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ORIGINAL ARTICLE

# Ultrasound combined with computed tomography in pancreatic cancer

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## *Summary*

***Purpose:*** *To investigate the diagnostic value of ultrasound combined with computed tomography (CT) in pancreatic cancer.*

***Methods:*** *312 patients with pancreatic lesions treated in the Affiliated Hospital of Qingdao University were retrospectively analyzed, including 217 patients definitely diagnosed with pancreatic cancer and 95 patients diagnosed with pancreatitis. A hundred and one patients with ultrasonic diagnosis were enrolled into the ultrasound group, 98 patients with CT diagnosis were enrolled into CT group, and 113 patients undergoing ultrasound combined with CT diagnosis were enrolled into combined group. The diagnostic value of the three examination methods in pancreatic cancer was compared and analyzed.*

***Results:*** *The sensitivity, accuracy and negative prognostic value in the combined group were higher than those in ultrasound group and CT group ($p<0.05$), but the missed diagnosis rate was lower than those in ultrasound group and CT group ($p<0.05$). In the combined group, the sensitivity was higher than those in the ultrasound group and the CT group, the accuracy and negative predictive value were higher than those in the ultrasound group, and the missed diagnosis rate was lower than those in the ultrasound group and the CT group, displaying statistically significant differences ($p<0.05$).*

***Conclusion:*** *Ultrasound combined with CT can make up for the deficiency of each other and effectively improve the predictive value in the diagnosis of pancreatic cancer, which can be used as an effective examination method in the diagnosis of this disease.*

***Key words:*** *ultrasound, CT, pancreatic cancer, early diagnosis, diagnostic value*

## Introduction

Pancreatic cancer is a malignant tumor of the digestive system, which frequently occurs in the middle-aged and elderly people with no obvious symptoms in the early stage. With the progression of disease, abdominal pain and other digestive tract symptoms will gradually appear, peripheral blood vessels will be invaded, or metastasis will occur, displaying rapid development of disease [1,2]. In recent years, the incidence rate of pancreatic cancer has been constantly increasing. Moreover, its mortality rate also stays at a high level due to the high malignant behavior while the prognosis is poor with 5-year survival rate of only 2% [3,4].Therefore, how to realize the early diagnosis of pancreatic cancer accurately is of great significance in the treatment and prognosis of pancreatic cancer patients.

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At present, the definite diagnosis of pancreatic cancer mainly depends on pathological diagnosis. However, the pancreas is located deeply, there are a large amount of connective tissue hyperplasia and inflammatory reactions around the pancreatic lesion, and tissues obtained are not always tumor tissues, so it is hard to perform biopsy at the lesion site, thus greatly obstructing the early diagnosis [5]. Currently, imaging is also a commonly used auxiliary diagnostic method for pancreatic cancer in the clinic [6], in which ultrasound is the most commonly used imaging means due to low price, non-invasiveness, simple operations and abilities to preliminarily judge the site, size and nature of pancreatic cancer [7]. However, ultrasonic diagnosis is influenced by intestinal gas and various other factors, limiting its diagnostic accuracy [8]. Computed tomography (CT) is also a commonly used imaging diagnostic method, which can well display the correlation of the tumor with blood vessels and organs, and determine whether there are metastatic lesions. However, CT is influenced by tumor morphology, size and examiner in the diagnosis of pancreatic cancer, so it is difficult to diagnose pancreatic cancer without symptoms in the early stage [9,10].

The single diagnosis via ultrasound or CT has certain limitations in the clinic. Therefore, the diagnostic value of ultrasound combined with CT in patients with pancreatic cancer was assessed, so as to provide better solutions for the diagnosis of this malignancy.

## Methods

*Data*

A total of 312 patients with pancreatic lesions treated in the Affiliated Hospital of Qingdao University from June 2015 to June 2017 were retrospectively analyzed, including 134 males and 178 females with an average age of 55.3±4.7 years. There were 217 patients definitely diagnosed with pancreatic cancer, including 156 cases in early stage (stage I-II) and 61 cases in middle-advanced stage (stage III-IV), and 95 patients diagnosed with pancreatitis. A hundred and one patients with ultrasonic diagnosis were enrolled into the ultrasound group, 98 patients with CT diagnosis were enrolled into the CT group, and 113 patients with ultrasound combined with CT diagnosis were enrolled into combined group. There were no significant differences in sex, age and body mass index (BMI) among the three groups (Table 1).

*Inclusion and exclusion criteria*

Inclusion criteria: patients pathologically and definitely diagnosed with pancreatic cancer or pancreatitis. Exclusion criteria: 1) patients who had received chemoradiotherapy; 2) pregnant or lactating patients; 3) patients with severe hepatic or renal dysfunction; 4) patients with known metastatic lesions; 5) patients with cognitive impairment and communication disorders; or 6) patients who did not cooperate. All subjects and their families needed to sign the informed consent and cooperate with the medical staff in the diagnosis and treatment.

*Experimental instruments*

Ultrasonic diagnosis was performed using the SIEMEAS Acuson sequoia 512 color Doppler ultrasound

**Table 1.** General data of patients

| *Data* | *Ultrasound* (n=101) n (%) | *CT group (n=98) n (%)* | *Combined group (n=113) n (%)* | $x^2$ | *p* |
|---|---|---|---|---|---|
| Sex | | | | 0.026 | 0.987 |
| Male | 44 (43.56) | 42 (42.86) | 48 (42.48) | | |
| Female | 57 (56.43) | 56 (57.14) | 65 (57.52) | | |
| Age, years | | | | 0.016 | 0.992 |
| ≤55 | 61 (60.40) | 60 (61.22) | 69 (61.06) | | |
| >55 | 40 (39.60) | 38 (38.78) | 44 (38.94) | | |
| BMI (kg/m2) | | | | 0.005 | 0.997 |
| ≤22 | 55 (54.46) | 53 (54.08) | 61 (53.98) | | |
| <22 | 46 (45.54) | 45 (45.92) | 52 (46.02) | | |
| Diagnosis | | | | 0.471 | 0.790 |
| Pancreatitis | 30 (29.70) | 28 (28.57) | 37 (32.74) | | |
| Pancreatic cancer | 71 (70.30) | 70 (71.43) | 76 (67.26) | | |
| Stage | | | | 0.196 | 0.907 |
| Stage I-II | 52 (73.24) | 49 (70.00) | 55 (72.37) | | |
| Stage III-IV | 19 (26.76) | 21 (30.00) | 21 (27.63) | | |
| Histology | | | | 0.621 | 0.996 |
| Ductal adenocarcinoma | 51 (71.83) | 49 (70.00) | 54 (71.05) | | |

diagnostic instrument (GE,USA) equipped with LA523 high-frequency linear array probe (12 MHz). CT diagnosis was performed using the Lightspeed 64-slice spiral CT scanner (GE,USA). Relevant parameters were as follows: voltage: 120 Kv, current: 220 mA, slice thickness: 8 mm and spiral pitch: 1 mm.

*Experimental methods*

Patients were instructed to fast for 6-8 h before examination, and drink 500 mL water to fill the stomach and duodenum at 10 min before examination, so that the peripancreatic anatomical structure could be clearly displayed [11,12]. In ultrasonic examination, scanning was performed in a supine position to record the size, echo, morphology and lymph node status of the pancreas or mass. In CT scan, conventional scanning was performed first, followed by enhancement scanning, and the site, size, density and lymph node metastasis of the pancreas or masses and peripheral vessels were recorded. Ultrasonic diagnosis criteria [13]: The mass <2 cm mostly has homogeneous hypoechoes, no capsule and no obvious boundary with surrounding tissues, and the attenuation of posterior echo is not obvious. The mass >2 cm has irregular morphology, heterogeneous internal echo or hyperecho, some have calcification, liquefaction, infiltration growth and unclear boundary, and the posterior echo abates. Diagnostic criteria for pancreatic cancer via CT [14]. There is localized enlargement or morphological changes in the pancreas, dilatation in the common bile duct and pancreatic duct, and unclear heterogeneous or low-density boundary in the pancreatic mass. The density of the tumor in the arterial phase is lower than that of normal pancreatic tissues. The density of the tumor in the pancreatic phase is equal to or relatively higher than that of normal pancreatic tissues. The density of the tumor in the delayed phase is slightly higher.

*Statistics*

SPSS 19.0 (Beijing NDTimes Technology Co., Ltd.) was used for the statistical analysis of data. Enumeration data were expressed as percentages (%) and the comparison between groups was analyzed by $x^2$ test.

P<0.05 suggested that the difference was statistically significant.

## Results

*Comparison of diagnostic value in pancreatic cancer between ultrasound group and combined group*

In the ultrasound group the sensitivity, specificity, accuracy, positive predictive value, negative predictive rate, misdiagnosis rate and missed diagnosis rates in the diagnosis of pancreatic cancer were 69.01%, 83.33%, 73.27%, 90.74%, 53.19%, 16.67% and 30.99%, respectively, and in the combined group they were 93.42%, 75.68%, 87.61%, 88.75%, 84.85%, 24.32% and 6.58%, respectively. The sensitivity, accuracy and negative predictive value rates in the combined group were higher than those in the ultrasound group, but the missed diagnosis rate was lower than that in the ultrasound group, displaying statistically significant differences (p<0.05) (Table 2).

**Table 2.** Comparison of diagnostic value in pancreatic cancer between ultrasound group and combined group

| *Diagnostic value* | Ultrasound group (n=101) n (%) | *Combined group (n=113) n (%)* | $x^2$ | *p* |
|---|---|---|---|---|
| Sensitivity | 49 (69.01) | 71 (93.42) | 14.581 | <0.001 |
| Specificity | 25 (83.33) | 28 (75.68) | 0.587 | 0.443 |
| Accuracy | 74 (73.27) | 99 (87.61) | 19.871 | <0.001 |
| Positive predictive rate | 49 (90.74) | 71 (88.75) | 0.137 | 0.712 |
| Negative predictive rate | 25 (53.19) | 28 (84.85) | 8.690 | <0.050 |
| Misdiagnosis rate | 5 (16.67) | 9 (24.32) | 0.102 | 0.750 |
| Missed diagnosis rate | 22 (30.99) | 5 (6.58) | 14.58 | <0.001 |

**Table 3.** Comparison of diagnostic value in pancreatic cancer between CT group and combined group

| *Diagnostic value* | CT group (n=98) n (%) | *Combined group (n=113) n (%)* | $x^2$ | *p* |
|---|---|---|---|---|
| Sensitivity | 54 (77.14) | 71 (93.42) | 7.841 | <0.050 |
| Specificity | 21 (75.00) | 28 (75.68) | 0.004 | 0.950 |
| Accuracy | 75 (76.53) | 99 (87.61) | 4.456 | <0.050 |
| Positive predictive rate | 54 (88.52) | 71 (88.75) | 0.002 | 0.967 |
| Negative predictive rate | 21 (56.76) | 28 (84.85) | 6.555 | <0.050 |
| Misdiagnosis rate | 7 (25.00) | 9 (24.32) | 0.004 | 0.950 |
| Missed diagnosis rate | 16 (22.86) | 5 (6.58) | 7.841 | <0.050 |

**Table 4.** Comparison of diagnostic value in the early diagnosis of pancreatic cancer between ultrasound group and combined group

| *Diagnostic value* | Ultrasound group (n=82) n (%) | *Combined group (n=92) n (%)* | $x^2$ | *p* |
|---|---|---|---|---|
| Sensitivity | 30 (57.69) | 46 (83.64) | 0.743 | <0.050 |
| Specificity | 22 (73.33) | 26 (70.27) | 0.077 | 0.782 |
| Accuracy | 52 (63.41) | 72 (78.26) | 4.667 | <0.050 |
| Positive predictive rate | 30 (78.95) | 46 (80.70) | 0.044 | 0.834 |
| Negative predictive rate | 22 (50.00) | 26 (74.29) | 4.822 | <0.050 |
| Misdiagnosis rate | 8 (26.67) | 11 (29.73) | 0.077 | 0.782 |
| Missed diagnosis rate | 22 (42.31) | 9 (16.36) | 8.743 | <0.050 |

**Table 5.** Comparison of diagnostic value in the early diagnosis of pancreatic cancer between CT group and combined group

| *Diagnostic value* | CT group (n=77) n (%) | *Combined group (n=92) n (%)* | $x^2$ | *p* |
|---|---|---|---|---|
| Sensitivity | 32 (65.31) | 46 (83.64) | 4.644 | <0.050 |
| Specificity | 21 (75.00) | 26 (70.27) | 0.178 | 0.673 |
| Accuracy | 53 (68.83) | 72 (78.26) | 1.936 | 0.164 |
| Positive predictive rate | 32 (82.05) | 46 (80.70) | 0.007 | 0.932 |
| Negative predictive rate | 21 (55.26) | 26 (74.29) | 2.875 | 0.090 |
| Misdiagnosis rate | 7 (25.00) | 11 (29.73) | 0.178 | 0.673 |
| Missed diagnosis rate | 17 (34.69) | 9 (16.36) | 4.644 | <0.050 |

*Comparison of diagnostic value in pancreatic cancer between CT group and combined group*

In the CT group the sensitivity, specificity, accuracy, positive predictive value, negative predictive value, misdiagnosis rate and missed diagnosis rate in the diagnosis of pancreatic cancer were 77.14%, 75.00%, 76.53%, 88.52%, 56.76%, 25.00% and 22.86%, respectively, and 93.42%, 75.68%, 87.61%, 88.75%, 84.85%, 24.32% and 6.58%, respectively, in the combined group. The sensitivity, accuracy and negative predictive value in the combined group were higher than those in the CT group, but the missed diagnosis rate was lower than that in CT group, displaying statistically significant differences (p<0.05) (Table 3).

*Comparison of diagnostic value in the early diagnosis of pancreatic cancer between ultrasound group and combined group*

Based on the survey for early-stage patients and pancreatitis patients, the sensitivity, specificity, accuracy, positive predictive value, negative predictive value, misdiagnosis and missed diagnosis rates in the early diagnosis of pancreatic cancer were 57.69%, 73.33%, 63.41%, 78.95%, 50.00%, 26.67% and 42.31%, respectively, in the ultrasound group, and 83.64%, 70.27%, 78.26%, 80.70%, 74.29%, 29.73% and 16.36%, respectively, in the combined group. In the combined group, the sensitivity, accuracy and negative predictive value were higher than those in the ultrasound group, but the missed diagnosis rate was lower than that in the ultrasound group, showing statistically significant differences (p<0.05) (Table 4).

*Comparison of diagnostic value in the early diagnosis of pancreatic cancer between CT group and combined group*

Based on the survey for early-stage patients and pancreatitis patients, the sensitivity, specificity, accuracy, positive predictive value, negative predictive value, misdiagnosis and missed diagnosis rates in the early diagnosis of pancreatic cancer were 65.31%, 75.00%, 68.83%, 82.05%, 55.26%, 25.00% and 34.69%, respectively, in the CT group, and 83.64%, 70.27%, 78.26%, 80.70%, 74.29%, 29.73% and 16.36%, respectively, in the combined group. In the combined group, the sensitivity was higher than that in the CT group, but the missed diagnosis rate was lower than that in CT group, showing statistically significant differences (p<0.05) (Table 5).

## Discussion

The morbidity and mortality rates of pancreatic cancer, a tumor with an extremely highly malignant behavior, are very high [15]. Both pancreatic cancer and pancreatitis have digestive tract symptoms, such as poor appetite and abdominal pain, so it is easy to confuse them in the clinic [16]. The early symptoms of pancreatic cancer are not obvious, so many patients have been often in the late stage once diagnosed, and the 5-year survival rate is very low with a poor prognosis [17,18]. There are a variety of methods for the clinical diagnosis of pancreatic cancer, such as ultrasound, CT, magnetic resonance imaging (MRI) and other imaging means [19], in which ultrasound and CT are commonly used diagnostic methods. Studies have demonstrated that the diagnostic rates of ultrasound and CT for pancreatic cancer are higher, and they are cheaper than MRI, so most patients prefer ultrasound and CT examination [20]. In this paper, the diagnostic value of ultrasound combined with CT in patients with pancreatic cancer was analyzed, so as to provide more optimized solutions for the diagnosis of this malignancy.

In this study, the diagnostic value of ultrasound and CT alone and their combination in pancreatic cancer was compared first, and it was found that the sensitivity, specificity, accuracy, positive predictive value, negative predictive value, misdiagnosis and missed diagnosis in the diagnosis of pancreatic cancer were 69.01%, 83.33%, 73.27%, 90.74%, 53.19%, 16.67% and 30.99%, respectively, in the ultrasound group, 77.14%, 75.00%, 76.53%, 88.52%, 56.76%, 25.00% and 22.86%, respectively, in the CT group, and 93.42%, 75.68%, 87.61%, 88.75%, 84.85%, 24.32% and 6.58%, respectively, in the combined group. The sensitivity, accuracy and negative predictive value in the combined group were higher than those in the ultrasound group and CT group ($p<0.05$), but the missed diagnosis rate was lower than those in the ultrasound group and CT group ($p<0.05$), indicating that the diagnostic value of ultrasound combined with CT in pancreatic cancer is higher than that of ultrasound and CT alone. It was reported in the study of Bruno et al [21] that the ultrasound combined with multi-slice spiral CT can effectively increase the diagnostic rate of pancreatic cancer to 93.3%. The slightly lower diagnostic rate in this study may be due to the fact that the diagnostic accuracy of multi-slice spiral CT is higher than that of general CT. Then the diagnostic value of ultrasound and CT alone and their combination in early pancreatic cancer was explored, and it was found that the sensitivity, specificity, accuracy, positive predictive value, negative predictive value, misdiagnosis and missed diagnosis rates in the early diagnosis of pancreatic cancer were 57.69%, 73.33%, 63.41%, 78.95%, 50.00%, 26.67% and 42.31%, respectively, in the ultrasound group, 65.31%, 75.00%, 68.83%, 82.05%, 55.26%, 25.00% and 34.69%, respectively, in the CT group, and 83.64%, 70.27%, 78.26%, 80.70%, 74.29%, 29.73% and 16.36%, respectively, in combined group. In the combined group, the sensitivity was higher than those in the ultrasound group and CT group, the accuracy and negative predictive value were higher than those in the ultrasound group, and the missed diagnosis rate was lower than those in the ultrasound group and CT group, displaying statistically significant differences ($p<0.05$), suggesting that the diagnostic value of ultrasound combined with CT in early pancreatic cancer is also higher than that of ultrasound and CT alone. Currently, the early diagnosis of pancreatic cancer is mainly realized via the detection of tumor marker micro ribonucleic acid (miRNA). The study Pannala et al. [22] showed that miRNA is abnormally expressed in the early stage of pancreatic cancer, and it may be used as a tumor marker in the early diagnosis of this disease. However, ultrasound combined with CT is more non-invasive and convenient than the detection of miRNA in the diagnosis of pancreatic cancer, so it is worth of clinical promotion.

## Conclusion

Ultrasound combined with CT can make up for the deficiency of each other, and its diagnostic value in pancreatic cancer is higher than that of ultrasound or CT alone, which can be used as an effective examination method in the diagnosis of pancreatic cancer. However, there are few reports on ultrasound combined with CT in the early diagnosis of pancreatic cancer, so it is hoped that the sample size can be further expanded for in-depth research by other authors.

## Conflict of interests

The authors declare no conflict of interests.

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