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# Comparison of hydrocolonic sonograpy accuracy in preoperative staging between colon and rectal cancer

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## Abstract

**AIM:** To compare the accuracy of hydrocolonic sonography (HUS) in determining the depth of invasion (T stage) in colon and rectal cancer.

**METHODS:** A total of 1 000-2 000 mL of saline was instilled per rectum using a system for barium enemas, and then ultrasonography was conducted by a SSA-270A (Toshiba Co, Japan) sonolayer unit with a 3.75 MHz for 17 patients with colon cancer and 13 patients with rectal cancer before operation. After operation, T stage in HUS was compared with postoperative histological findings.

**RESULTS:** Overall, the accuracy of T stage was 70%. It was 88% in colon cancer and 46% in rectal cancer. In evaluating nodal state, the accuracy of HUS was low in both colon (71%) and rectal cancers (46%) compared with conventional CT or MRI. The overall accuracy of N staging was 60%.

**CONCLUSION:** HUS is valuable to evaluate the depth of invasion in colon cancer, but is less valuable in rectal cancer. Because HUS is low-cost, noninvasive, and readily available at any place, this technique seems to be useful to determine the preoperative staging in colon cancer, but not in rectal cancer.

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## INTRODUCTION

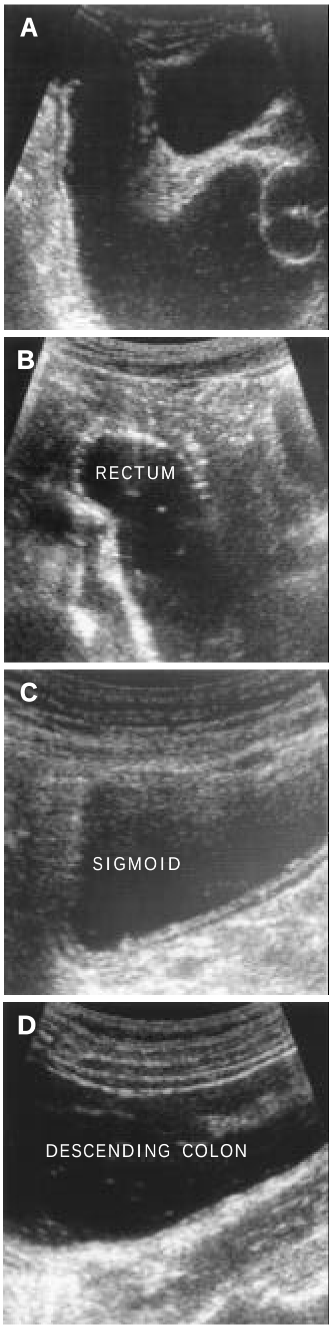
It is well recognized that the prognosis of colorectal cancer is very closely related to TNM stage[1,2]. In general, computed tomography (CT) or magnetic resonance imaging (MRI) has been widely used for the clinical staging before surgery. These modalities have shown a comparatively high accuracy, especially in evaluating N and M stages. But these modalities have shown some limitation in the depth of invasion[3-5]. Thus, to overcome this limitation, endoscopic ultrasonography (EUS) was developed, and has recently been widely performed[5-11]. However, this modality requires endoluminal access and expensive equipments available only at large medical institutes. Therefore, its application is limited.

Conventional ultrasonography (US) is a simple and safe method, most widely used for screening and diagnosis of abdominal diseases. But, it has limitations to evaluate the endoluminal surface and the depth of invasion of bowel wall[11,12], because of the inability of sonic waves to penetrate air. Over the last years, sonographic evaluation of gastrointestinal (GI) tract has been improved by the instillation of water into the endoluminal area. This procedure is called hydro-sonography (HUS), which allows us to visualize the endolunimal lesion and the depth of invasion of bowel wall in stomach or colon[13-23]. Because HUS is low-cost, non-invasive, and readily available in small medical institutes, it would be an acceptable modality for preoperative staging of colorectal cancer especially in evaluating the depth of invasion. The purpose of this prospective study was to compare the accuracy of HUS in T and N staging between colon and rectal cancer.

## MATERIALS AND METHODS

Seventeen patients with colon cancer and 13 patients with rectal cancer, who visited Severance Hospital from 1997 to 2002, were enrolled. In all the cases, a barium enema was performed for detection of other lesions, and a colonoscopy with biopsy for histological confirmation was done as much as possible. They all underwent HUS before operation. Surgery was performed within 7 d after HUS, and we compared the histological stage with the preoperative stage by HUS. All the patients gave their written informed consent before treatment, and the study protocol was approved by the Ethical Committee for the Clinical Research of Institutional Review Board of Yonsei Medical Center in Korea.

For the preparation of bowel before HUS, all the patients took an oral laxative, magnesium sulfate 30 mg (Magrol 250 cc), and received two enemas using warm saline-soapy water suspension on the previous day of the examination. They did not eat anything overnight, and were given pre-medication, scopolamine-N-butyl bromide, 20 mg, intramuscularly just before examination for relaxation of the bowel and suppression of the sense of urgency for defecation. Eighteen Fr-Foley catheters were inserted through the anus and fixed to anal sphincter by ballooning. A total of 1 000-2 000 mL of warm saline water was instilled per rectum using a system, that was usually used for barium enemas (Pneumocolon; Barnes-Hind Barium Products) until the bowel wall was fully distended, and continuous sonography of the large intestine was conducted for adequate filling of water into the colon and rectum (Figure 1A). On occasion, the patients changed their position for optimal sonographic plane. We used a SSA-270A (Toshiba co, Japan) sonolayer unit with a 3.75 MHz convex type transducer, and lower frequency beams for proper penetration. The diagnosis of lesions was based on the sonographic evidence mentioned by Limberg[16]. The main criteria for malignancy were as follows: irregular thickening of the bowel wall with visible destruction of layer boundaries, infiltration into adjacent structures. The main criteria for enlarged regional lymph nodes were as follows: $\geqslant$ 5 mm round hypoechoic mass to be delineated definitive tumor margin around primary lesion because there were no accurate sonographic parameters to distinguish benign lymph node hyperplasia from malignant infiltration[9]. The first hyperechoic layer adjacent to the lumen corresponded to mucus, the second hypoechoic layer to the muscularis mucosa (MM), the third hyperechoic layer to the submucosa (SM), the fourth hypoechoic layer to the muscularis propria (PM), the fifth echogenic layer to serosa and the peri-colic fat tissues. The integration of mucus and MM layer was defined as mucosa layer (M)[16]. Normal images of colorectal wall architecture at each site were demonstrated in Figures 1B-F. A tumor was classified as T1 when the mass was confined to mucosal and submucosal layer of colon, as T2 when confined to the muscularis propria, as T3 when the tumor penetrated through muscularis propria layer (subserosa) and extended to the serosal layer (including pericolic fat infiltration), and as T4 when the tumor extended to the adjacent organs[24]. Additionally, we compared HUS with abdominal pelvic CT in accuracy. Statistical analysis was performed with nonparametric paired *t*-test, Mann-Whitney test. A two tailed *P* value less than 0.05 was considered statistically significant.



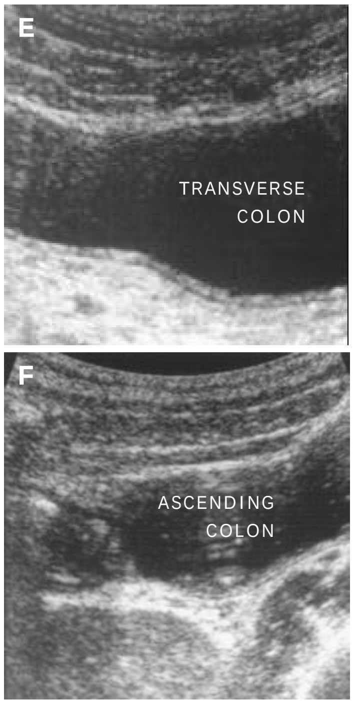




**Figure 1** Normal images of five-layered colorectal wall architectures at each site. A: Distended rectum by instilling 1 000-2 000 mL warm saline inserted with a balloon catheter, B: rectum, C: sigmoid colon, D: descending colon, E: transverse colon, F: ascending colon. The first hyperechoic layer and the 2nd hypoechoic lesion were mucosa, the 3rd hyperechoic layer was submucosa, the 4th hypoechic lesion was muscularis propria, and the 5th outer echogenic layer was serosa (from inner to outer of the lumen).

## RESULTS

### *Patient characteristics*

The clinicopathological characteristics of the thirty patients are demonstrated in Table 1. There were no significant differences between colon and rectal cancer (*P*>0.05).

**Table 1** Characteristics of the patients (*n*=30)

| | Colon cancer (*n*=17) | Rectal cancer (*n*=13) | *P* value |
|---|---|---|---|
| Sex | | | NS |
| Male | 9 | 7 | |
| Female | 8 | 6 | |
| Age | | | NS |
| Median (range) | 52 (37-68) | 56 (43-75) | |
| Size | | | NS |
| Mean (range) | 5.76 (3-9) | 5.8 (3-9) | |
| Time intervals to operation day | | | NS |
| Median (range) | 4 (3-7) | 5 (3-9) | |
| Failure to passage of colonoscopy | 7 | 1 | NS |
| Shape | | | NS |
| Polypoid | 4 | 3 | |
| Ulcerative | 2 | 2 | |
| Ulcerofungating | 4 | 4 | |
| Ulceroinfiltrative | 7 | 4 | |
| Site | | | |
| Rectum | - | 13 | |
| Sigmoid colon | 4 | - | |
| Descending colon | 1 | - | |
| Transverse colon | 6 | - | |
| Ascending colon | 6 | - | |

(*P*=0.05, Mann-Whitney test), NS: no significance.

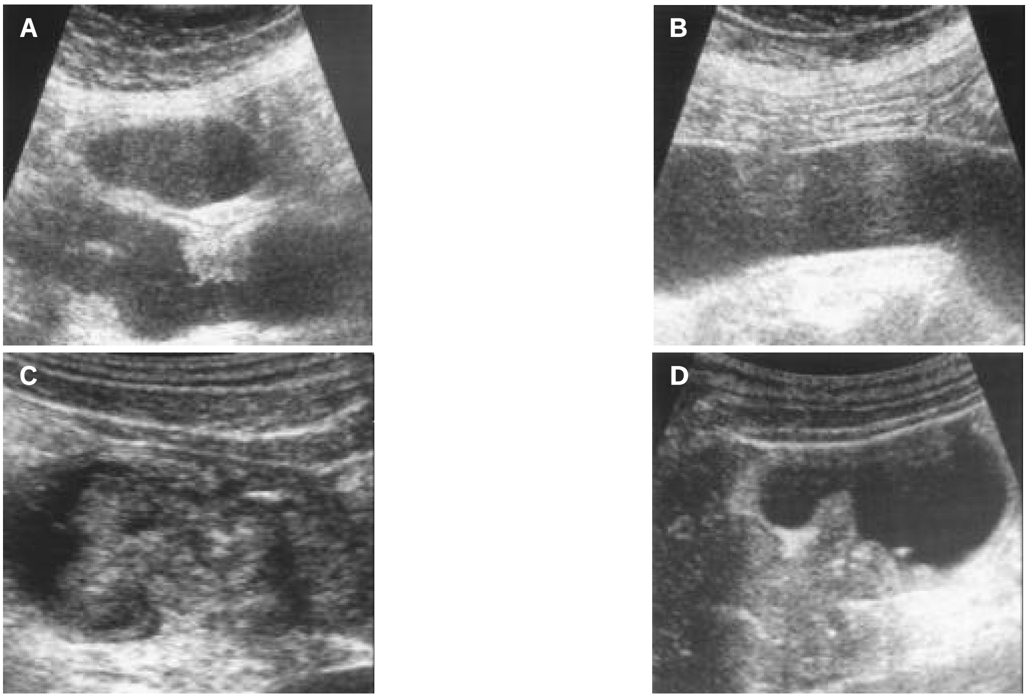



**Figure 2** Images of HUS corresponding with their histological stage A: A round mass originated from submucosal (SM) layer in the descending colon, its histological stage was SM (T1). B: A round mass with deformed PM layer (T2) in transverse colon, its histological stage was PM (T2). C: A large endoluminal polypoid mass penetrating the wall and extending to pericolic fat layer. HUS judged stage was T3, its histological stage was T3. D: A carcinoma with serosal infiltration extending into pericolic adjacent tissue in descending colon. HUS judged stage was T4, its histological stage was T4.

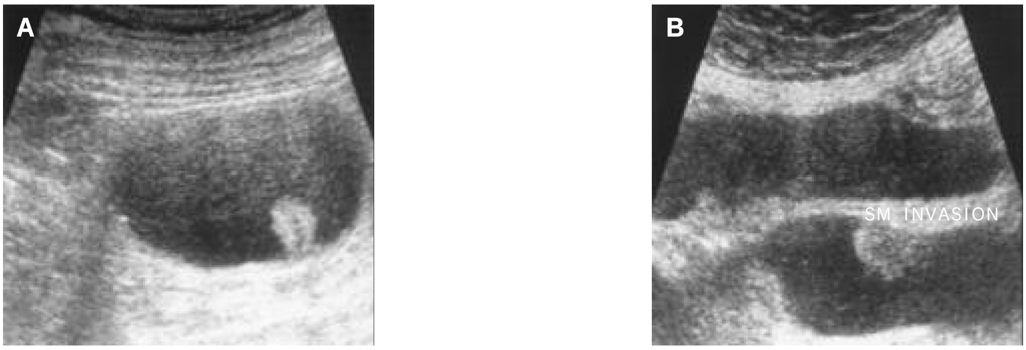



**Figure 3** Images of HUS not corresponding with their histological stage. A: Sigmoid colon cancer; HUS judged as PM cancer (T2), but histology revealed pericolic fat infiltrated by tumor cells (T3). B: Transverse colon cancer; HUS judged as PM cancer (T2), but histology revealed intact PM layer and tumor cells infiltrated only SM layer (T1).

### *Detection for lesions*

All the patients completed all the procedures successfully. Because we had acquired some information about the tumor location and shape before HUS by colonoscopy or barium enema, and the patients changed their position for optimal sonographic plane, no lesions were missed even though the tumor was located in the posterior wall opposite to the tranducer, or a site adjacent to the loops of small bowel or flexure.

### *Depth of invasion and T stage*

HUS made a correct staging in 21 of the 30 colorectal cancers. Figure 2 demonstrates the preoperative HUS imaging corresponding to the postoperative histological staging, and Figure 3 demonstrates the discordant staging. The overall accuracy of HUS was 70%.

The accuracy of staging by HUS was favorable in colon cancer (88%), especially when the lesions were located in the descending or ascending colon and their depth was confined to pericolic fat infiltration (93 %) (Table 2). When the lesions were located in the sigmoid, transverse colon, and its flexure and confined to the mucosal layer, the accuracy was relatively lower. Underestimated cases were relatively smaller than 2 cm and ulceroinfiltrating shaped masses, and overestimated cases were larger than 3 cm and fungating mass. But the differences were not statistically significant. In rectal cancer, however, the accuracy was unfavorable (46.1%) compared with colon cancer, at any site or of any shape (Table 2, $P = 0.038$). Table 3 demonstrates the accuracy of CT in staging of depth of invasion in colon and rectal cancers.

### *Nodal stage and N stage*

The overall accuracy of HUS for N staging in colorectal cancer was 60%. The sensitivity and specificity were 55% and 67%, respectively. It showed 71% accuracy in colon cancer and 46% accuracy in rectal cancer, respectively. The accuracy of N staging by HUS was relatively lower than that by conventional CT or MRI in both colon and rectal cancers. In addition, the accuracy of N staging was affected by the size of the node. There was no statistically significant difference in the accuracy of N staging by HUS between colon and rectal cancers although it was higher in colon cancer than in rectal cancer (Table 4). Table 5 demonstrates the accuracy of CT in staging of lymph node metastasis in colon and rectal cancers.

**Table 2** Comparison of hydrocolonic sonography accuracy in depth of invasion between colon and rectal cancers (*P*=0.038)

| Pathologic Diagnosis | Colon cancer T1 | T2 | T3 | T4 | Accuracy (%) | Rectal cancer T1 | T2 | T3 | T4 | Accuracy (%) |
|---|---|---|---|---|---|---|---|---|---|---|
| T1 | 1 | | | | 1/1 (100) | | | 1 | | 0/1 (0.0) |
| T2 | 1 | | | | 0/1 (0.0) | | 2 | 1 | | 2/3 (66.7) |
| T3 | | 1 | 14 | | 14/15 (93) | | 3 | 4 | 1 | 4/8 (50.0) |
| T4 | | | | | 0/0 | | | | 1 | 1/1 (100) |
| Total | 2 | 1 | 14 | | 15/17 (88) | | 5 | 6 | 2 | 6/13 (46.2) |

**Table 3** Comparison of the accuracy of CT in depth of invasion (*P*=0.048)

| Pathologic Diagnosis | Colon cancer T1 | T2 | T3 | T4 | Accuracy (%) | Rectal cancer T1 | T2 | T3 | T4 | Accuracy (%) |
|---|---|---|---|---|---|---|---|---|---|---|
| T1 | | 1 | | | 0/1 (0.0) | | | 1 | | 0/1 (0.0) |
| T2 | | 1 | | | 1/1 (100) | | 1 | 2 | | 1/3 (33.3) |
| T3 | | 4 | 10 | 1 | 10/15 (66.7) | | 1 | 5 | 2 | 5/8 (62.5) |
| T4 | | | 0 | 0 | 0/0 (0.0) | | | 1 | | 0/1 (0.0) |
| Total | 0 | 6 | 10 | 1 | 11/17 (64.7) | | 2 | 9 | 2 | 6/13 (46.2) |

(*P*=0.05, Mann-Whitney test).

**Table 4** Comparison of the accuracy of hydrocolonic sonography in lymph node metastasis between colon and rectal cancers (*P*=0.183)

| Pathologic Diagnosis | Colon cancer *n* (-) | *n* (+) | Rectal cancer *n* (-) | *n* (+) |
|---|---|---|---|---|
| N (-) | 8 | 1 | 4 | 5 |
| N (+) | 4 | 4 | 2 | 2 |
| Total | 12 | 5 | 6 | 7 |
| Accuracy (%) | 12/17 (70.6) | | 6/13 (46.2) | |

**Table 5** Comparison of the accuracy of CT in lymph node metastasis (*P*=0.275)

| Pathologic Diagnosis | Colon cancer *n* (-) | *n* (+) | Rectal cancer *n* (-) | *n* (+) |
|---|---|---|---|---|
| N (-) | 8 | 1 | 5 | 4 |
| N (+) | 3 | 5 | 2 | 2 |
| Total | 12 | 5 | 7 | 6 |
| Accuracy (%) | 13/17 (76.5) | | 7/13 (53.8) | |

(*P*=0.05, Mann-Whitney test), N (-): lymph node negative, N (+): lymph node positive.

## DISCUSSION

Over the last years, sonographic evaluation of gastrointestinal (GI) tract has been improved by the instillation of water into the endoluminal area, named as HUS[13-24]. Allowing the sonographic differentiation of five layers of the colon wall, theoretically HUS was able to predict stage of colorectal cancer with a high sensitivity, specificity, and predictive value[16,18,22,23]. HUS also could diagnose a variety of colonic endoluminal lesions including polyp, inflammatory bowel disease, *etc*. with a high accuracy[14,15]. According to some reports, the accuracy of HUS was close to that of EUS in depth of invasion in colon cancer (79-92%)[22]. However, the accuracy of HUS in rectal cancer was poor[22]. In the present study, we compared the accuracy of HUS in local staging between colon and rectal cancers, and observed under what condition the accuracy of HUS was relatively higher.

The accuracy of T staging by HUS was favorable in colon cancer (88%), especially when the lesions were located in the descending or ascending colon and their depth was confined to pericolic fat infiltration (93%). The result was similar to previous studies by Dux *et al*.[22]. The lower accuracy of HUS in T staging of rectal cancer was assumed to be caused by anatomical obstacle, that is, pubic symphysis, and incomplete removal of bowel gas[22]. Although the patient' s position was changed to head-up or down position to avoid these obstacles, the limitation still occurred. In N staging, the accuracy of HUS was unfavorable in both colon and rectal cancers. The reasons might be that there were no accurate sonographic parameters to distinguish benign hyperplastic lymph node from malignant infiltration, and the nodes far away from the probe (N3) could not be traced sufficiently, and lymph node metastasis could occur without size enlargement[9,10]. However, in our study, the accuracy of N staging was affected by the size of the node.

Sigmoidoscopy has been widely accepted as an outpatient diagnostic procedure for colorectal cancer. But, in reality, 40% of colonic tumors occurred outside the sigmoid[25]. So, colonoscopy is required in order to detect the right side lesion. But incomplete studies were infrequent due to various reasons, such as lumen obstruction, poor preparation of the bowel, and anatomical problems, *etc*.[26]. Under such circumstances, a barium enema may be performed for detection of the right side or upper side lesion except for obstructive diseases. But it can not evaluate the depth of invasion. Besides, EUS cannot be always performed because it requires endoluminal access. Thus, HUS may be preferred.

Although we detected all lesions, some were difficult to detect and evaluate, such as the lesions in patients with obesity, located in the flexure and adjacent to the small bowel, with their size less than 2 cm.

In conclusion, HUS is valuable in evaluating the depth of invasion (T) of colon cancer at any site and of any shape. However it has limitations in rectal cancer. Because HUS is low-cost, noninvasive, and readily available at any place, this technique seems to be useful in local staging of colon cancer especially in cases where colonoscopy and EUS can not be performed.

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