Impact of intra-operative ultrasonography in liver surgery
Parul J Shukla, Durgatosh Pandey, Pramod P Rao,* Shailesh V Shrikhande, Meenakshi H Thakur,* Supreeta Arya,* Subhash Ramani,* Shaesta Mehta,** K M Mohandas**
Departments of GI Surgical Oncology, *Radio-Diagnosis, and **Department of Digestive Diseases and Clinical Nutrition, Tata Memorial Hospital, Mumbai 400 012

Background/Objective: Intra-operative ultrasonography (IOUS) during surgery for primary and metastatic hepatic tumors identifies additional lesions and helps in determining the most optimal surgical strategy. We assessed the impact of IOUS in liver surgery at our hospital, a tertiary-care cancer center.

Methods: Patients with potentially resectable hepatic tumors underwent surgical exploration. The relationship of the tumor with regard to the intrahepatic vasculature was determined by IOUS. A search was also made for additional lesions not detected by pre-operative imaging modalities. In appropriate cases, IOUS was also used to assist resection and radiofrequency ablation / ethanol injection.

Results: Between January 2003 and January 2005, 52 patients underwent surgery for primary or secondary hepatic tumors. IOUS was performed in 48 of these patients. It detected additional hepatic lesions in 14 patients (29.2%). IOUS contributed to changing the operative plan in 21 patients (43.8%). It was directly responsible for avoiding resection or ablation in 7 patients (14.6%), 5 of whom had multiple bilobar lesions, 1 had IOUS-guided biopsy that revealed caseating granuloma on frozen section, and 1 patient had no lesion on IOUS. Three patients had extent of resection changed based on IOUS findings. IOUS also guided radiofrequency ablation in 8 patients and ethanol injection in one patient.

Conclusion: IOUS is an essential tool in surgery for hepatic tumors. In addition to accurate staging, it also aids in safe resection and radiofrequency ablation in appropriate cases. [Indian J Gastroenterol 2005;24:62-65]

Intra-operative ultrasonography (IOUS) is considered as the most accurate staging method for both primary and metastatic hepatic tumors. In addition to identifying lesions not detected on pre-operative imaging, it helps in accurate definition of the extent of tumor and precise delineation of intrahepatic vascular architecture so that liver resection can be performed safely.

Fig: Relationship of mass with intrahepatic vasculature
Results

Fifty one of the 52 patients who underwent surgery for hepatic lesions had potentially resectable lesions based on pre-operative imaging. One patient with cirrhosis was planned for IOUS-guided FNAC and RFA/ethanol injection of a suspicious nodule. The distribution of these cases was as follows: hepatocellular carcinoma (HCC; n=20), metastatic tumor (24, including 13 with primary colorectal tumor), hepatoblastoma (5), and intrahepatic cholangiocarcinoma, hepatic adenoma, and hemangioma (1 each).

Of these 52 patients, 48 underwent IOUS. Four patients did not require IOUS because the findings on intra-operative exploration and palpation were sufficient to abandon further surgery. One patient each had multiple bilobar surface metastases, obvious portal vein invasion by HCC, cirrhosis with caudate lobe extension of HCC, and cirrhosis with a large tumor that would have otherwise required extended right hepatectomy.

The operative procedures performed in these 48 patients were: only resection (n=32); resection + RFA (6), RFA only (2), ethanol injection (1), and no resection or RFA (7). The range of liver resection included extended right hepatectomy, right or left hepatectomy, left lateral hepatectomy, and segmental / non-anatomic resections. The nature and extent of the tumor as well as the condition of the remaining liver determined the extent of liver resection. RFA was performed either alone or in combination with resection in patients with multiple lesions.

Five of the 7 patients who did not undergo resection or RFA had multiple bilobar lesions detected on IOUS. One patient underwent IOUS-guided biopsy, which revealed caseating granuloma suggestive of tuberculosis on frozen section, and one patient had no lesion on IOUS (biopsy from suspicious area on CT scan had revealed normal liver tissue on frozen section).

Impact of IOUS

IOUS detected additional lesions in 14 patients (29.2%). Five of these patients had multiple lesions not amenable to resection or RFA. IOUS was responsible for a change in operative plan in 21 of 48 patients (43.8%). The Table summarizes the details of these patients. In 7 patients, resection or RFA was avoided. Extended or additional resection was performed based on the IOUS findings in 3 patients. A combination of resection and RFA was required in 6 patients, and only RFA was performed in 2 patients based on the findings of IOUS. Three patients with HCC had extent of resection changed based on IOUS findings. In addition, IOUS-guided RFA or ethanol injection was done in 9 cases (18.8%).

In the 38 patients in whom hepatic resection was performed, IOUS was helpful in determining the extent of tumor and its relationship with the intrahepatic vasculature. Specifically, 2 patients with HCC who were initially planned for right hepatectomy finally underwent extended right hepatectomy as IOUS revealed tumor extension into segment 4. One patient with HCC who was initially planned for right extended hepatectomy finally underwent RF-assisted resection of segments 4B and 5 as IOUS revealed tumor confined to these segments.

Sixteen of 21 patients in whom IOUS changed the operative strategy had pre-operative diagnosis of liver metastases. Fourteen of these patients had additional lesions and 2 had no metastases. Five patients with HCC had their operative strategy changed because of IOUS. Of them, 3 had the extent of resection changed and 2 underwent IOUS-guided RFA instead of resection because of intra-operative finding of cirrhosis.

Discussion

In our study, IOUS seems to have had a greater application in metastatic tumors of the liver as far as detection of additional lesions was concerned. In HCC, it was important in determining the extent of resection or guiding ablation.

Pre-operative imaging modalities have their limitations in the accurate evaluation of hepatic lesions. In a prospective study comparing various pre-operative imaging modalities for colorectal liver metastases, combining information from contrast-enhanced helical CT scan, CT with arterioprtography, and contrast-enhanced MRI

<table>
<thead>
<tr>
<th>Table: Details of 21 patients in whom IOUS changed operative plan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
</tr>
<tr>
<td>--------</td>
</tr>
<tr>
<td>5</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>6</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>1</td>
</tr>
</tbody>
</table>
had a staging accuracy of 76%. The authors concluded that the diagnostic accuracy of these three investigations is similar and combining them does not improve accuracy.

Bismuth et al reported that IOUS provided additional information in 35% of patients and changed the operative plan in 20%. Similarly, Parker and colleagues reported that IOUS influenced operative management in 49% of their patients. With advancements in pre-operative imaging modalities, this view has recently been challenged. In an analysis of 111 patients undergoing surgery for primary or metastatic hepatic tumors, Jarnagin et al reported that although additional lesions were detected by IOUS and palpation in 55% of the patients, new findings did not preclude complete resection in a majority of these. Similarly, Sahani et al reported additional lesions detected by IOUS in 10 of 79 patients but only 3 patients had a change in surgical management because of these new findings. Cerwenka and colleagues reported additional lesions detected intra-operatively in 16 of 122 patients (8 by IOUS only), leading to a change in operative strategy in 14 patients (6 due to IOUS only). These reports reflect the impact of improved pre-operative imaging as well as a more aggressive surgical approach to liver tumors.

In contrast, other recent studies have reported change in surgical strategy in 18% and 22.8% of patients because of IOUS. In our series, IOUS detected additional lesions in 14 of 48 patients (29.2%). All these patients had pre-operative evaluation by contrast-enhanced helical CT scan. IOUS contributed to a change in surgical strategy in 21 of 48 patients (43.8%). It was directly responsible for avoiding resection or ablation in 7 patients (14.6%).

Although pre-operative imaging is valuable for making a decision, intra-operative ultrasonography is critical in determining the optimal operative strategy in such patients. IOUS is helpful in determining the relationship of the tumor with the intrahepatic vasculature and aids in performing safe surgery. In all our 38 patients who had hepatic resection done, the extent of tumor and relationship with the vasculature was assessed by IOUS. The extent of surgical resection was changed in 3 patients directly due to the findings of IOUS.

The advent of non-resection ablative procedures like RFA and cryoablation has expanded the indications for surgery in primary and metastatic hepatic neoplasms. Tumors not amenable to surgical resection can be ablated using these techniques. IOUS is vital in guiding these ablative procedures. In our series, IOUS helped in RFA in 8 patients and ethanol injection in one patient. Six of these patients had hepatic resection planned pre-operatively but they underwent RFA of the additional lesions detected on IOUS. This approach of combining resection and ablation achieves a surgical strategy that improves the curative potential in these patients.

There has been a recent concern regarding the inaccuracy of IOUS in differentiating necrotic changes from viable tumor following RFA. Solbiati and colleagues reported that contrast-enhanced IOUS using sulphur hexafluoride microbubbles as contrast agent is more sensitive in detecting viable tumor after RFA, and its use reduced the rate of partially unablated tumor from 16.1% with non-contrast IOUS to 5.9%. Another advantage of contrast-enhanced IOUS is its greater accuracy in differentiating cirrhotic nodules from HCC by adding information about nodule vascularity, as well as its greater sensitivity in detecting small colorectal metastases.

RFA has also been used under IOUS guidance to create a zone of coagulative desiccation around the tumor that allows hepatic resection with minimal blood loss. This approach was used by us in one patient in whom resection of segments 4B and 5 was performed for HCC. This approach will perhaps have its greatest potential in performing non-anatomic and segmental resections when there are no well-defined surface markings of the intrahepatic vessels.

Recent advances in IOUS have a potential to improve the overall management and results of surgery for hepatic tumors. Three-dimensional ultrasonography performed intra-operatively demonstrates the intrahepatic vasculature and their three-dimensional relations accurately and may be helpful in liver surgery.

In conclusion, IOUS is an essential tool in surgery for primary and metastatic hepatic tumors. Apart from detecting additional lesions (especially in metastatic tumors) and changing the surgical strategy in some patients, it guides non-resection ablation of tumors. It also aids in safe resection by determining the relationship of the tumor with the intrahepatic vasculature.

References


Correspondence to: Dr Shukla, In-Charge. Fax: (22) 2414 6937. E-mail: pjshukla@doctors.org.uk

Received October 19, 2004. Received in final revised form February 15, 2005. Accepted March 4, 2005