Clinical Application of Ultrasonic Probing for Preoperative Staging of Colorectal Carcinoma

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OBJECTIVE: The aim of this study was to assess the value of ultrasonic probing (USP) on colonoscopy for the preoperative staging of colorectal carcinoma.

METHODS: Seventy-five patients with colorectal carcinomas proven pathologically underwent USP (Olympus UM-2R, 12 MHz; UM-3R, 20 MHz) on colonoscopy before surgery for colorectal cancer. The results were compared with pathological findings of resected specimens.

RESULTS: Colorectal carcinoma appeared as a hypoechoic mass on USP. USP had an overall accuracy rate of 82.7% for diagnostic T staging of colorectal carcinoma. In determining lymph node metastasis, the sensitivity and specificity were 53.2% and 61.5% respectively. The positive and negative predictive values were 0.87 and 0.22, respectively.

CONCLUSIONS: USP is valuable for the staging of colorectal carcinoma and has a high accuracy rate for determining the depth of tumour invasion. The preoperative information obtained by this tool may influence the choice of therapy. (Asian J Surg 2003;26(1):13–6)

Introduction

The current treatment of colorectal carcinoma includes surgery, chemotherapy and radiation. The preoperative staging of colorectal carcinoma plays an important part in therapeutic management and facilitating the choice of adjuvant treatment for individual patients. Nonetheless, it is difficult to assess the extent of invasive depth correctly using traditional procedures such as colonoscopy, barium enema, computerized tomography (CT) and magnetic resonance imaging. In recent years, endoscopic ultrasonography (EUS) has been widely used as a diagnostic tool for staging upper gastrointestinal carcinomas and pancreaticobiliary tumours.

The aim of this study was to assess the value of ultrasonic probing (USP) on colonoscopy for the preoperative staging of colorectal carcinoma and to determine the relevance of this technique for making therapeutic decisions.

Patients and methods

USP was performed on colonoscopy in 75 consecutive patients with colorectal carcinoma between January 2001 and November 2001. Tumours were located in the right ascending colon (n = 7), transverse colon (n = 9), left descending colon (n = 10), sigmoid colon (n = 23) and rectum (n = 26). The patient group comprised of 34 men and 41 women, with a mean age of 63 years (range, 32–78 yr). All patients underwent surgical resection (n = 71) or endoscopic mucosal resection (n = 4). The diameter of tumours ranged from 0.5 cm to 5 cm. All of the specimens were confirmed pathologically to be carcinoma.

Instruments

Preoperative USP (Olympus UM-2R, 12 MHz; UM-3R, 20 MHz, Tokyo, Japan) was performed under electronic colonoscopy (Olympus CF-Q240, Tokyo, Japan) and endoscopic ultrasonography (Olympus EU-M30, Tokyo, Japan).
The video images were recorded using an ultrasonography image recorder (Sony UP-890, Tokyo, Japan).

**Techniques**

Patients undergoing USP were prepared using the same methods as for conventional colonoscopy. Midazolam 5 mg was administered intramuscularly and scopolamine butylbromide 10 mg was injected intravenously for sedation before the procedure. When a lesion was observed endoscopically, the tip of the colonoscope was placed at the distal end of the tumour. The lumen was filled with 100 to 200 mL of water to achieve acoustic coupling between the transducer and the colon wall (Figure 1). Subsequently, the USP was introduced through the working channel of the colonoscope and advanced beyond the tumour. The lesion was assessed using real-time ultrasonography, while the probe was moved over the tumorous region. Obstructive tumours that could not be traversed by the colonoscope were found in some patients. In spite of the stenosis, it was possible to advance the probe over the tumour in all cases. Based on the results of USP, the patients underwent endoscopic or standard surgical resection.

**Staging criteria**

The depth of the tumour invasion was classified as follows: invasion involving the first three mucosal layers (mucosa and submucosa) was classified as T1 (Figure 2); invasion into the muscularis propria (4th layer) was staged as T2 (Figure 3); tumours that extended into the serosa or pericolic fat were staged as T3 (Figure 4); and invasion into contiguous organs or the peritoneal cavity was staged as T4. The criteria for the diagnosis of metastatic lymph node involvement included a pericolic, hypoechoic mass lesion with a well-defined margin and a size ≥ 5 mm in diameter, or those that revealed a direct connection with the primary tumour (Figure 5).

**Results**

USP was successfully performed in all 75 patients with colorectal carcinomas. The 12 MHz and 20 MHz USP provided high-resolution images of the colorectal wall and adjacent tissues.

The normal wall of the colon displayed five layers (Figure 1). The first two layers represented the mucosa (m). The third layer was the submucosa (sm). The muscularis propria (mp) was the 4th layer. Adventitia or serosa (sa) was sometimes displayed as the 5th layer. The lower part of the rectum below the peritoneal reflections had no serosa; the pericolic fat and the mural outer layer consisted of a hypoechoic layer.

By USP, colorectal carcinoma was clearly demonstrated as a hypoechoic mass, with an echo level intermediate between the hyperechoic level of the 3rd layer and hypoechoic level of the 4th layer. The images showed that the hypoechoic mass protruded into or out of the lumen, or was located intramurally. Such masses were circular or semicircular in shape. The layers of the colon wall may be interrupted, contorted, poorly demarcated or thickened.

The depth of invasion (T staging) was correctly determined in 62 of the 75 patients with colorectal tumours (overall accuracy of 82.7%) (Table 1). Six T2 tumours in which the muscularis propria was irregular were overstaged as T3, while one T2 tumour was understaged as T1 due to micro-invasion of
tumour and biopsy can provide the necessary pathological information, abdominal B ultrasound and CT may reveal metastasis to distant organs such as the liver and lungs. Nonetheless, none of them can determine the exact invasion depth of colorectal carcinoma.

Under these conditions, the development of EUS has opened a brand new dimension in the diagnosis of colorectal carcinoma. USP can image the entire structure of the colon wall and adjacent organs. The normal colorectal wall appeared as a five-layered structure, and a carcinomatous lesion was demonstrated as a hypoechoic mass in the wall. In general, the lower the frequency employed, the better the depth of US penetration and the clearer the images. Therefore, a 20-MHz probe is suitable for clear images of superficial carcinomas. On the other hand, 7.5 MHz and 12 MHz probes are more suitable for the evaluation of advanced carcinoma and regional lymph nodes. In previous reports, EUS could stage the colorectal tumours with an accuracy of 84% (75%–93%). The probe frequencies employed in our study were 12 MHz and 20MHz, for an accuracy of 82.7%. To improve the diagnostic accuracy, it is fundamental to keep the probe at a vertical position to the lesion to get the image as clear as possible.

When using a frequency of 20 MHz to determine tumour penetration, the operator should always adapt the focus of the probe, keeping a certain distance (usually 0.2–1.0 cm) between the probe and tumour to get a full image of the tumor. Despite the fact that USP has a high accuracy in T staging colorectal carcinoma, some errors do occur. Overstaging usually occurs when the tumour deeply or massively invades the submucosa or muscularis propria, or when accompanying inflammation is present around the tumour. On the other hand, the main reason for understaging is the presence of minute carcinoma invasion, which can only be detected microscopically.

In the literature, the reported accuracy of EUS in assessing lymph node metastases ranges from 62% to 85%. The sensitivity and specificity in our study were 53.2% and 61.5%, respectively, which were slightly lower than those reported in the literature. This may also be due to the relatively high frequency of USP that we used. The smallest lymph node detected in our study was 4 mm in diameter. It is rather difficult for USP to diagnose lymph node metastasis because of the variation in shape and echogenicity of lymph nodes. The study by Catalano et al claimed that, if a lymph node was greater than 10 mm in diameter, round, hypoechoic and with a distinct margin, it has a 100% chance of being invaded by the primary tumour. In a recent study by Tseng et al, EUS-guided fine needle aspiration

### Table 1. Ultrasonic probing (USP) staging compared to pathological T staging of colorectal carcinoma

<table>
<thead>
<tr>
<th>Pathology Number of patients</th>
<th>Preoperative USP stage</th>
<th>Accuracy rate (%)</th>
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<tbody>
<tr>
<td>T1 11</td>
<td>T2 10 T3 1 T4 90.9</td>
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</tr>
<tr>
<td>T2 18</td>
<td>T1 16 T3 35 T4 88.9</td>
<td></td>
</tr>
<tr>
<td>T3 43</td>
<td>T1 35 T3 2 T4 81.4</td>
<td></td>
</tr>
<tr>
<td>T4 3</td>
<td>T1 2 T3 1 T4 33.3</td>
<td></td>
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<tr>
<td>Total 75</td>
<td>11 18 43 3 82.7</td>
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</tr>
</tbody>
</table>

### Table 2. Comparison of nodal staging by pathology and ultrasonic probing (USP)

<table>
<thead>
<tr>
<th>USP stage</th>
<th>Pathological stage</th>
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<tbody>
<tr>
<td>uN0 8</td>
<td>pN0 29</td>
</tr>
<tr>
<td>uN1 5</td>
<td>pN1 33</td>
</tr>
</tbody>
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Discussion

Although the standard therapy for colorectal carcinoma today is still surgical resection, most mucosal carcinomas can potentially be treated endoscopically, since the probability of lymph node metastasis is almost zero. The range of lymph node dissection at surgery depends on the stage of carcinoma extension because remarkable differences exist in the rate of lymph node metastasis among submucosal carcinomas, carcinomas invading the muscularis propria, those penetrating through the entire wall, and invading adjacent organs. The preoperative staging is, therefore, a critical factor that influences the choice of therapy and the judgement of the prognosis. Barium enema X-ray can make the location and morphology of the tumour clear, colonoscopy can directly observe the tumour and biopsy can provide the necessary pathological information, abdominal B ultrasound and CT may reveal metastasis to distant organs such as the liver and lungs. Nonetheless, none of them can determine the exact invasion depth of colorectal carcinoma.
of lymph nodes revealed an accuracy rate of 100%. Since the involved lymph nodes could be some distance away from the colon wall, the technical difficulty of USP in detecting nodal metastasis with colorectal carcinoma is inherent. Because USP cannot differentiate lymph node metastases from lymphadenitis, we suggest that any lesion that is hypoechoic, ≥ 5 mm in diameter, near the tumour and not related with vessels can be diagnosed as an involved lymph node.

Although TNM staging is a critical factor that influences the choice of therapy and the judgement of the prognosis, only after the carcinoma is resected and examined pathologically can the TNM staging be judged correctly. Preoperative USP may provide precise information about tumour invasion, though it has some difficulty in diagnosing nodal metastasis. As since early colorectal carcinomas restricted to the mucosa, local resection may be an adequate treatment, for early colorectal carcinoma is rarely associated with lymph node metastasis. Four patients in our study were diagnosed with rectal carcinomas confined to the mucosa and underwent endoscopic mucosal resection. After a mean follow-up period of 14 months, we did not find any sign of recurrence. Since there is increasing concern over the role of laparoscopically assisted resection for colorectal carcinoma, accurate preoperative staging by USP may help select patients for laparoscopic resection without compromising oncological principles.

In conclusion, USP is a valuable modality for the preoperative staging of colorectal carcinomas. Employing the appropriate probe frequency for USP can further improve the accuracy of preoperative staging for colorectal carcinoma. Using preoperative USP, it is easier to choose the appropriate therapy for patients with colorectal carcinoma.

Acknowledgements

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References