oslo-CoMet (NCT01516710) single-centre study, comparing open *versus* laparoscopic parenchyma-sparing resection for colorectal liver metastases (CRLM),

has completed recruitment, with preliminary results showing reduced morbidity and hospital stay in favour of the laparoscopic group. Orange II Plus (NCT01441856), a multicentre European study comparing open and laparoscopic hemihepatectomy, is still recruiting.

Current views therefore rely on cohort and case-matched series, sometimes with propensity score matching, along with meta-analyses derived from these observational studies. Most early reports involved minor resections in favourable locations<sup>2</sup>, with the gradual introduction of major and/or more complex resections including anatomical parenchyma-sparing resections and removal of tumours from difficult locations<sup>3–6</sup>. Two comprehensive reviews in 2009<sup>7</sup> and 2014<sup>8</sup> showed a rise in the number of reported LLRs from fewer than 3000 to over 9000 operations, along with a rise in the proportion of major or complex resections from 15 to 30 per cent. Meta-analyses<sup>8</sup> suggest several short-term advantages for laparoscopic surgery, including decreased pain, less bleeding, lower morbidity and shortened hospital stay. Comparative oncological outcomes, including resection margin status and overall and disease-specific survival, all seem similar to those after open surgery<sup>8–11</sup>.

Of the two major consensus meetings, the first established the feasibility and safety of LLR in selected patients and made recommendations about indications<sup>12</sup>. The second was a rigorous conference that included a panel of laparoscopic experts facing an independent jury of 'open' liver surgeons

and scholars<sup>13</sup>. The jury recommendations, although emphasizing the limited level of available evidence, validated laparoscopic minor resections as standard practice, whereas major and/or complex anatomical laparoscopic resections were still considered to be at an exploration stage.

Laparoscopic operations seem applicable in 20–50 per cent of liver resections depending on the referral base and local expertise. Indications for LLR should not be different from those for open resection. There are, however, specific issues that require attention.

The current classification of liver resections is based on the amount of resected parenchyma, defining major hepatectomy as three or more segments and minor hepatectomy as fewer than three segments. This overlooks the complexity of resection, which varies according to the segmental location and the sites of tumours within those segments. A difficulty score for LLR, proposed at the second consensus conference<sup>13</sup>, suggested that 'easy' procedures involve solitary lesions of 3 cm or less located in peripheral segments (segments II–VI). These require minor resections, including left lateral sectionectomy. 'Complex' operations include not only major resections (right and left hepatectomies), but also anatomical parenchyma-sparing segmentectomies and sectionectomies in the difficult posterosuperior segments VII/VIII and upper part of segment IV. As parenchyma-sparing resections are considered the standard

of care, this concept should not be compromised by the laparoscopic approach. Unnecessary laparoscopic right hepatectomies to overcome difficult locations should be avoided.

Tumour size and number are also critical. Although anecdotal cases of LLR for huge tumours, multiple bilobar metastases or lesions requiring biliary and/or vascular reconstruction have all been reported, these types of lesion are still considered contraindications to LLR at most centres.

Benign liver disease (mainly tumours and intrahepatic stones) still represents about 35 per cent of reported LLRs. It is paramount that the availability of the laparoscopic approach does not encourage unnecessary resection of harmless benign lesions, such as asymptomatic focal nodular hyperplasia or liver haemangioma<sup>12</sup>.

Hepatocellular carcinoma (HCC), occurring mainly in patients with cirrhosis, is the most common single indication for LLR reported worldwide. Although peripheral partial resections were initially common, more demanding anatomical resections are now increasingly performed<sup>6</sup>. The dominance of HCC is the result of growing numbers of Asian series, but also reflects the fact that HCC appears more amenable to a laparoscopic approach, owing to screening programmes that have led to diagnosis of early HCC in patients with known liver disease and the recognition of improved tolerance of patients with cirrhosis to laparoscopy compared with laparotomy, with less postoperative decompensation and ascites<sup>3,6</sup>. Reduced fluid requirement, avoidance of long abdominal incisions, collateral preservation, less manipulation and less respiratory impairment may all play a part in better outcomes. Another advantage of LLR for HCC is facilitation of repeat resection or salvage liver transplantation<sup>3</sup>.

In contrast, CRLM account for about 25 per cent of the operations undertaken for malignancy. This reflects the slower penetration of LLR in Western countries and the clinical features of CRLM, making them less amenable to a laparoscopic approach than HCC. Frequent bilobar disease requires complex and/or staged resections. Management of the primary tumour needs to be considered, and there may be concerns about insufficient exploration, especially after downsizing chemotherapy. Improvements in preoperative imaging and laparoscopic ultrasonography should limit these reservations, and more patients are now being considered for LLR<sup>10,11</sup>. Difficulties can be turned to advantages, such as combined laparoscopic liver and colonic resections or laparoscopy in staged or repeat resections. Earlier recovery after LLR may also be associated with enhanced access to adjuvant chemotherapy, similar to laparoscopic pancreatic resection<sup>14</sup>.

Laparoscopic living donor hepatectomy remains controversial. Avoiding long incisions clearly improves donor quality of life, but concerns about donor safety have limited its diffusion. Laparoscopic left lateral donor hepatectomy for adult to child transplantation is gaining wider acceptance, but full right or left laparoscopic donor hepatectomy has been reported by only a handful of teams and should still be considered to be in a developmental phase<sup>13</sup>.

LLR has gained a significant and irreversible place in hepatic surgery as a result of recognized short- and long-term advantages. Minor resections in peripheral segments are now performed laparoscopically by a majority of hepatopancreatobiliary teams, and the diffusion of major and/or complex resections is increasing annually. There is a need for organization of LLR. This should

focus on regular updates, allowing enough time to be spent on developing advances in techniques, clarifying indications, evolving guidelines and creating international registries, along with specific training and credentialing. All need development, so that meaningful improvements in patient care and outcomes will follow.

## Disclosure

The author declares no conflict of interest.

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