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Evaluating the ability to detect pancreatic lesions using a special ultrasonography examination focusing on the pancreas

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ABSTRACT

Purpose: The ability to detect pancreatic cysts was compared between special ultrasonography (US) examination focusing on the pancreas (special pancreatic US) and routine upper abdominal ultrasonography to objectively assess the ability of the former to detect cysts.

Subjects and methods: Of 3704 patients who underwent special pancreatic US at our hospital, 186 underwent routine upper abdominal US within six months, had pancreatic cysts, and underwent magnetic resonance imaging (MRI). In these patients, 447 cysts measuring ≥5 mm were detected via MRI, which was used as the gold standard. The ability and sensitivity of the US modalities to detect each cyst was determined.

Results: The sensitivity of special pancreatic US was 92.2% (95% confidence interval [CI], 89.7% − 94.7%) and that of routine upper abdominal US was 70.2% (95% CI, 66.0% − 74.5%). McNemar test (Stata Version 13.1) revealed a significant difference in the cyst (≥5 mm) detection sensitivity between the two modalities ($p < 0.001$). An analysis stratified by patients similarly revealed a significant difference between the two modalities ($p < 0.001$). The cyst detection sensitivity was also analyzed in various parts of the pancreas. The sensitivity of special pancreatic US was 88.7% for the uncinate process and inferior head, 97.5% for the head, 97.1% for the body, 89.0% for the body-tail, and 66.7% for the tail, whereas that of routine upper abdominal US was 74.2% for the uncinate process, 69.5% for the head, 81.0% for the body, 67.0% for the body-tail, and 26.7% for the tail. The McNemar test revealed significant differences in the sensitivity of the two modalities for all pancreatic parts ($p < 0.001 - 0.016$).

Conclusion: Compared with routine upper abdominal US, special pancreatic US had higher sensitivity in detecting pancreatic cysts.

1. Introduction

Pancreatic cancer is associated with an extremely poor prognosis, and its 5-year survival rate does not reach 10% [1,2]. One of the reasons for this poor prognosis is the difficulty in making an early diagnosis, resulting in a large number of patients who have advanced pancreatic cancer at the time of diagnosis [3,4]. To diagnose pancreatic cancer at early stages, effective screening programs are needed. Although there are several known risk factors for pancreatic cancer, such as the family history, smoking history, chronic pancreatitis, and diabetes mellitus, no standard screening program for high-risk patients is available at present [4]. Ultrasonography (US) is a useful screening test for pancreatic diseases. Although it is also a useful screening method for early detection of pancreatic cancer because of its minimal invasiveness, it has the following weaknesses: its sensitivity in detecting pancreatic cancer is approximately 75%–89% [4], and its ability to

Abbreviations: UICC, Union for international cancer control; MRI, magnetic resonance imaging; CI, confidence interval

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detect cancer is reduced in obese individuals or by the presence of intestinal gas [5]. To overcome these weaknesses of US, we developed a special US examination focusing on the pancreas (hereinafter referred to as special pancreatic US), in which only the pancreas and its surroundings are closely examined in patients who are placed in an innovative position following the ingestion of a particular liquid to fill the stomach and reduce the effect of gastric gas [6]. Using this examination, we started a prospective follow-up study on the early detection of pancreatic cancer in May 1998, and reported that patients with a dilated main pancreatic duct (≥2.5 mm) or pancreatic cysts (≥5 mm) were at high risk for pancreatic cancer [7]. Furthermore, because six of 12 patients (50%) diagnosed with pancreatic cancer during this study had early-stage cancer (stages 0 and I based on the Union for International Cancer Control [UICC] classification), screening with this special pancreatic US was demonstrated to be effective [7].

In the present study, we retrospectively compared the ability to detect pancreatic cysts between special pancreatic US and routine upper abdominal US performed at our hospital to objectively assess the ability of the former to detect cysts.

2. Subjects and methods

2.1. Subjects

At our hospital, from June 2007, patients with pancreatic cysts (≥5 mm) and/or a dilated pancreatic duct (≥2.5 mm) who appear to be at high risk for pancreatic cancer, were registered to the follow-up study in order to diagnose pancreatic cancer at an early stage, and using special pancreatic US was performed as a screening examination. Basically, special pancreatic US was performed for two reasons: the first is to follow up registered patients with pancreatic cyst (≥5 mm) or dilatation of the main pancreatic duct (≥2.5 mm). This procedure is performed to detect pancreatic cancer at an early stage because the dilatation of the main pancreatic duct (≥2.5 mm) and presence of a pancreatic cyst (≥5 mm in diameter) were both strong independent predictors for subsequent pancreatic cancer development, as shown in our previous study [7]. The other reason is to screen patients for suspected pancreatic abnormalities, such as for detecting high titer of tumor markers or abnormal mass lesions by other imaging modalities. The routine upper abdominal US was performed for various purposes, such as finding the cause of abdominal discomfort and abnormal laboratory data of the liver and/or pancreas. The routine upper abdominal US was also conducted to follow up on chronic liver or gall bladder disease (e.g., stones or polyps).

Of 3704 patients who underwent special pancreatic US between April 2011 and March 2013, 275 who underwent routine upper abdominal US for a purpose other than the close examination of the pancreas within 6 months before and 6 months after special pancreatic US (mean: +1.0 month) were selected. Of them, 186 patients (71 men and 115 women with a mean age of 69.1 ± 10.3 years at the time of examination) with pancreatic cysts who underwent abdominal magnetic resonance imaging (MRI) (mean interval from MRI to special pancreatic US, 4.7 months; mean interval from MRI to routine upper abdominal US, 5.7 months) were included.

In cases where pancreatic cysts were detected, the coexistence of solid nodules in the cysts or solid tumor in other areas of the pancreas was carefully examined. Malignant lesions were ruled out if such lesions were detected through further investigations such as contrast medium-enhanced CT or endoscopic ultrasonography. Therefore, all pancreatic cysts referred to in this study are noncancerous. Some cysts are suspected to be intraductal papillary mucinous neoplasm because of the connection of the cysts to the main pancreatic duct, which was confirmed using image modalities such as US or MRI. Of course, the possibility that the cysts in this study included true simple cysts or pseudocysts after pancreatitis could not be denied.

2.2. Methods

While abdominal MRI was used as the gold standard, we examined which of the pancreatic cysts that were detected via MRI could be detected using the two US modalities. In this study, only pancreatic cysts measuring ≥5 mm were evaluated.

The special pancreatic US was performed by following a previously published protocol [6,8,9]. Briefly, patients were placed in the sitting position, with each examination taking more than 20 min, and at least 12 standard images of the pancreas before and after the ingestion of 350 mL of liquid were taken to observe the whole pancreas. Before drinking, the presence of air in the stomach disturbs the visualization of the pancreas, especially its tail. However, after the patient was allowed to drink in a sitting position, the liquid filled the body of the stomach, pushing away the air up to the fornix. The pancreas tail becomes clearly observable through US because the stomach body is usually in front of the pancreas tail.

The liquid-filled stomach method is a test method to eliminate the effect of gastric gas, facilitating observation of the pancreatic body-tail and tail at the dorsal side of the stomach via the ingestion of a certain amount of a particular liquid. In this study, commercially-available black tea with milk or green tea (for patients who cannot drink black tea with milk because of glucose limitation, taste, etc.) contained in steel cans or heat-resistant polyethylene terephthalate bottles was used as the liquid for the liquid-filled stomach method.

The basic position during special pancreatic US is the Fowler position. In many patients placed in the Fowler position, the liver descends down to the ventral side of the pancreas and serves as an acoustic window for observation of the pancreas. To allow patients to maintain this position without stress, an examination table with an adjustable backrest (Fig. 1) is used, and the backrest is set at an angle of approximately 60°. Because this method does not cause tensing of the abdominal wall, unlike that in the Fowler position achieved by having patients place their hands behind their back, the probe can be placed closer to the pancreas by pressing the probe on the abdomen. We have developed a manual of the above-described procedure to eliminate inter-examiner differences. Routine upper abdominal US is generally performed with patients in the supine position. When necessary, they are placed in the Fowler position. In routine abdominal US, at least 40 standard images were obtained to observe the liver, gall bladder, spleen, pancreas, and kidneys, which usually takes 10–15 min. In both special pancreatic and conventional US, patients were requested not to consume food and drinks starting on the morning of the examination day.

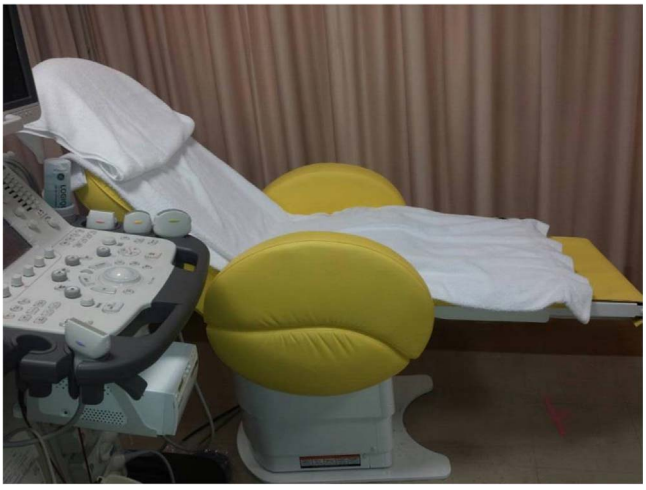

Fig. 1. Examination table with an adjustable backrest. The backrest can be adjusted electrically. It is set at an angle of approximately 60° when the special ultrasonography examination focusing on the pancreas is performed.