Preoperative evaluation of gastric cancer by endoscopic ultrasound

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Abstract
The preoperative use of endoscopic ultrasound was evaluated in 74 patients with confirmed gastric cancer. It was used in diagnosing the depth of invasion in the gastric wall, the infiltration to the adjacent organs, and the involvement of the perigastric lymph nodes. Results were compared with histological findings in resected specimens. Accuracy in staging gastric cancer using the T grade of the 1987 TNM system was 81·1% (60 of 74 patients). Endoscopic ultrasound provided excellent results compared with computed tomography and conventional ultrasound, particularly in evaluating perigastric lymph node metastasis and direct infiltration to the adjacent organs. The success rate in detecting lymph node metastasis was 50% (11 of 22 patients); the accuracy in diagnosing direct infiltration to the adjacent organs was 60% (three of five patients). This technique is useful in diagnosing malignant invasion and lymph node metastasis of gastric carcinomas but requires further refinement for use in diagnosing the disease itself. Its preoperative use is recommended for establishing surgical and other treatment plans, as well as in predicting the prognosis of gastric cancer.

The postoperative five year survival rate of patients with gastric cancer depends on the depth of tumour infiltration and the extent of lymph node metastasis. Curative treatment of gastrointestinal cancer using endoscopic laser treatment[1-3] and endoscopic resection[4] has recently been undertaken in high risk patients. Accordingly, it is important to assess preoperatively the depth of tumour infiltration and the extent of lymph node involvement. Because of a lack of adequate imaging techniques, however, accurate assessment is often difficult. Endoscopic ultrasound, a combination of endoscopy and ultrasound, has recently been developed to improve diagnostic accuracy by directly imaging the target lesion via the gastrointestinal lumen.[1 5-15] This new technique is expected to provide an accurate assessment of the extent of tumour invasion of the upper gastrointestinal tract because of the clear visualisation of tumour infiltration and the involvement of adjacent lymph nodes.[6-10 13 15] In this study we evaluated the practical application of endoscopic ultrasound in diagnosing the depth of cancerous invasion into the gastric wall, involvement of the perigastric lymph nodes, and direct infiltration into the adjacent organs by comparing its results with the histological findings.

Methods

Between October 1986 and March 1990, we performed preoperative endoscopic ultrasound in 74 patients with a diagnosis of gastric cancer that had been confirmed by endoscopic biopsy specimen. There were 49 men and 25 women whose ages ranged from 17 to 85 years (mean 60 years). They underwent surgery after preoperative examinations including upper gastrointestinal series, endoscopy, endoscopic ultrasound, conventional transcutaneous ultrasound, and computed tomography. All the resected specimens, including lymph nodes, were examined histopathologically and results of the preoperative endoscopic ultrasound scanning were compared with both the intraoperative macroscopic findings and the pathology of the resected specimens. Echoendoscopes with radial sector scan transducers (GF-UM2, UM3, frequency 7·5 or 12 MHz) manufactured by Olympus (Tokyo, Japan) were used. The maximal penetration of the ultrasonic beam is 10 cm with 7·5 MHz and 3 cm with 12 MHz.

To evaluate the gastric cancer, the echoendoscope was introduced into the stomach after premedication. The lesions were first observed endoscopically. Next the stomach was filled with deaerated water via the echoendoscope in sufficient quantity to allow us to see the lesion through the water occasionally. In addition the water filled balloon method[14] was used to confirm small lesions. Thereafter, we used the endoscopic ultrasound scanning technique to obtain an image of the lesion and of the normal gastric wall through the water. The entire procedure took about 20 minutes and there were no complications.

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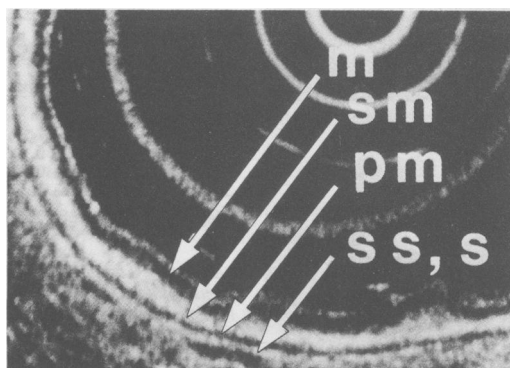
Accepted for publication
26 June 1990

Figure 1: Endoscopic ultrasound scan of normal gastric wall using GF-UM3 with 12 MHz sector scan transducer. m=mucosa, sm=submucosa, pm=muscularis propria, ss,s=subserosa and serosa.

Results

ENDOSCOPIC ULTRASOUND IMAGE OF NORMAL
GASTRIC WALL AND OF GASTRIC CANCER

As previously reported, the normal gastric wall was observed to have five layers.[16-22] An endoscopic ultrasound image of the normal gastric wall is shown in Figure 1. The first layer is hyperechoic and the second hypoechoic, corresponding with the interface echo and the mucosa. The third layer is hyperechoic and represents the submucosa; the fourth layer is hypoechoic and represents the muscularis propria; while the fifth layer represents the subserosa, serosa, and interface echo.

Representative findings in a patient with cancer staged T1 are shown in Figure 2. In Figure 2A the third layer, corresponding to the submucosa, was narrowed by cancer invasion (white arrow) but the fourth layer (muscularis propria) was intact indicating that the depth of invasion of the carcinoma was probably limited to the submucosal layer. Histological examination of the resected specimen confirmed this finding (Fig 2B). Figure 3 shows endoscopic ultrasound findings in a patient with cancer staged T3. The fifth layer, corresponding to the serosa, was interrupted by carcinomatous invasion (arrows), indicating that the cancer had reached the serosa. Figure 4 shows a patient whose tumour was classified as T4. Not only was the fifth layer interrupted, the border between the stomach and the liver was also unclear. These findings suggested direct invasion of the liver. This was confirmed by gross observations at

Figure 3: Endoscopic ultrasound scan of a tumour classified as T3. The fifth layer, corresponding to the serosa (arrow-s) was interrupted (arrows) by cancer (T) invasion.
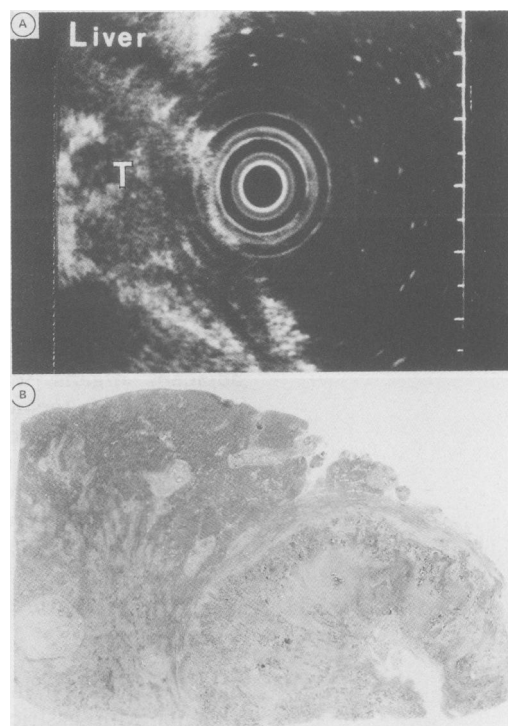
Figure 4: (A) Endoscopic ultrasound scan of a gastric cancer classified as T4. The fifth layer was interrupted by tumour (T), and the border of the liver was unclear. These findings indicate direct invasion to the liver. (B) Corresponding histopathology showed a gastric cancer invading the liver (classified as T4) (haematoxylin and eosin stain, original magnification ×6).

TABLE I   *Results of histopathology and endoscopic ultrasound in assessing the depth of gastric cancer infiltration using 1987 TNM classification (74 patients)*

	Endoscopic ultrasound staging				
Histopathology	T1	T2	T3	T4	Total
T1	37	3	0	0	40
T2	7	12	2	0	21
T3	0	0	8	0	8
T4	0	0	2	3	5

Diagnostic accuracy: 81·1% (60 of 74 patients).

TABLE II   *Comparison of endoscopic ultrasound (EUS) transcutaneous ultrasound (US), and computed tomography (CT) in detecting perigastric lymph node metastasis (22 patients with metastatic disease evaluated histologically)*

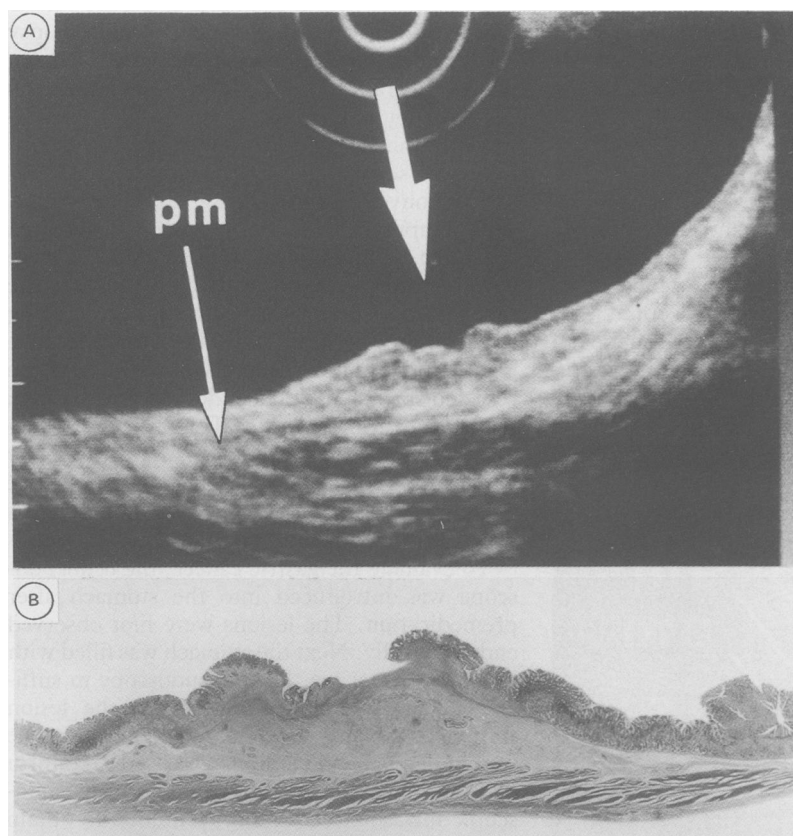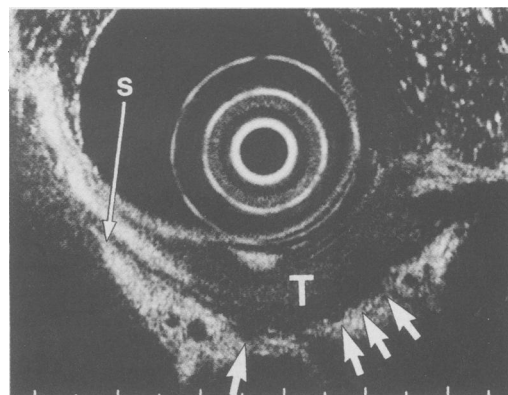| Histopathological findings	EUS	US	CT
Metastatic	11	3	5
Non-metastatic	11	19	17
Detection rate (%)	50	13·6	22·7

Figure 2: (A) Endoscopic ultrasound scan of a gastric cancer classified as T1. The larger white arrow shows spread of the gastric cancer to the submucosa (T1). The muscle layer (arrow-pm) was echogenically intact. (B) Corresponding histopathology showed a cancer limited to the submucosal layer (classified as T1) (haematoxylin and eosin stain, original magnification ×4).

surgery. Neither conventional transcutaneous ultrasound nor computed tomography could provide such information preoperatively in all patients with cancers classified as T4.

ACCURACY OF ENDOSCOPIC ULTRASOUND

We classified tumours in accordance with endo-scopic ultrasound findings by T grade using the 1987 TNM classification.[23][24][25] These results compared with histological evaluation in assessing the depth of infiltraton of the tumour are summarised in Table I. The accuracy of endo-scopic ultrasound in staging tumours was: 92·5% (37 of 40 patients) for T1, 57·1% (12 of 21 patients) for T2, 100% (eight of eight patients) for T3, and 60% (three of five patients) for T4. Overall, the accuracy rate was 81·1% (60 of 74 patients).

DETECTION OF PERIGASTRIC LYMPH NODE METASTASIS

In 22 patients, lymph node involvement was histopathologically confirmed. Endoscopic ultrasound had a success rate of 50% (11 of 22 patients) in detecting perigastric lymph node

Figure 5: (A) Endoscopic ultrasound scan showing metastatic lymph nodes (arrows) in a patient with advanced gastric cancer. (B) Corresponding histopathology showed lymph node metastasis (haematoxylin and eosin stain, original magnification ×6).

metastasis. In addition it had better diagnostic capabilities than conventional transcutaneous ultrasound and computed tomography (Table II). An endoscopic ultrasound image of multiple metastatic lymph nodes and their corresponding histology is shown in Figure 5.

Discussion

Endoscopic ultrasound, a new gastrointestinal diagnostic technique, was shown to detect and stage gastric cancer in this study. Its advantages include the ability to visualise clearly intra or extramural invasion and the involvement of the adjacent perigastric lymph nodes. Compared with conventional endoscopy, radiography using contrast material, computed tomography and conventional transcutaneous ultrasound, endo-scopic ultrasound provided better resolution in evaluating the depth of cancerous invasion into the gastric wall, metastasis into the perigastric lymph nodes, and the extent of direct infiltration of the adjacent organs.

Endoscopic ultrasound is widely recognised as an accurate procedure for obtaining diagnostic information about the mucosa, submucosa, muscularis propria, and subserosal layers of the wall of the gastrointestinal tract. Diagnosis of malignant invasion of the gastric wall is one of its most important capabilities. A correct pre-operative diagnosis of the extent of cancer invasion is a major factor in determining the feasibility not only of surgery[25][26] but of the endoscopic management of early gastric cancer. Endoscopic ultrasound, however, occasionally gives an incorrect diagnosis because of micro-scopic invasion of cancer cells, and this presents problems in judging the depth of invasion by the technique currently used. In addition, it has limited application in diagnosing this disease.

Evaluation of lymph nodes over 10 mm in diameter is feasible with endoscopic ultrasound but it is difficult to detect smaller lymph nodes with micrometastatic involvement.[1][15] In the evaluation of perigastric lymph node metastasis the technique is more accurate than either con-ventional transcutaneous ultrasound or com-puted tomography. Because this information is essential for predicting the prognosis after surgery[25][26] and in planning curative endoscopic treatment, we recommend that endoscopic ultra-sound be used routinely before surgery in examining patients with gastric cancer.

In this study we classified gastric cancers by T grade using the 1987 TNM classification in accordance with endoscopic ultrasound findings. The staging accuracy of the technique was 60% (three of five patients) in T4 tumours. Tio *et al*[24] have reported that the accuracy of endoscopic ultrasound in staging T4 disease was 87·5% (seven of eight patients). With regard to the detection of direct infiltration to adjacent organs, endoscopic ultrasound is more accurate than conventional transcutaneous ultrasound or com-puted tomography. It is important to have this information before surgery in order to determine whether to undertake the combined resection of the surrounding organs and to predict the operative risk.[26] Diagnosis of distant metastases is more difficult, however, because of the limited
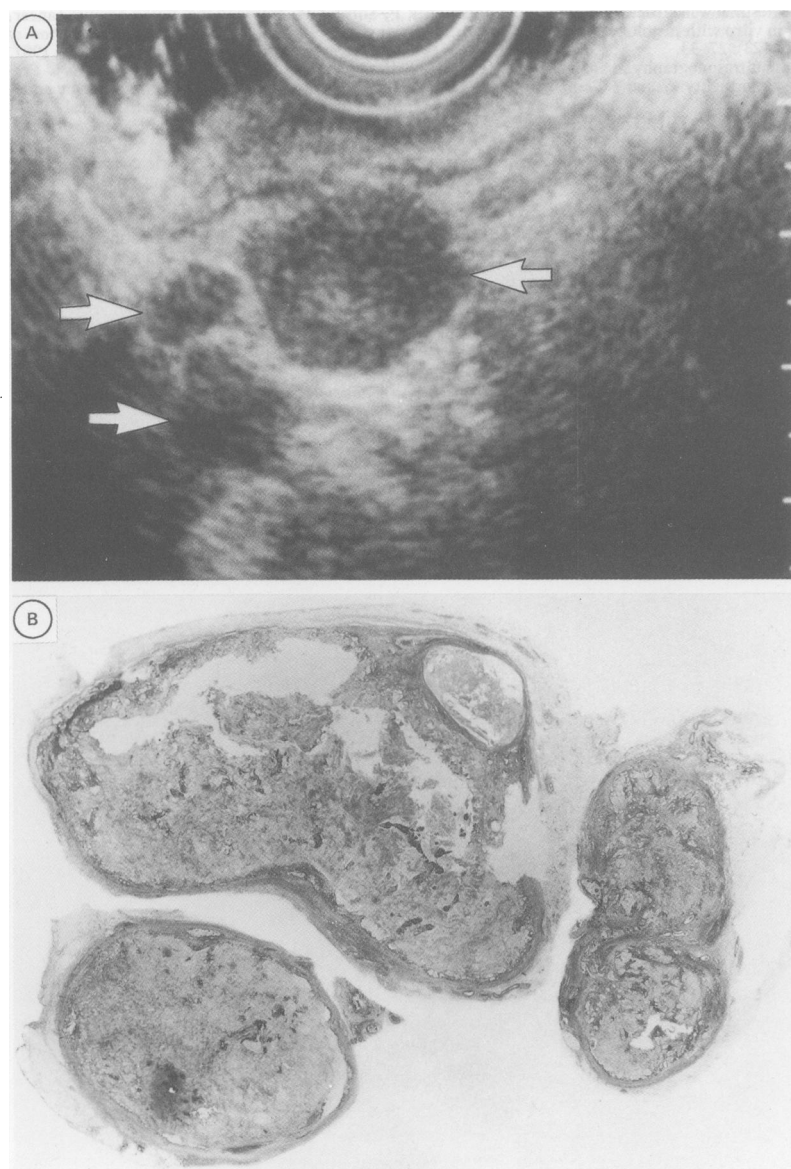
depth of penetration of ultrasound. Accordingly the combination of conventional transcutaneous ultrasound and computed tomography is recommended in the diagnosis of distant metastases.

We showed that the currently available endoscopic ultrasound technique is useful for identifying those gastric carcinoma patients most likely to benefit from surgery and for planning non-surgical treatments such as endoscopic laser therapy, endoscopic resection, and radio or chemotherapy, or both. The problem of diagnosing gastric carcinoma with endoscopic ultrasound, however, requires further investigation.

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