Review

Surgical management of hepatic metastases from colorectal malignancies

R. Malafosse, Ch. Penna, A. Sa Cunha & B. Nordlinger

Department of digestive surgery, Ambroise-Paré Hospital, Boulogne, France

Summary

Liver metastasis represents the major cause of death of patients who have been treated for colorectal adenocarcinoma. Spontaneous survival rarely exceeds two years. Surgery can offer long-term survival and resection should be considered when liver metastases can be totally resected with clear margins and when there is no non-resectable extra-hepatic disease. The choice between anatomical or wedge resection depends on the number and the location of the metastases but does not influence survival. Clamping methods limit blood loss. Operative mortality is generally less than 5%. The five-year survival rate after surgical resection varies from 20% to 45% according to several prognostic factors. The longer survival is observed in patients with fewer than four lesions, with lesions smaller than 4 cm, without extra-hepatic disease, with lesions that appeared more than two years after the resection of a stage I or II colorectal cancer and whose CEA level is normal. After resection, follow-up can detect hepatic recurrence that can be treated with repeat hepatectomy. The efficacy of systemic chemotherapy using new agents can increase the number of patients amenable to surgery. Regional therapies with cryotherapy or radiofrequency ablation can help to treat unresectable or non-totally resectable lesions and may improve survival. The effects on survival of adjuvant treatments, including pre- or postoperative systemic or postoperative intra-arterial chemotherapy, are currently under evaluation.

Key words: adjuvant chemotherapy, colorectal cancer, liver metastases, surgery

Introduction

Nearly half of the patients with colorectal adenocarcinoma will develop liver metastases, which represent the major cause of death. Untreated, these lesions have a poor prognosis with a median survival ranging from 4 to 21 months, and a three-year survival below 3% [1]. Palliative systemic chemotherapy improves quality of life but has little impact on survival [group ASCO 1999]. Retrospective studies have reported 0% to 2% five-year survival for patients with untreated but potentially resectable liver metastases vs. 25% to 28% for resected patients [2-4]. Despite much bias inherent to such retrospective comparisons, it appeared that surgical resections were able to ensure long-term survival in 25% to 30% of patients. Surgical resection should be discussed in every case, but should only be proposed when all metastatic disease can be removed. Preoperative assessment is then essential in the selection of patients for surgery. The goals of surgery are to remove all macroscopic liver deposits while preserving non-tumorous liver with minimal mortality and morbidity. The improvements in patient selection and surgical technique now allow liver resections with low mortality-morbidity rates and five-year survival approaching 30%. However, the wide range of survival follows several well-established prognostic. Hepatic recurrences occur in nearly two thirds of the patients and are sometimes amenable to repeat resections. New treatment modalities including chemotherapy, local destruction and radio-surgical techniques are currently under evaluation to improve the overall picture of treatment of liver metastases.

In this review we propose to summarise the knowledge on the surgical treatment of liver metastases from colorectal cancer and to discuss some modalities that may affect the management of this disease in the near future.

Selection of patients for surgery

Patient

Standard clinical and anamnestic criteria, briefly summarised in the ASA score, should be used to determine if the patient is suitable for a general anaesthesia and surgery with potential bleeding. Special attention is given to the cardiocirculatory status as clamping manoeuvres of hepatic pedicle and vena cava may be used during the hepatic resection. It is important that coagulation profile be assessed since a transient decrease in vitamin K-dependant clotting factors and an increase in plasma fibrinogen concentration and fibrinogen degradation products may accompany major resections [5].

Liver function

The hepatic functional reserve should be sufficient to ensure postoperative liver function. If liver parenchyma
is normal, up to six anatomical segments or 75% of the volume of the liver can be resected without inducing post-operative liver failure. The absence of underlying disease and the functional capacity of the liver can be assessed by hepatic biological blood tests (AST, ALT, alkaline phosphatases, gamma GT) and by the classic Child and Pugh classification. Liver function tests such as indocyanin green (ICG) or C14-aminopyrin tests may theoretically help to evaluate the liver function preoperatively. However in non-cirrhotic patients, these data are not predictive of the risk of post-operating liver failure [6]. A trans-cutaneous needle biopsy of non-tumorous liver may be helpful to assess the status of liver parenchyma. In metastatic disease, liver parenchyma is rarely fibrotic or cirrhotic but can have been damaged by previous chemotherapy. Recent data have demonstrated that prolonged systemic chemotherapy could induce steatosis, portal or peri-portal fibrosis, micro-vascular changes such as peliosis or sinusoidal congestion [7]. These vascular changes can be responsible for increased risk of bleeding during surgery [8].

Control of primary and extra-hepatic tumour sites

When metastases are discovered during the follow-up after resection of a colorectal cancer, absence of recurrence at the site of the primary tumour should be checked. A rectal digital examination, a colonoscopy to eliminate anastomotic recurrence or a new colic cancer and a CT scan to verify the absence of loco-regional spread are usually considered adequate. Endorectal ultra-sonography can be helpful after primary rectal cancer excision and low anterior anastomosis. Magnetic Resonance Imaging seems to be of valuable interest when local recurrence is suspected after abdomino- perineal excision.

Chest X-ray and thoracic CT scan are performed to rule out lung metastases. Lung metastases do not contra-indicate hepatectomy if they can be entirely removed during a simultaneous or delayed resection. Recent studies have shown that in patients with liver metastases from colorectal cancer and no evidence of lung metastases on chest X-ray, the chest CT had a low yield and a low predictive value and therefore could be avoided [9, 10].

Brain CT scan and bone scintigraphy are performed only if there is a clinical suspicion of brain or bone metastasis. Their presence is usually considered to be a contra-indication for liver resection.

Hepatic involvement

Incomplete resection of intra-hepatic metastases is not associated with any clinical benefit, does not prolong survival [11, 12] and therefore should not be performed. An accurate localisation of all intra-hepatic lesions is essential to plan an adequate type of resection.

Trans-abdominal ultrasound has a low sensitivity for the detection of lesions less than 1 cm but is helpful to determine the relations between deposits and the intra-hepatic vessels and the vena cava.

Bolus dynamic computed tomography has a good sensitivity and allows a good appreciation of the volume of the non-tumorous liver parenchyma, giving helpful information to decide which type of resection should be performed [13-15]. Helical CT scans with CT images obtained during the portal venous phase following intravenous contrast administration has a sensitivity exceeding 80% for the detection of liver deposits with a good specificity.

CT arterial-portography [16] obtained during the portal venous phase following a superior mesenteric angiography is more sensitive, but is invasive. Overall sensitivity for detection of small liver metastases exceeds 90% but perfusion abnormalities and pseudo-lesions are frequently observed reducing the specificity of the test [17].

Magnetic resonance imaging (MRI) is less invasive. Sensitivity was considered inferior to that of arterial portography but the use of super-paramagnetic iron oxide particles coupled with more powerful computers has markedly increased its sensitivity [18-20].

Intra-operative exploration

The exact role of laparoscopy used alone or in combination with laparoscopic ultrasound is not yet fully evaluated, but recent studies have suggested that it could be helpful in some cases either to avoid unnecessary laparotomy or to adapt abdominal incision to the extent of resection [21].

During laparotomy, a careful exploration of the abdominal cavity is performed. The gastro-intestinal tract and the site of the primary tumour are examined. The diaphragm, the paracolic gutters and the Douglas pouch are palpated, looking for peritoneal deposits. The routes of lymphatic drainage of the primary tumour are exposed and palpated, such as the origin of the inferior mesenteric artery for a left colonic or rectal cancer. The celiac axis and the hepato-duodenal ligament are explored. If lymph nodes or peritoneal deposits are found, specimens should be taken for frozen sections. The presence of metastatic lymph nodes in the porta hepatis and the celiac region considerably worsens the prognosis but should not be considered an absolute contra-indication to resection, in particular if they can be completely removed. Five-year recurrence-free surviving patients have been reported in such cases [22].

Intra-operative ultrasonography

Intra-operative ultrasonography can detect small intra-parenchymatous lesions and thus modify the initially planned operation [23]. In terms of sensitivity and specificity, intra-operative ultrasonography for liver metastases detection is significantly better than surgical exploration and pre-operative ultrasonography [24] and comparable to computed arterial portography for sensitivity. In a comparative prospective study, detection
rates for liver metastases were 89% with a combination of ultrasonography and computed tomography arterial portography, vs. 96% for intra-operative ultrasonography [25].

Per-operative ultrasonography improved the surgical treatment in 11% to 30% of patients operated for liver tumours [23, 26, 27]. It can also guide fine needle biopsies, clarify the nature of detected lesions and give a precise mapping of the anatomical relations of the metastases to the main vessels [28].

Surgical resection

Choice of operation

The goal of surgery for liver metastases is to remove all the metastatic sites with free margins of at least 1 cm. The type of liver resection is not by itself a prognostic factor. The extent of liver resection depends on the size, number, location and relation of the metastases to the main vascular and biliary pedicles, and on the volume of the liver parenchyma to be left in place after surgery. Small metastases located near the liver capsule can be resected with wedge resections, whereas larger lesions often require anatomical resections. However, it may be necessary to perform a major liver resection to remove a centrally located small solitary metastasis. In some cases the choice is between several wedge resections and a major liver resection removing all the deposits at once. The first solution preserves more normal liver parenchyma but the cut section of the liver may be larger increasing the risk of bleeding. A major liver resection allows a better free margin between the tumour and the cut section of the liver and a better control of intra-hepatic vessels, but removes more parenchyma. The risk of post-operative hepatic failure and the theoretical risk of promoting the development of dormant liver metastases, by the mechanisms involved in liver regeneration [29], are increased.

Timing of liver and intestinal surgery for synchronous metastases

Resection of primary tumour and liver metastases can be either synchronous or delayed. In the majority of cases it seems preferable to delay the hepatic resection. The abdominal wall incision is usually different for the colorectal and the liver resection; bowel section and preliminary dissection of the porta hepatis. The liver surface. At the end of the operation a cholangiography can be performed to control biliary pedicles. Drainage of the sub-diaphragmatic space is generally left in place after major resection [43].

Results of surgery

Post-operative complications

In the absence of complications the mean hospital stay after liver resection averages 10 to 15 days. The improvements of anaesthesia and techniques of surgical resection had a significant effect on the decrease of the mortality and morbidity rates [44, 45, 46, 47]. In most studies, in-hospital mortality is less than 5% and is strongly influenced by per-operative blood loss, pre-operative liver function and extent of liver resection. Delayed liver and multi-organ failure may occur after major or extended hepectomy [48]. Morbidity after resection of liver metastases ranges from 20% to 40% [11, 12, 49] and is usually due to transient liver failure, haemorrhage, sub-hepatic abscesses or biliary fistula (Table 1). Associated diseases such as diabetes or chronic pulmonary disease increase the risk of post-operative complications [44, 50].

Long-term results

Following surgery, five-year survival rates ranged from 25% to 40% [12, 51–53] (Table 2). In a large series of 350
Table 1. Complications of liver resections for metastases [11, 46, 69, 87].

<table>
<thead>
<tr>
<th></th>
<th>Rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Liver-related complications</strong></td>
<td></td>
</tr>
<tr>
<td>Peri-hepatic fluid collection or abscess</td>
<td>5-10</td>
</tr>
<tr>
<td>Bile leak</td>
<td>3</td>
</tr>
<tr>
<td>Liver failure</td>
<td>1-5</td>
</tr>
<tr>
<td>Haemorrhage</td>
<td>1-2</td>
</tr>
<tr>
<td><strong>Infections</strong></td>
<td></td>
</tr>
<tr>
<td>Wound</td>
<td>1-3</td>
</tr>
<tr>
<td>Intra-abdominal sepsis</td>
<td>1-3</td>
</tr>
<tr>
<td><strong>General complications</strong></td>
<td></td>
</tr>
<tr>
<td>Pleural effusion</td>
<td>2-5</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>2-5</td>
</tr>
<tr>
<td>Deep vein thrombosis-pulmonary embolism</td>
<td>1-2</td>
</tr>
<tr>
<td>Cardiac failure, myocardial infarction</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 2. Results of surgery.

<table>
<thead>
<tr>
<th></th>
<th>n</th>
<th>Mortality (%)</th>
<th>Morbidity (%)</th>
<th>Survival (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>3 years</td>
<td>5 years</td>
<td>10 years</td>
</tr>
<tr>
<td>Nordlinger 1987 [88]</td>
<td>80</td>
<td>5</td>
<td>13</td>
<td>40</td>
</tr>
<tr>
<td>Scheele 1991 [12]</td>
<td>207</td>
<td>5</td>
<td>22</td>
<td>41</td>
</tr>
<tr>
<td>Doci 1991 [89]</td>
<td>100</td>
<td>5</td>
<td>39</td>
<td>41</td>
</tr>
<tr>
<td>AFC 1992 [22]</td>
<td>1818</td>
<td>2</td>
<td>24</td>
<td>41</td>
</tr>
<tr>
<td>Fong 1999 [90]</td>
<td>1001</td>
<td>2.8</td>
<td>37</td>
<td>22</td>
</tr>
<tr>
<td>Harmon 1999 [91]</td>
<td>110</td>
<td>4</td>
<td>34</td>
<td>46</td>
</tr>
<tr>
<td>Minagawa 2000 [92]</td>
<td>235</td>
<td></td>
<td>38</td>
<td>26</td>
</tr>
</tbody>
</table>

Table 3. Prognostic factors [68].

<table>
<thead>
<tr>
<th>Factors</th>
<th>T3</th>
<th>N+</th>
<th>Free interval &lt; 2 years</th>
<th>n &gt; 4</th>
<th>Marge &lt; 1 cm</th>
<th>CEA level</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 pt</td>
<td>1 pt</td>
<td>1 pt</td>
<td></td>
<td>1 pt</td>
<td>1 pt</td>
<td>&lt; 30 µg/l</td>
</tr>
<tr>
<td>Low risk</td>
<td>Intermediate risk</td>
<td>High risk</td>
<td></td>
<td></td>
<td></td>
<td>&gt; 30 µg/l</td>
</tr>
<tr>
<td>&lt; 3 pts</td>
<td>&lt; 5 pts</td>
<td>&gt; 5 pts</td>
<td></td>
<td>1 pt</td>
<td>2 pts</td>
<td></td>
</tr>
<tr>
<td>78%</td>
<td>59%</td>
<td>44%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

patients who have had a potentially curative liver resection for colorectal metastases, the actuarial 5, 10 and 20 years survival rates were 39%, 23% and 17% respectively, with a 33.6% tumour-free survival rate at five years [46]. In the largest retrospective multicentric trial assessing the results of hepatic resections in 1818 patients with liver metastases of colorectal metastases, overall survival was 41% at three years and 26% at five years. Five-years survival was 28% in 1588 patients who had a resection of isolated colorectal liver metastases and 15% in 250 patients who had resected liver and extra-hepatic metastases. None of the 77 patients who had a palliative resection survived five-year [11]. In a multi-institutional study from the American Registry of Hepatic Metastases that included 607 patients that underwent a curative resection of liver colorectal metastases, the five-years survival rate was 33% and the five-years disease-free survival rate was 25% [54].

Recurrences are observed in 2/3 of the patients [11, 54, 55] and occurs within 12 months in 66% of cases [56-59].

**Prognostic factors**

In order to provide a better selection of the patients before surgery, numerous studies have been directed towards the search for factors influencing survival. They are summarised in Table 3. The sex of the patient and the site of the primary tumour do not seem to influence the outcome. The stage of the primary tumour appears to be of major relevance with a five-year survival rate of 70% after hepatectomy in stage I or II, vs. 33% when lymph nodes are invaded [11]. Prognosis is better in patients with fewer than four small metachronous metastases, whereas the involvement of one or both lobes does not seem to influence the outcome [11, 12, 58, 60-62]. The influence of the number and distribution of lesions remains unclear. CEA level is strongly correlated to the recurrence-free survival [11, 62, 63]. A free margin of at least 1-cm offers a better chance of survival [12, 49, 64, 65]. In a retrospective study including more than 1500 patients, five-year survival was 30% when the margin was more than 1 cm, 15% when it was less than 1 cm and 0% when resection was incomplete [11]. However, several recent series have shown that a smaller margin does not affect survival [66, 67]. The type of resection does not seem to influence the prognostic providing that a clear margin is obtained. Blood transfusions could be associated with an adverse outcome but may reflect the surgical difficulties faced with large and numerous lesions [62].

Uni- and multivariate analysis of the prognostic value of different factors has permitted the proposal of simple prognostic scoring systems to evaluate the chances of cure of patients after resection of liver metastases. One of these scoring systems was developed from a retro-
pective series of 1568 patients with resected liver metastases from carcinoma [68]. Two- and five-year survival rates were 64% and 28%, respectively, and were affected by CEA level, stage of the primary tumour, disease-free interval, number of liver nodules and resection margin. Giving one point to each factor, the population was divided into three risk groups with different two-year survival rates: 0–2 (79%), 3–4 (60%), 5–7 (43%). Another risk score for recurrence following liver resection for colorectal metastases was established by multivariate analysis of a series of 456 patients [69].

These data suggests that patients who underwent a surgical resection with a tumour-free surgical margin, have increased survival regardless of other prognostic factors.

Repeat liver resections

Recurrences are observed in 2/3 of operated patients, half of them occurring in the liver. The role of occult metastases or dormant cancer cells, which later developing into patent metastases, has been established in an experimental model [29].

Recurrences limited to the liver, following previous hepatic resection are amenable to iterative resection [70–72]. Such recurrences occur in 25% to 53% of the cases [70, 73, 74]. Post-operative mortality and morbidity do not differ from those reported after a first resection and the mean survival approaches two years [72, 74, 75]. In a series including 146 patients with intra-hepatic recurrence following hepatectomy treated by repeat liver resection the actuarial survival rate was 78% at one year, 30% at three years, 16% at 5 and 10 years, comparable to that observed following primary liver resections [73]. Hepatic recurrences should therefore be resected whenever possible.

How to improve results

To date, surgical resection is the best treatment for hepatic metastases. However, only 10% to 20% of the patients fulfill selection criteria and are amenable to surgery. New modalities including portal vein embolisation, local destruction and chemotherapy aim to increase the number of patients that can be resected, therefore improving the overall results of treatment of liver metastases.

Portal embolisation

A technically feasible curative liver resection might be contra-indicated because the volume of the remnant liver, as measured by volumetric CT scan, will be too small to ensure a good hepatic function (i.e. inferior to 20% of the volume of the non-tumorous liver). In some of these cases, a pre-operative portal venous branch embolisation can be performed in order to induce an atrophy of the lobe to be removed and a compensatory hypertrophy of the lobe that will be left in place. A gelfoam-gentamicin powder and N-butyl-2-cyanoacrylate with lipiodol are used to perform portal embolisation, usually by percutaneous trans-hepatic access under ultrasonographic control. Hepatic volume is checked every two weeks by computed tomography volumetry. The resection is generally performed three to six weeks after the embolisation when morphological control shows an adequate hypertrophy of the remaining liver parenchyma. Selective portal embolisation is performed with a 90% technical success rate and may lead to a 20% to 50% hypertrophy of the remnant lobe, with minimal morbidity and without inducing increased post-operative complication [76–79].

Local destruction (Table 4)

Therapies such as cryotherapy or radiofrequency ablation attempt to destroy tumours in situ. The efficiency of these new treatment modalities have not yet been tested in randomised trials and their use should be restricted to the treatment of otherwise non-resectable liver deposits.

Cryotherapy involves the freezing and thawing of liver tumours by means of a cryoprobe inserted into the tumour. During freeze/thaw cycles, ice formation occurs in an area termed iceball leading to tumour destruction. Cryosurgery is feasible for tumours up to 6 or 8 cm even if located near the main vascular pedicles. The size of the probe precludes percutaneous utilisation. Complications include haemorrhage, sub-phrenic or hepatic abscess, bile collection or fistula, myoglobinuria. Radio-frequency ablation involves percutaneous or intra-operative insertion of an electrode into the lesion under ultrasonic guidance. RF energy is emitted through the electrode and generates extreme heat, leading to coagulative necrosis. RF is feasible for tumours less than 3 cm and some strategies can increase the treatment area up to 5 cm (multi-probe arrays, internal cooling of the electrode, vascular clamping...). Complication rate is very low, usually below 2%.

The effectiveness of cryotherapy and RF in destroying liver metastases has been demonstrated in several retrospective studies, but the long-term results and the beneficial effects on survival are not yet proven.

Regional therapies can be used as palliative treatment for non-resectable lesions or can be associated with surgical resection.
In a prospective, non-randomised study, radiofreque-
ncy was used in 123 patients with histologically
confirmed, unresectable hepatic malignancies without
extra-hepatic disease. The mortality and morbidity rates
were 0% and 2.4% respectively. With a median follow-up
of 15 months, secondary lesions recurred at the site of
local destruction in only 3% of patients. New hepatic or
extra-hepatic disease developed in 30% of patients, the
liver being the first site of recurrence in 80% of these
patients [80].

Peri-operative chemotherapy

To date, surgical resection alone is the standard treat-
ment for patients with resectable liver metastases. The
benefit of adjuvant chemotherapy has not been clearly
proven. A German multicenter trial failed to demon-
strate any benefit of an adjuvant postoperative arterial
treatment using 5-FU and folinic acid [81, 82]. Two
recent studies using adjuvant hepatic arterial infusion of
FUDR and systemic chemotherapy after resection of
liver metastases demonstrated a significant improve-
ment in three year recurrence-free survival compared
with surgery alone and an improved two-year survival
rate after HAI and systemic chemotherapy compared to
systemic chemotherapy alone [83]. These results are
encouraging for the future but the significant toxicity,
cost, patient and centre selection, and the absence of
long term survival benefit may limit the widespread use
of this therapy.

Systemic chemotherapy using SFU in combination
with newer drugs such as oxaliplatin or CPT-11 can
reduce the volume of liver metastases [84, 85]. One
objective of chemotherapy can therefore be to render
resectable liver metastases previously considered to be
non-operable. In one study systemic chemotherapy per-
mitted surgical resection of liver metastases in 16% of
patients previously considered to be non-resectable be-
cause of their location, size, number, or the association
with extra-hepatic disease. There was no operative mor-
tality. The cumulative three- and five-year survival rates
were 54% and 40%, comparable to those observed after
surgical resection of resectable lesions. Hepatic recur-
rence in 34 patients was amenable to repeat surgery in 15
cases. [86].

These results questioned the role of neo-adjuvant
chemotherapy before liver resection in resectable lesions.
A multi-institutional intergroup randomised prospective
trial was recently initiated by EORTC to demonstrate
the impact of preoperative systemic chemotherapy on
resectability, disease-free survival and overall survival
for patients with resectable liver metastases.

Conclusion

The field of surgery of liver metastases is evolving rapidly.
The proportion of metastases resected is increasing
with surgeons becoming more aggressive, encouraged
by results of treatment. Some unresectable deposits can
now be destroyed by local ablation techniques used
during surgery or percutaneously. Some metastases can
shrink and become resectable after administration of
chemotherapy.

However, in spite of the excitement inspired by such
progress we must not forget that most of these tech-
niques have not yet been validated and we must organise
well-prepared clinical trials to demonstrate that they can
have an impact on survival of the patients.

References

1. Stangl R, Altendorf-Hofmann A, Charnley RM, Scheele J. Fac-
tors influencing the natural history of colorectal liver metastases.
2. Wagner JS, Adson MA, Van Heerden JA et al. The natural history
of hepatic metastases from colorectal cancer. A comparison with
3. Wanebo HJ, Semiglou C, Attiyeh F, Stearns Jr MJ. Surgical
management of patients with primary operable colorectal cancer
4. Wilson SM, Adson MA. Surgical treatment of hepatic metastases
5. Iwatsuki S, Shaw Jr BW, Starzl TE. Experience with 150 liver
6. Yamanaka N et al. A prediction scoring system to select the
surgical treatment of liver cancer. Further refinement based on
7. Sebagh M et al. Evaluation histologique et biochimique de la
nociception hépatique d’une chimiothérapie systémique. Gastroen-
8. Elias D, Lasser P, Rougier P et al. (Major hepatectomy after intra-
arterial chemotherapy for initially unresectable liver tumors. Fre-
cency, technical problems, results and indications). Ann Chir
9. Povoski SP, Fong Y, Sgouros SC et al. Role of chest CT in patients
with negative chest X-rays referred for hepatic colorectal meta-
computed tomography in the staging of patients with potentially
resectable liver metastases from colorectal carcinoma. Cancer
11. Nordlinger B, Jaeck D. Traitement des métastases des cancers
of prognosis after hepatic resection for colorectal secondaries.
15. Werncke K et al. Detection of hepatic masses in patients with
carcinomas: Comparative sensitivities of sonography, CT, and MR
16. Soyer P, Blumenc DA, Fishman EK. CT during arterial portography
for the preoperative evaluation of hepatic tumors: How, when,
from colorectal cancer: Detection and false-positive findings with
helical CT during arterial portography. Radiology 1994; 193 (1):
71–4.
18. Soyer P, Levesque M, Caubron C et al. MRI of liver metastases
from colorectal cancer vs. CT during arterial portography. J
FLASH MR imaging during gadolinium chelate-enhanced arte-


Received 4 April 2001; accepted 18 April 2001.

Correspondence to.

B. Nordlinger, MD
Department of digestive surgery
Ambroise-Paré Hospital
9, avenue du Général de Gaulle
92100 Boulogne
France
E-mail: bernard.nordlinger@apr.ap-hop-paris.fr