Current techniques and results of liver resection for colorectal liver metastases

Zaed Z. R. Hamady, Anil Kotru, Hideki Nishio and J. Peter A. Lodge

HPB and Transplant Unit, St James’s University Hospital, Leeds, UK

Colorectal cancer remains the second most common cause of cancer death in the West. Every year in the UK alone, around 14,000 patients develop secondary hepatic deposits from a primary colorectal cancer. Surgery remains the mainstay of treatment for liver metastases. Although not every patient is a candidate for surgery, earlier referral and rapid assessment are required to improve outcome. With the use of most recent technologies and radical surgery, increasing numbers of patients should have therapy with curative intent. This paper reviews preoperative patient evaluation and selection, surgical strategies, adjuvant therapy and postoperative follow-up. Other treatment modalities to increase tumour resectability are also described.

Introduction

Haematogenous spread to the liver occurs in 40–60% of colorectal cancer patients. Synchronous lesions are detected in 15–25%, and metachronous metastases are detected in a similar percentage within 3 years of potentially curative colorectal resection. Cancer cells metastasize to the liver via the portal circulation. In the liver they develop an autonomous blood supply and grow at variable rate. In one-third of patients the disease is limited to the left or right hemi-liver.

Following diagnosis, the median survival for patients with colorectal liver metastases (CRLM) is less than 9 months in most described series for untreated patients and only 12–18 months for patients treated with chemotherapy alone. The prognosis of patients with untreated CRLM is related to tumour burden. Cady reported that patients with multiple bilateral liver metastases had a mean survival of 3 months, compared with 17 months for patients with metastases limited to a single hemi-liver and 25 months for those with solitary metastases. Wagner et al. reviewed 252 patients with biopsy-proven unresected solitary and multiple unilobar metastatic lesions and reported median survivals of 21
months and 15 months, respectively. Scheele et al. reported patients with potentially curable but unresected metastases with no 5 year survivors, whereas patients with resected lesions achieved nearly 40% of actuarial 5 year survival.

Since 1940, when Cattell performed the first hepatic resection for metastatic disease, liver resection has been performed with increasing frequency, particularly during the last three decades. Although almost all the data are from retrospective non-randomized studies, liver resection remains the gold-standard potentially curative treatment for CRLM with reported median survival times of 35–69 months. Advances in liver resection procedures and adjuvant therapies mean that virtually no liver tumour should be considered as unresectable, even though the majority of patients continue to present at a late stage in their disease. In our own centre, this radical approach has helped to achieve satisfactory results for many patients who used to be considered inoperable (Fig. 1).

Fig. 1 Survival pattern for 272 patients (1995–2001) after primary resection of CRLM in Leeds. Median survival 51 months (95% confidence interval, 38–63). The analysis was performed after 24 months follow-up period.
Surgical strategies for liver metastases

Preoperative assessment

The preoperative work-up should evaluate patient fitness for anaesthesia and major surgery, search for extrahepatic metastases and delineate tumour distribution in relation to liver anatomy.

Patient fitness

Patients should undergo detailed evaluation of their pulmonary and cardiac function, as many are elderly and have significant comorbidities. Patients with liver metastases usually have essentially normal liver function, but there is a significant risk of transient liver failure following major resection. Attempts at assessment of hepatic functional reserve have been made but no clear conclusions have been reached. Surgical experience and careful judgements based on pre- and intraoperative findings are essential to ensure a successful outcome. Most studies suggest that advanced age is not a contraindication to surgery, but the potential benefits and risks of any proposed intervention should be carefully assessed.

Search for extrahepatic metastases

The most common sites of extrahepatic disease are the lungs, recurrence at the colorectal resection bed and other intra-abdominal sites (mesenteric and retroperitoneal lymph nodes, peritoneum and adrenals). Therefore thoracic, abdominal and pelvic computed tomography (CT) scans should be used in addition to colonoscopy to exclude extrahepatic disease. We have a very low threshold to perform pelvic magnetic resonance imaging (MRI) if pelvic recurrence is expected. However, the presence of local recurrence and/or pulmonary metastases does not always preclude liver resection. Bone and brain scans are performed if clinically indicated. Recent data suggest an increasing role for fluoro-2-deoxy-D-glucose positron emission tomography (FDG-PET) scanning in the future.

Delineate hepatic anatomy

In order to plan the surgical approach accurately, it is important to acquire sufficient information about tumour site, size, number and relation to hepatic pedicles and the volume of tumour-free parenchyma that will be left in place after resection. In our centre, MRI is the investigation of choice. The use of the newer iron oxide contrast media has increased its sensitivity for small metastases. It is also useful for visualizing vascular structures and determining their relation to the tumour and for distinguishing metastatic tumour from benign lesions. Spiral CT scanning is preferred in some units.
In very complex cases, venography may be used to visualize the inferior vena cava and hepatic veins. This is occasionally useful if all three major hepatic veins are involved with tumour as an adequate inferior or middle-right hepatic vein may obviate the need for complex venous reconstruction.\textsuperscript{10}

**Plan of surgical procedure**

Liver resection remains the only potentially curative therapy for CRLM. It can be either anatomical resection, in which one or more complete segments are removed according to International Hepato-Pancreato-Biliary Association (IHPBA) terminology,\textsuperscript{11} or atypical (wedge) resection. Segmental liver resection has been proposed as the preferred oncological procedure as it allows better clearance\textsuperscript{12} and is associated with less chance of intraoperative bleeding because fewer vessels lie in the interface between the segments. However, it removes more liver parenchyma and therefore there is a greater likelihood of postoperative liver dysfunction. Furthermore, our own data suggest that a large resection margin is unnecessary (see below).

The type of resection performed depends on size, site, number of tumours and relation to vascular and biliary structures. Small superficially located tumours can be resected by wedge resection or ‘metastasectomy’. Larger and multiple lesions usually need anatomical resection.

As a general rule, patients who are fit, without unresectable extra-hepatic disease and in whom at least 20–25\% of functional hepatic parenchyma can be left after resection should be considered for surgery. In our own centre, we will often accept patients in whom only 15\% of hepatic parenchyma can be retained.

**Intraoperative assessment**

**Intraoperative ultrasound scanning**

The application of intraoperative ultrasound scanning (IOUS) as an adjunct to hepatobiliary surgery was first described in the 1980s, and is now a standard part of almost all liver resection procedures. It is used to assess tumour burden and to identify occult lesions (non-palpable) as small as 2–3 mm in diameter and to define their relationship to vital intra-hepatic structures. It can evaluate the patency of intrahepatic vessels and the presence of tumour thrombus; thus it helps to assess the resectability and selection of the most appropriate procedure.

IOUS is more sensitive (>90\%) and more specific (>90\%) in evaluating liver tumours than other imaging modalities.\textsuperscript{13} In up to one-third of
cases the operative plan may be changed based on IOUS findings, and it
provides useful information in about half of patients with hepatic
lesions. Furthermore, it has been suggested that the appearance of
liver metastases on IOUS correlates with prognosis; patients with hyper-
echoic CRLM had better survival and better disease-free survival than
patients with hypo-echoic lesions in one reported series. However,
recent improvements in MRI technology and contrast media mean that
intraoperative studies are beginning to play a lesser role.

Key points of surgery

Extrahepatic disease
At laparotomy it is important to look for evidence of recurrence at the
primary colonic cancer bed, mesenteric and portal hilar lymph node
involvement and peritoneal seedlings. If there is any doubt, biopsies
should always be taken and it may be necessary to reconsider the role of
hepatic resection. Widespread disease will preclude resection, but local-
ized disease should not.

Resection margin
The aim of surgery should always be to achieve complete removal of the
tumour with cancer-free margins. Patients with incomplete removal of the
tumour have similar outcomes to non-operated patients. It has been
believed that an inability to achieve a tumour-free resection margin of 1 cm
is a relative or even an absolute contraindication to surgery. However,
recent reports suggest that such a generous margin is not essential for
achieving a curative outcome. After more careful analysis of patholog-
ical data from patients undergoing primary (first operation) liver resection
for CRLM, we have recently concluded that only 1 mm of tumour-free
resection margin is enough to achieve survival and disease-free survival
comparable to that of patients with >1 mm of tumour-free margin (Fig. 2).

Intraoperative blood loss
Another important risk factor to consider during hepatectomy is to keep
blood loss to a minimum. Many studies, including our own, have
shown that excessive blood loss is a major determinant of perioperative
outcome (Fig. 3). In our experience only 15% of patients undergoing
liver resection of less than four segments need blood transfusion. The
methods of achieving less blood loss are meticulous surgical technique,
ultrasonic dissection, low central venous pressure (CVP) anaesthesia and
vascular inflow and outflow control. Other methods, such as adminis-
tration of recombinant factor VIII, argon beam coagulation and fibrin
glue, are all aids in achieving haemostasis.
Low CVP surgery. The absence of valves in the major hepatic veins means that blood loss can be severe if these vessels are transected in the presence of a high CVP. Therefore we aim to achieve a CVP of 0–5 mmHg by restricted fluid administration during induction of anaesthesia and the surgical procedure; fluid therapy is adjusted to maintain urine output at 0.5–1 ml/kg/h. In our centre, we also use epidural anaesthesia and maintain systemic blood pressure using peripheral vasoconstrictors and inotropes.

Pringle manoeuvre and total vascular exclusion. Intermittent clamping of the portal triad is now often used as healthy human liver can tolerate up to 90 min of warm ischaemia. Ischaemic preconditioning followed by continuous clamping has also been found to be an effective strategy for minimizing the ischaemic insult during liver resection, particularly in patients requiring a prolonged period of vascular clamping and patients with abnormal liver parenchyma. We prefer to avoid ischaemia whenever possible as we have noticed an increased postoperative morbidity and longer hospital stay in patients who have experienced prolonged ischaemic time. In fact, <50% of our major resections have required

![Recurrence Rate % vs. Months](image-url)
Liver resection for colorectal liver metastases

Pringle’s manoeuvre. Total vascular exclusion (additional clamping of the hepatic veins or inferior vena cava to prevent hepatic vein back-bleeding) may be used for more challenging cases but it is not well tolerated, particularly in elderly patients. Segmental ischaemia for a single- or multi-segment hepatic resection is an alternative used in our centre (Fig. 4).

Liver parenchyma transection. There are no bloodless planes through which liver resection can be performed. A number of techniques have been developed to separate soft parenchyma from vascular and duct structures.

The first technique described was the use of finger fracture, and this was then modified by using a small clamp for blunt dissection. Although this method is still in use, more advanced techniques have been introduced such as the use of the Cavitron ultrasonic aspirator (CUSA), water-jet cutters, laser dissection and harmonic scalpels to reduce resection time and blood loss.

CUSA has gained the widest acceptance, and it is associated with a reduction in blood loss when compared with conventional techniques. Blood loss has been further reduced by the additional use of electrosurgical coagulation. This system principally consists of a vibrating titanium...
tip which provides suprasonic pressure waves that lead to tissue cavitation and fragmentation. Different types of tissue fragment at different suprasonic frequencies because of their differing water contents; thus dissection can be performed sparing vascular structures. However, other authors prefer the water-jet cutter because of a claimed reduction in blood transfusion requirements and liver ischaemic time.28

Synchronous colorectal and liver resection

The optimum strategy for treatment of synchronous resectable colorectal metastasis is debatable. There are many factors which determine whether these two procedures can be carried out simultaneously: expertise of the surgeon, extent of liver disease and fitness of the patient. The decision to proceed should not compromise or influence the extent of either colorectal or hepatic resection.

In expert hands, combined single-stage resection of colorectal cancer and liver metastases appears to be safe and feasible with no increase in perioperative morbidity or mortality.29 It allows prompt completion of surgical therapy and earlier initiation of adjuvant therapy and, by avoiding a second laparotomy, the complication rate may be reduced. However, in recent reports29,30 the strategy of simultaneous resection yielded no difference in survival compared with staged resection, and it

Fig. 4 Segment 6 made ischaemic by segmental vascular control. A clear line of demarcation can be seen and the ischaemic segment appears darker.
is mandatory that a suitably experienced liver surgeon is readily available. This strategy is still controversial and more studies are needed before its use can be advocated.

**Laparoscopic liver resection**

Although the first laparoscopic liver resection was attempted in 1992, it is still not widely accepted. Its main use at present is in patients undergoing resection for benign lesions or cysts. The main reasons for the limited use of laparoscopy in liver resection for CRLM are technical difficulties, the potential hazard of intraoperative bleeding and the controversial concerns of tumour cells seeding at port sites and in the peritoneal cavity.

The advantages of laparoscopic technique are reduced postoperative pain, quicker return to normal activity and reduced hospital stay. The overall morbidity has been shown to be lower with laparoscopic resection. However, its feasibility is limited to patients with small malignant tumours located in the left lateral section or in the anterior segment of the right liver unless the surgeon has specific expertise.

**Methods of increasing resectability**

The main causes of CRLM unresectability are disseminated extrahepatic disease, unfit patient and a technically unresectable tumour (impossible to achieve a disease-free margin or insufficient hepatic reserve to support postoperative hepatic function). The following strategies may be undertaken to allow a potentially curative resection for the last of these patient groups.

**Neoadjuvant chemotherapy**

‘Downstaging’ of tumour is an acceptable modality of treatment for patients with multiple or very large metastases when resection is initially not feasible. This modality can be used in an attempt to convert unresectable tumours into potentially resectable ones.

Twenty per cent of tumours respond to 5-fluorouracil (5-FU) with folinic acid alone; however, this can be improved to about 50% by addition of oxaliplatin or irinotecan. The role of these agents in downstaging is very well documented. Neoadjuvant chemotherapy may permit resection of about 15% of metastases which have previously been considered unresectable. With this regimen a 5 year survival of 34–40% has been achieved in bilateral multiple CRLM after resection, which is comparable to survivals following primary resection. Unfortunately,
although chemotherapy causes shrinkage of the metastases, it rarely changes the tumour relationship to the vascular structures, which is the most frequent cause of unresectability.

These data should not lead to the routine use of chemotherapy prior to hepatectomy as chemotherapy only allows resection of a few unresectable tumours. Furthermore, there are problems with neoadjuvant chemotherapies. In our experience, patients who have received preoperative chemotherapy are three times more likely to suffer from postoperative liver failure due to the unavoidable effects of chemotherapy on liver parenchyma.

**Portal vein embolization**

Some patients with CRLM may be considered ineligible for liver resection because the liver remnant is apparently too small to provide sufficient postoperative liver function. Preoperative selective portal vein embolization (PVE) is an effective means of inducing ipsilateral atrophy and contralateral hypertrophy of the liver remnant in these patients, thus allowing safe resection without postoperative liver failure. The portal vein is usually accessed percutaneously via a transhepatic route (through tumour-free liver) under ultrasound and fluoroscopic guidance.

In patients with healthy liver parenchyma PVE can induce an increase of up to 50% in the size of the non-embolized lobe in 4–6 weeks. Following embolization, curative liver resection would be expected to be feasible in ~50% of patients who were initially considered inoperable. Morbidity and mortality for resections with PVE are almost comparable to those for resections without PVE, and 5 year survivals approaching 37% have been reported.37

**Two-stage resection**

Adam *et al.*38 have suggested using two-stage hepatectomy to convert non-resectable liver metastases into potentially curable cases. This strategy is usually applied to multinodular bilobar metastases. The first-stage resection is intended to remove the highest possible number of tumour lesions. This is followed by a liver regeneration period. During this period the patient is usually treated with chemotherapy to limit disease growth. It is recommended that this chemotherapy should start 3 weeks after surgery (so that it does not interfere with initial regeneration) and continue for 2–3 months, when a further set of assessment tests are performed in order to evaluate the patient for the second curative stage. The second stage is only performed if it is potentially curative and only if enough parenchymal hypertrophy has occurred to reduce the risk of postoperative liver failure. Furthermore, in order for the patient to be
eligible for two-stage hepatectomy, the tumour should be downstaged or stabilized by initial neoadjuvant chemotherapy. The objective of this technique is to avoid post-hepatectomy liver failure.

Long-term results from this strategy are still awaited, but initial evaluation of a small series suggested a 3 year survival of 35% and a perioperative mortality risk of 15%.38

Management of CRLM with inferior vena cava involvement

Inferior vena cava (IVC) involvement can often be dealt with by simple venous side-clamping, but in more extensive cases hepatic vascular exclusion and veno-venous bypass may be required. In 40% of cases this necessitates IVC reconstruction with either a synthetic interposition graft or an autologous vein patch. IVC resection accounts for 4.5% of the metastatic work at our centre.

Tumours involving all the major hepatic veins with or without IVC invasion, and particularly tumours involving the hepatocaval confluence and needing IVC replacement, continue to pose a surgical challenge. In situ hypothermic perfusion and ex vivo resection offer a potential lifeline for this group. For this purpose, the portal triad structures and the IVC are clamped and cooling is achieved by infusion of a preservation solution into the portal vein or hepatic artery. The IVC is clamped above and below the liver and the infrahepatic IVC is incised above the clamp, from where the venous effluent is actively sucked to prevent body cooling. In the ex vivo method the liver resection is carried out on the bench and the liver is then reimplanted. Liver transplant techniques, including veno-venous bypass, are usually required in these types of case. There are now a few series with a reasonable perioperative mortality (9–25%) and 5 year survival rates of 22–30%39,40

Tumour ablation

Patients with liver-only metastasis who are not candidates for liver resection may be offered one of the in situ destruction methods such as cryotherapy or radiofrequency ablation (RFA). These techniques can be used on their own or as an adjunct to surgery.

These techniques may be used through a laparotomy incision, laparoscopy port or percutaneously. Cryotherapy and RFA have similar initial complication rates (7–9%) and success rates. However, local tumour recurrence rates seem to be less with RFA (18% versus 53%).41 Both techniques have limitations related to tumours in close proximity to vascular structures. To date, no randomized trial has demonstrated the
superiority of one treatment over the other, and 3 year survivals have been disappointing at 20–40%, with few 5 year survivals reported.

RFA has been more widely adopted. One of the limitations of these techniques is the size of the liver lesion. They are not efficient for tumours of size >3 cm; however, repositioning of the needle for multiple treatments has helped to achieve complete destruction of larger tumours. Their use is also limited in tumours close to the hepatic hilum because of the increased risk of bile duct stricture and fistula. Other associated risks are damage to the diaphragm or colon, pleural effusion, bleeding, biloma, subcapsular haematoma, abscess in treated tumour and arterioportal venous fistula. If RFA is applied incorrectly, it may cause peripheral burns in the vicinity of the necessary external electrical earthing plates.

RFA alone or in combination with resection provides survival superior to non-surgical treatment (3 year survival of 40% compared with 10%). However, it has a significantly lower survival rate than surgical resection alone. Therefore it cannot be considered as an equivalent to complete resection. However, there may be a place for this modality in recurrent CRLM after hepatectomy. At present, we believe that its role in CRLM is largely limited to patients who are not fit for major resection.

Adjuvant therapy

Adjuvant regional [hepatic arterial infusion (HAI)] and systemic chemotherapy after CRLM resection is of unproven value. In a multi-institutional trial, HAI (5-FU plus folinic acid) was equivalent to observation alone. A further trial suggests that combined HAI (5-floururidine and dexamethasone) with systemic 5-FU is superior to systemic 5-FU alone. More recently, systemic 5-FU-based therapy has demonstrated an improvement in 5 year survival. These studies were not well designed and so no convincing conclusions can be drawn. New randomized trials are needed with inclusion of newer agents including oxaliplatin or irinotecan. Our current practice is to start all post-hepatectomy patients on a systemic 5-FU-based regimen unless they have received chemotherapy for their primary disease within the previous 12 months.

Results of CRLM resection

Outcome

With recent advances in anaesthetic and surgical techniques the operative mortality in most centres has fallen to <5%. Perioperative blood loss is a major determinant of operative mortality and morbidity. Postoperative
Liver resection for colorectal liver metastases

complications remain frequent and are observed in 25–40% of cases after liver resection (Table 1).

In our centre, a recent analysis has demonstrated 3, 5 and 10 year survival rates of 61%, 46% and 38%, respectively, and disease-free survival rates of 36%, 25% and 23%, respectively. Our median survival is 51 months. (Fig. 1).

Table 1 Complications of liver resection for patients operated on in Leeds (1995–2001)

<table>
<thead>
<tr>
<th>Complication</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transient liver failure</td>
<td>5.5</td>
</tr>
<tr>
<td>Acute renal failure</td>
<td>3</td>
</tr>
<tr>
<td>Multigorgan failure</td>
<td>0.4</td>
</tr>
<tr>
<td>Bile leak</td>
<td>1.4</td>
</tr>
<tr>
<td>Cardiac/respiratory</td>
<td>6</td>
</tr>
<tr>
<td>Sepsis/intra-abdominal collection</td>
<td>3</td>
</tr>
<tr>
<td>Wound infection</td>
<td>6</td>
</tr>
</tbody>
</table>

Predictors of favourable outcome

Several studies have attempted to define prognostic indicators for patients with CRLM. The stage of primary tumour and volume of liver metastases are the main indicators of outcome.

A primary diagnosis of a Dukes’ C tumour is an independent predictor of unfavourable outcome in most reports. Many series report that patients with more than four metastases, tumour diameter >5 cm and bilobar metastases have a higher incidence of recurrence and lower survival. It seems that patients with multiple metastases are at a higher risk of having a cancer-involved resection margin and four times more likely to have microscopic satellite nodules associated with it, and this may indicate adverse tumour biology and potential for spread. However, patients with multiple hepatic metastases can achieve long-term survival and the number of metastases should not be used as a contraindication to surgery. There is a consensus that the preoperative carcinoembryonic antigen (CEA) level correlates with disease-free survival. Hilar or coeliac lymph node involvement with tumour is associated with adverse outcome, and biopsy of a suspicious lymph node is highly recommended but should not always exclude patients from curative resection. Resection margin involvement is associated with a poor prognosis, yet the width of the free margin does not appear to have an impact on survival (see above).

Synchronous metastases have been presumed to represent a more aggressive tumour and therefore to be associated with lower survival. However, this was not the case with our patients or in most other reports. Rather, the timing of metastasis detection (more or less than
12 months) appeared to be an important predictor. Age, gender and type of resection do not seem to influence prognosis provided that a clear margin can be obtained. Clinical scoring systems may be used to predict outcome but not to exclude patients from surgery.

**Follow-up**

We advocate an aggressive follow-up surveillance policy with regular imaging to detect recurrence in these patients. Thirty per cent of the recurrences are expected to occur in the first postoperative year, another 24% would be expected to occur in the second year and a further 24% in the following 3 years (Fig. 5). We tend to see our liver resection patients at ~4 weeks after hospital discharge. At this visit, in addition to physical examination, liver function and tumour markers are tested. A return of tumour markers to normal (if previously elevated) serves to confirm that the goal of resection has been achieved. If they do not return to normal, a

![Recurrence pattern following first liver resection of CRLM (n = 261; perioperative death was excluded) for patients operated on in Leeds (1995–2001). Median disease-free survival was 20 months (95% confidence interval, 15–25). The analysis was performed after 24 months follow-up period.](https://academic.oup.com/bmb/article-abstract/70/1/87/332352)
meticulous search for treatable tumour should be performed. Following this postoperative check, patients are seen at 3, 6, 12, 18 and 24 months after surgery, and then annually up to 10 years. During each of these visits liver function and tumour markers are assessed and a CT scan of the chest, abdomen and pelvis is performed. Suspicions raised by patient symptoms, CT findings or tumour marker findings prompt further investigation by MRI or FDG-PET scans. In our practice, colonoscopy is also performed regularly to check for colorectal recurrence.

Management of recurrent metastases

In our experience, liver-only recurrence occurs in 28% of patients after CRLM, and this is a very worthwhile group to consider for further surgery. Repeat hepatectomy can provide a significant survival benefit. It is safe and appears to be as effective as initial resection with similar postoperative morbidity and mortality risks. The same indications for primary resection should apply for repeat resection. Our 5 year survival after second hepatectomy is currently 65% for patients in whom we have achieved a negative margin.

Adam et al. reported a 5 year survival after third hepatectomy of more than 30%. Therefore hepatic recurrence should be resected whenever possible. In this series, the interval between initial resection and diagnosis of recurrence appeared to be an important predictor of outcome. This is because patients with a shorter disease-free interval have adverse tumour characteristics and therefore a higher potential for spread and recurrence.

Recurrence limited to the lungs occurs in 20% of cases following CRLM resection. These patients should be considered for resection as a good long-term survival can be achieved.

Limited recurrence at the colorectal resection bed or mesenteric lymph nodes occurs in <10% of cases. These should be treated with further resection, according to emerging data.

Future prospects

Surgical resection is the only hope for patients with liver metastases. Rapid referral and assessment are required to improve outcome. New technologies and neoadjuvant therapies should allow more patients to become candidates for resection. Recent progress in molecular and cell biology has opened the way to novel therapies based on immunotherapy, anti-angiogenesis and gene therapy, but clinical application does not appear to be imminent.
References


Liver resection for colorectal liver metastases


