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Differential Diagnosis between Benign and Malignant Bowel Lesions on Ultrasonogram and CT

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=**Abstract**=

PURPOSE : To evaluate the diagnostic criteria for differentiation between benign and malignant bowel wall lesions on ultrasonogram (US) and CT.

MATERIAL & METHODS : We prospectively analyzed 55 bowel lesions on US and CT, including 29 cases of benign lesion and 26 cases of malignant lesion. The thickness and length of the lesions were measured and the bowel features were classified into four categories : a) obliteration of bowel wall layers, b) marginal irregularity, c) eccentric wall thickening, and d) heterogeneous perilesional fat changes. We analyzed the sensitivity, specificity, positive and negative predictive values of each criterion.

RESULTS : The mean thickness of malignant bowel lesions was 1.77 /1.84 cm on US /CT, and that of benign lesions was 0.71 /0.80 cm on US /CT. There was statistically significant difference in thickness between benign and malignant lesions ($P < .05$). The statistical anaysis of incremental study showed that the most sensitive and specific criteria for malignant lesions were more than 1.2 cm in thickness and less than 5.0 cm in length. Among feature criteria, bowel wall obliteration, irregular margin and eccentric contour were statistically and significantly different between benign and malignant lesions ($P < .05$). The most sensitive and specific feature criterion was the bowel wall obliteration.

CONCLUSION : The most sensitive and specific criteria for differentiation between benign and malignant bowel lesions were thickness and obliteration of bowel wall layers. Particulary, US was useful for the detection of bowel wall layers.

Index terms : Benign. Malignant bowel lesions, Ultrasonogram. CT

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INTRODUCTION

The clinical value of abdominal ultrasonogram (US) and CT for the evaluation of bowel disease has been proved by a number of authors [1-5]. Although US or CT scan cannot depict mucosal lesion of the gut with the same detail as colonoscopy or double contrast radiography, they offer several major advantages including noninvasiveness and accuracy for the detection of intramural and intraperitoneal extent [1-4]. Wall thickening of the small intestine has been reported in inflammatory bowel lesions or intestinal parasitic disease on US [4, 6]. The usefulness of abdominal CT in establishing the diagnosis of intestinal obstruction or differentiation of diverticulitis from colon cancer has been described [7, 8].

The initial Assessment of bowel lesions are performed by using conventional criteria, such as lesional location, thickness, length, contour, margin, symmetricity and perilesional fat changes [2-4]. However, as the radiologic findings of bowel lesions are often nonspecific, the differential considerations are necessarily broad. We try to analyze the diagnostic criteria for differentiation between benign and malignant bowel lesions on US and CT.

MATERIALS AND METHODS

We prospectively analyzed 55 patients who had thickened bowel wall on US and CT from August 1993 through September 1995. Of the 55 patients with bowel lesions, 36 were men and 19 were women who ranged in age from 3 to 84 years (mean age, 49 years). Fifty five bowel lesions consisted of 29 benign lesions and 26 malignant lesions, and the diagnoses were based on surgical confirmation in 44 patients; endoscopic or US guided biopsy in six patients; barium study and clinical findings in five patients. Benign lesions included 17 cases of infectious or inflammatory bowel lesions of ileum, ascending and sigmoid colon (seven cases of peritonitis with appendiceal perforation, five cases of tuberculosis, three cases of diverticulitis, one case of Crohn's disease, one case of salmonellosis), five cases of jejunal or ileal obstruciton with adhesion, four cases of ileal ischemia, and three cases of traumatic intramural hematoma and contusion in duodenum and transverse colon. Malignant lesions included 18 cases of primary colon cancers, three cases of rectal cancers, four cases of metastatic cancers of small bowel loops, and one case of lymphoma in terminal ileum.

US was obtained by Aloka (Mitaka-shi, Tokyo, Japan) or Acuson 128 × P10 (Mountain View, California, USA) with either 3.5~, or 5.0~7.0 MHz sector or linear transducers. CT scans were performed with GE 9800 (GE Medical System, Milwaukee, Wisconsin, USA). Enhanced contrast CT scans were obtained in all patients with 5 mm collimation at intervals of 10 mm from diaphragm to pelvis. Oral contrast material (370 mgI / ml, Gastrografin diluted 1 : 40 in water, Schering, Seoul, Korea) and 100~150 ml of intraveneous contrast media (300 mgI / ml, Ultravist®, Schering, Seoul, Korea) were given.

The bowel wall thickening was determined by the consensus of two experienced radiologists. Thickness of the bowel lesion was measured from inner most layer to outer serosal layer and lesional length was measured along the longitudinal axis of thickened bowel loops. The diagnostic thresholds of thickness and length were variably defined by increasing 2 mm in thickness and 5 mm in length, and these data were analyzed by comparing their sensitivity, specificity, and positive and negative predictive values for differential diagnosis.

The feature criteria of malignant bowel lesion were classified into four categories: a) obliteration of bowel layers, b) marginal irregularity, c) eccentric wall thickening, and d) heterogeneous perilesional fat changes. Bowel wall obliteration was considered to be negative when the wall layers were preserved on US and CT (Fig. 1). Diagnosis of bowel wall obliteration was done when the distinct bowel layers disappeared and the bowel wall was replaced with low echogenic mass on US or obliterated with heterogeneously enhancing mass on CT (Fig. 2, 3). Outer margin of bowel wall was considered to be irregular when the interface between bowel wall and perilesional fat was lobulated and not smooth (Fig. 3). Eccentric wall thickening was determined when the asymmetric bowel wall thickening exhibited more than one half fold or eccentric displacement of intraluminal gas or fluid (Fig. 2, 3). Perilesional fat was considered to be heterogeneous when mixed echogenic mesenteric fat was detected on US, or irregular, streaky or fuzzy enhancement of perilesional fat was detected on CT (Fig. 1~3).

US and CT were compared and statistical analysis

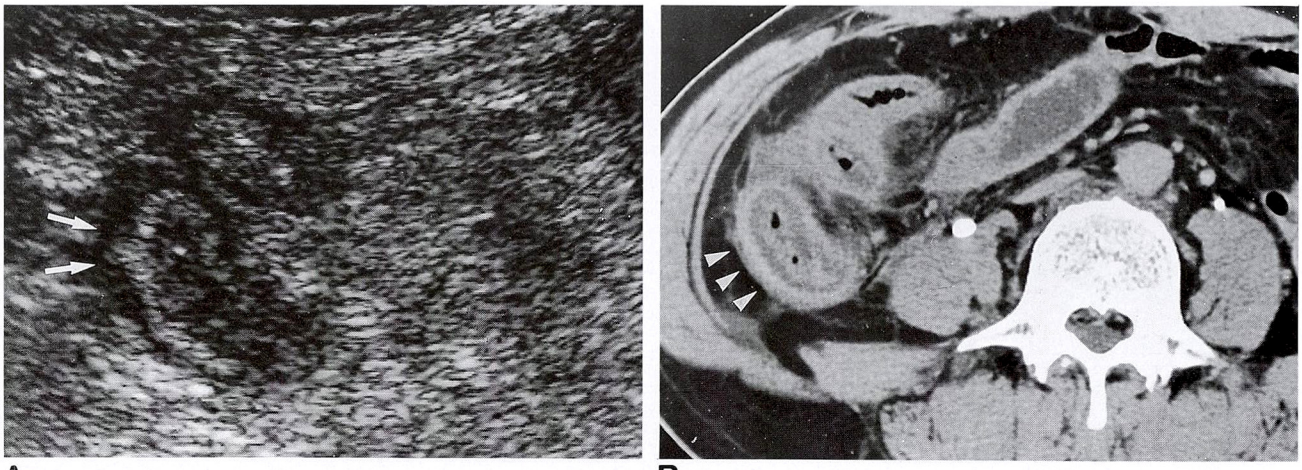

Fig. 1. A 56 year old man with right lower abdominal pain. Six months ago, he had a right hemicolectomy due to diverticulitis. **A.** The ultrasonogram shows target-like inner, middle and outer wall layers (arrows) without bowel wall obliteration. **B.** The CT scan shows thickened terminal ileum with thickness less than 0.8 cm and well defined bowel wall layers (arrowheads). This case was ileal strangulation with mesenteric adhesion.

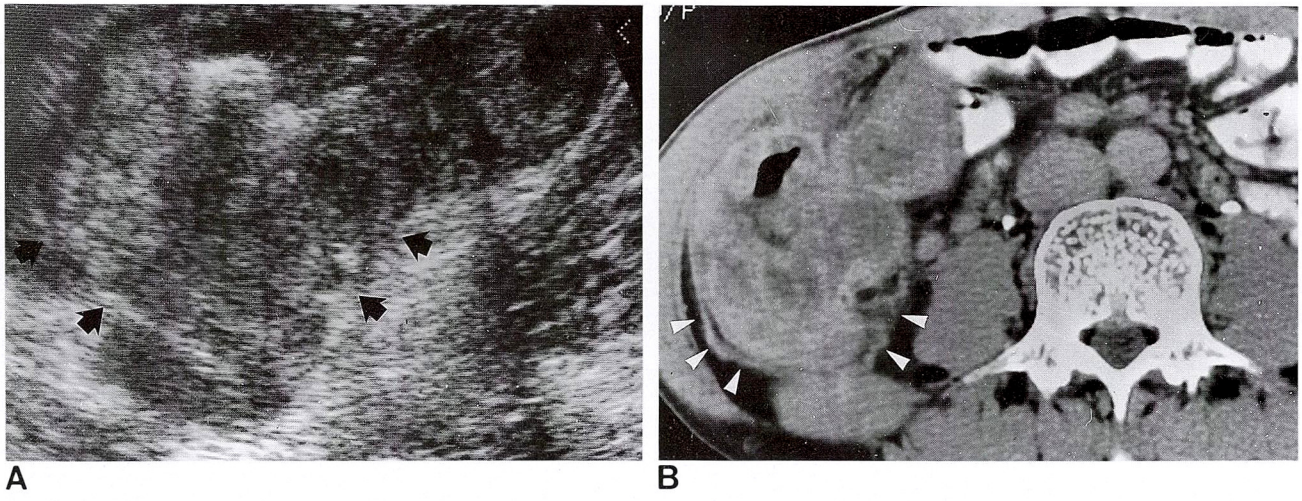

Fig. 2. A 54 year old man with right lower quadrant pain. **A.** The ultrasonogram shows bowel wall obliteration and mixed echogenic mass with irregular margin and eccentric contour (arrows). **B.** The CT scan shows thickened bowel wall and heterogeneously enhancing mass with eccentric contour and perilesional fat changes (arrowheads). This case was ascending colon cancer.

was perfomed with p-value less than 0.05 indicating a statistically significant difference. All measurements were tested for statistical significance by means of a two tailed student t-test for unpaired data. With the use of x^2-test, descriptive statistics (sensitivity, specificity, positive predictive value, and negative predictive value) were evaluated for the analysis of diagnostic accuracy of feature criteria.

RESULTS

Thickness and Length Criteria

The mean thickness of benign bowel lesions was 0.71 (± 0.29) cm on US and 0.8 (± 0.32) cm on CT. The mean thickness of malignant bowel lesions was 1.77 (± 0.73) cm on US and 1.83 (± 0.78) cm on CT. The mean length of benign bowel wall lesions was 6.

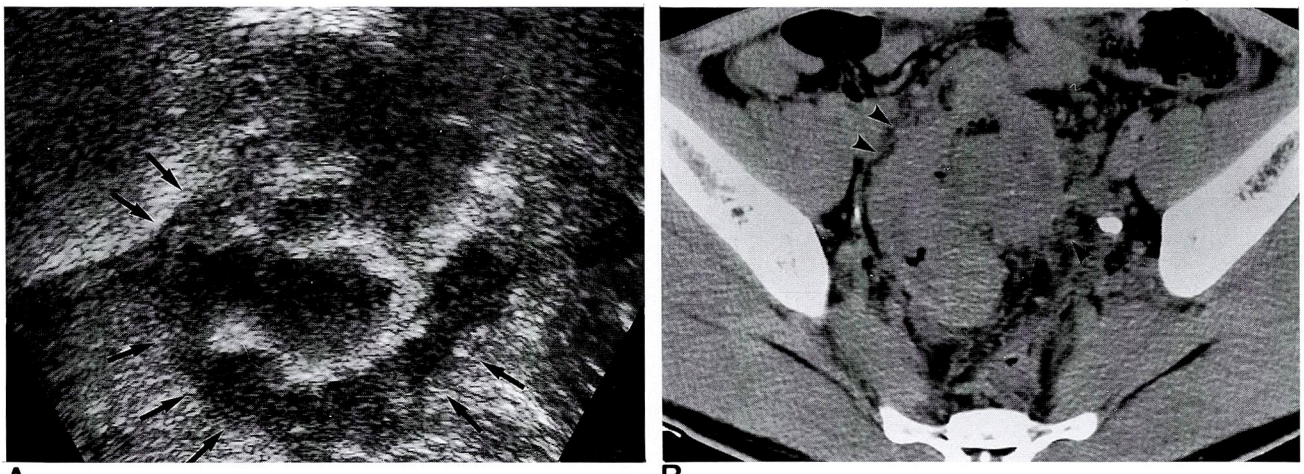

Fig. 3. A 35 year old man with hematochezia. **A.** The ultrasonogram shows obliterated bowel wall layer and low echogenic mass with irregular margin (arrows). **B.** The CT scan shows isoattenuated mass with irregular margin and perilesional fat changes (arrowheads). This case was sigmoid colon cancer.

35 (± 4.28) cm on US and 6.1 (± 4.28) cm on CT. The mean length of malignant bowel lesions was 5.44 (± 2.36) cm on US and 5.74 (± 2.48) cm on CT. The statistical analysis of thickness and length showed good agreement in measurement values between US and CT. The mean thickness of malignant bowel lesion was thicker than that of benign bowel lesion ($P < 0.05$), however, there was no significant difference in length between benign and malignant bowel lesions ($P > 0.05$).

As the thresholds of thickness and length were increased, sensitivity decreased, and specificity increased. As a result, the most sensitive and specific criteria for diagnosis of malignant bowel lesion were thickness more than 1.2 cm, and length less than 5.0 cm on US and CT (Table 1).

Feature Criteria

The obliteration of bowel wall layers was detected in 3 (10%) / 7 (24%) cases of benign lesions and in 22 (85%) / 19 (73%) cases of malignant lesions on US / CT scan. The bowel wall obliteration was most evident in malignant lesions and there were significant differences between benign and malignant lesions on US and CT ($p < 0.05$).

Marginal irregularity of bowel wall was detected in 4 (14%) / 5 (17%) cases of benign lesions and in 14 (54%) / 14 (54%) cases of malignant lesions on US / CT. Eccentric bowel wall thickening was detected in 5 (17%) / 5 (17%) cases of benign lesions and in 12 (46%) / 11 (42%) cases of malignant lesions on US / CT. Heterogeneous perilesional fat change was detected in 14 (48%) / 18 (62%) cases of benign lesion and 17 (65%) / 16 (62%) cases of malignant lesions on US / CT. The marginal irregularity and eccentric wall thickening showed significant difference between benign and malignant lesions ($p < 0.05$), however, their sensitivities were lower than other criteria (Table 2).

DISCUSSION

The US and CT has emerged as important imaging techniques for the evaluation of primary gastrointestinal diseases and extent of the lesions [1-4, 9]. US has become an initial imaging procedure of choice in acute abdomen such as acute appendicitis, diverticulitis or inflammatory bowel lesions, and CT scan has emerged as one of the most important imaging technique for the evaluation of gastrointestinal diseases [2-7, 9, 10]. Conventional barium examinations are remained superior to US and CT for the evaluation of intraluminal and mucosal lesion. However, US and CT are far more accurate for evaluating the intramural and extraintestinal extents, including involvement of the mesentery, peritoneal cavity, retroperitoneum, and other solid organs [2-4, 11, 12]. Technological advances with the development

Table 1-a. Sensitivity, Specificity, Predictive values of Thickness Criteria for Malignant Bowel Lesion

Thickness (cm)	Sn	Sp	PPV	NPV	p val.
	US / CT	US / CT	US / CT	US / CT	
> 0.8	100 / 100	59 / 59	68 / 68	100 / 100	< .05
> 1.0	92 / 96	83 / 72	83 / 76	92 / 96	< .05
> 1.2	85 / 85	93 / 90	92 / 88	87 / 87	< .05
> 1.4	73 / 65	97 / 93	95 / 89	80 / 75	< .05
> 1.6	50 / 50	100 / 97	100 / 93	69 / 68	< .05
> 1.8	35 / 46	100 / 100	100 / 100	63 / 67	< .05

Table 1-b. Sensitivity, Specificity, Predictive values of Length Criteria for Malignant Bowel Lesion

Lenght (cm)	Sn	Sp	PPV	NPV	p val.
	US / CT	US / CT	US / CT	US / CT	
< 4.5	54 / 46	45 / 45	47 / 43	52 / 48	> .05
< 5.0	58 / 46	45 / 45	48 / 43	54 / 48	> .05
< 5.5	39 / 50	48 / 45	40 / 45	47 / 50	> .05
< 6.0	42 / 50	48 / 45	42 / 45	48 / 50	> .05
< 6.5	38 / 46	48 / 55	40 / 48	47 / 53	> .05
< 7.0	31 / 46	52 / 59	36 / 50	45 / 55	> .05

Sn : Sensitivity, Sp : Specificity, PPV : Positive predictive value, NPV : Negative predictive value

Table 2. Sensitivity, Specificity, Predictive values of the Feature Criteria for Malignant Bowel Lesion

Feature Criteria	Sn	Sp	PPV	NPV	p val.
	US / CT	US / CT	US / CT	US / CT	
Obliteration of layers	85 / 73	90 / 76	88 / 73	87 / 76	< .05
Irregular margin	54 / 54	86 / 83	78 / 74	68 / 67	< .05
Eccentric contour	46 / 42	83 / 83	71 / 69	63 / 62	< .05
Heterogeneous fat	65 / 62	52 / 38	55 / 47	63 / 52	> .05

Sn : Sensitivity, Sp : Specificity, PPV : Positive predictive value, NPV : Negative predictive value

of high resolution scanners and accumulated clinical experience lead to better interpretation providing high accuracy of diagnosis.

Radiologic considerations of bowel lesions are location, size, thickness, length, symmetricity, inner or outer contour, and texture of thickened wall [2, 4]. Associated findings such as lymphadenopathy, adjacent mesenteric inflammation, distant metastasis, ascites or abscess are considered to be helpful for the differential diagnosis [2-4, 10]. However, a number of gastrointestinal lesions show atypical and overlapped features of benign and malignant presentation, and technical failure leads to an erroneous interpretation.

The normal small bowel and colonic wall is approximately 2-3 mm in thickness [1, 13]. The wall is considered abnormal if there is thickening greater than 4 mm in small bowel wall and 5 mm in colonic wall [1, 14, 15]. Balthazar et al. [2] reported benign bowel wall thickening usually not exceeding 1 cm from the luminal to the serosal surface, and malignant bowel wall thickening usually exceeding 2 cm. In sonogram of inflammatory bowel disease, the lesional thickness of the ileal wall was 4~15 mm [4]. These criteria were sensitive for differentiating benign and malignant bowel lesions and compatible with our results.

Although focal wall thickening may be seen with both benign and malignant neoplasms, the common causes are primary carcinoma, metastasis and lymphoma [2, 4]. Diffuse bowel wall thickening is often caused by inflammatory disease (such as granulomatous colitis, infectious disease and diverticulitis), hemorrhage, ischemia and radiation enteritis [1, 4]. However, in our experience, the length of bowel lesion was not significantly considered as differential point between benign and malignant disease. Since associated peritumoral edema, ischemia or inflammation lead to obscure the real length of malignant lesion, the measured length can be longer than that of true lesion. In our results, segmental thickening with band or adhesion was also play a role of shortening the mean length of benign lesions.

Imaging quality of bowel wall layers in gastrointestinal lesions has improved using high resolution US and CT. With in vitro US, appendiceal wall layers showed good correlation with histologic specimens [5, 16]. CT and pathologic correlation demonstrated that two or three different rims are related with mucosal and submucosal edema, inflammation or fat deposition [2, 9, 17-19]. Inflammatory bowel disease produce mucosal edema, errosion, ulceration, and submucosal ischemia or hemorrhage. The mucosa and submucosal layer tend to be preserved in benign lesions, however, obliterated in malignant lesions. If US and CT depict the bowel layers well, they may propose major clue for differentiation in various bowel lesions. In our comparative study, preserved bowel wall layers was better delineated on US than on CT, and considered to be highly sensitive and specific criterion for differential diagnosis.

As US and CT experiences of gastrointestinal lesion are accumulated, some reliable principles of interpretation of bowel lesions have been discussed. Balthazar et al. [2] reported that the hallmark of the CT appearance of a benign intestinal lesion is the circumferential and symmetric thickening of the bowel wall, and alternated rings with low and high attenuation referred to as a double halo or target sign. However, Goerg et al. [10] reported that classic target pattern indicates advanced circumferential infilitration of gastrointestinal lymphoma. The inflammatory bowel wall thickening was less severe, uniform, diffuse and usually concentric, however, malignant bowel wall thickening was eccentric or asymmetric, irregular in contour and associated with soft tissue mass [4, 18]. In our experiences, lesional asymmetry or marginal irregularities were considered to be helpful and specific criteria for differential diagnosis, but these criteria showed relatively low sensitivities.

Perilesional mesenteric fat changes of bowel lesions were commonly encountered in various disease entities including inflammation, edema or tumor infiltration [11]. CT allows clear depiction of abnormal soft tissue masses or fluid colleciton on low attenuated background. Padidar et al. [17] reported that CT findings of fluid at the root of the mesentery and vascular engorgement are useful in distinguishing sigmoid diverticulitis from carcinoma. However, mesenteric pathology is not definitely proved and has relatively low diagnostic sensitivity. In our cases, perilesional fat changes showed low sensitivity and specificity for differential diagnosis, and revealed intermodality differences on US and CT.

The US and CT characteristics are helpful for differential diagnosis of the majority of cases encountered in clinical practice. However, some of the most common entities leading to potential pitfalls in US and CT diagnosis are the following: a) malignancy associated with edema or inflammatory process was not distinguished with benign disease; b) chronic severe inflammatory or infectious disease may obliterate wall layers, and be misinterpreted as a malignant lesion; c) perilesional fat infiltration can be misinterpreted as a eccentric thickening or irregular margin; d) detection of abnormal bowel wall thickening were interfered with collapsed bowel loops.

In conclusion, the most sensitive and specific criteria for differential diagnosis were lesional thickness and obliteration of bowel wall layers on US and CT. Particularly, US was more sensitive and specific modality for the detection of obliteration of the bowel wall layers than CT. In our experience, US was readily available and accurate initial imaging modality for the differential diagnosis of bowel lesions.

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=국문초록=

초음파와 CT상 양성 및 악성 장관병변의 감별진단

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목적 : 초음파와 CT상 나타난 장관벽비후 소견을 비교 분석하여 양성과 악성병변 감별에 유용한 진단기준을 알아보고자 하였다.

대상 및 방법 : 29예의 악성병변과 26예의 양성병변을 포함한 55예의 장관병변을 전향적으로 분석하였고, 전예에서 초음파와 CT 촬영을 시행하였다. 병변의 두께와 길이를 측정하였으며, 감별진단 기준으로 최소 측정값에서 부터 2mm 두께와 5mm 길이의 간격으로 증가시킬 때 각각의 민감도와 특이도를 비교하였다. 비후된 장관벽의 소견은 1) 장관벽층의 소실, 2) 경계의 불규칙성, 3) 편심성 비후, 4) 인접지방층의 비균질성으로 구분하였고 양성과 악성병변의 감별에 가장 민감하고 특이도가 높은 진단기준을 설정하였다.

결과 : 악성병변의 평균 두께는 초음파와 CT에서 각각 1.77cm, 1.84cm였고, 양성병변은 0.71cm, 0.8cm로서 악성과 양성병변사이에 통계적으로 유의한 차이가 있었다($p < .05$). 악성병변을 진단하기 위한 기준으로서 1.2cm 이상의 두께와 5.0cm 이하의 길이를 선정했을 때 민감도와 특이도가 가장 높았다. 그러나 병변의 길이는 양성과 악성병변 사이에 통계적으로 유의한 차이가 없었다($p > .05$). 장관벽층의 소실, 경계의 불규칙성, 편심성 비후의 소견은 양성과 악성병변에서 통계적으로 유의한 차이가 있었으며, 가장 민감하고 특이도가 높은 감별진단 기준은 장관벽층의 소실이었다.

결론 : 양성 및 악성장관 병변을 감별하기 위한 가장 민감하고 특이도가 높은 진단기준은 병변의 두께와 장관벽층의 소실 유무였다. 특히 초음파는 장관벽층을 구별하는데 유용한 검사방법으로 사료된다.