

A new method: measurement of pancreas volume in computerised tomography as a diagnostic guide for acute pancreatitis

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Abstract

Objective: To investigate whether measuring pancreas volume with abdominal tomography in patients with severe abdominal pain can predict acute pancreatitis.

Method: The case-control study was conducted at Adnan Menderes University from January 1, 2015, to January 1, 2017, and comprised patients who were diagnosed with acute pancreatitis. Pancreas volume measurements of patients and control group were made with Telemed Ekinoks software using freehand technique. Presence of a correlation between pancreas volume and pancreatitis was found in patients aged <57 years and a cut-off value was calculated for pancreatitis in this particular patient group.

Results: Of the 183 subjects, 132(72%) were patients with a mean age of 59.6±16.5 years, and 51(28%) were controls with a mean age of 55.8±18.6 years (p=0.170). The difference between the groups in terms of pancreas volume was significant (p<0.001). There was a negative correlation between age and pancreas volume among the patients (p<0.001), the correlation was not significant among the controls (p=0.898). Among the subjects aged <57 years, the cut-off value was calculated at 95.055, and sensitivity to pancreas volume was 70.91% while specificity was 82.14%. Positive predictive value was 88.6%.

Conclusion: High pancreas volume with pancreatitis was observed in patients aged <57 years.

Keywords: Abdominal pain, Pancreatitis, Pancreas volume, Computed tomography.

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Introduction

Acute pancreatitis (AP) is a severe inflammation of the pancreas with sudden onset of serious abdominal pain and a high rate of resulting morbidity and mortality. Although the aetiology is not exactly known, it is most often associated with gallbladder stones and alcohol.¹ AP is also associated with intra-acinar activation of proteolytic enzymes, leukocyte chemo attraction, release of cytokines and oxidative stress.²⁻⁴ The common effect on in all these pathways is inflammation extreme response.

The human pancreas is a small, soft organ intertwined with the bowels, stomach, spleen and visceral fat. AP must be confirmed by a thorough in vivo volumetric pancreas evaluation. So far, pancreatic volume (PV) evaluation studies have been limited to autopsies and computed tomography (CT) studies, which require the use of X ray.⁵ Only a handful of magnetic resonance imaging (MRI)

examinations have been published⁶⁻⁸ but none were valid. Previous studies in humans, however, have demonstrated that PV changes are consistent with age and the development of metabolic diseases.^{5,9,10}

All major CT companies are developing volume-based softwares with high prices. Many countries in the world cannot afford these expensive softwares. The major problem of these softwares is that calculations must be done in CT portals, and not on personal computers (PCs). The current study was planned to suggest an affordable and practical software for measuring PV in an effort to speed up the diagnosis of pancreatitis.

Patients and Methods

The case-control study was conducted at Adnan Menderes University from January 1, 2015, to January 1, 2017, and comprised AP patients. After approval from the institutional ethics committee, patients admitted to the emergency room (ER) due to severe abdominal pain were evaluated with CT with the following specifications: axial slices, W/L: 400/40, kVp/mA:120/50, slice thickness/

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increment: 3/1.5mm, pitch: 0.75, scan range: 1 cm above the diaphragm to the end of the pelvis, contrast injection parameters: automatic triggering, increased flow >5mL/min, high iodine concentration >300 iodine/mL, suspended respiration. Patients included had at least two of the three stated conditions: acute abdominal pain and tenderness suggestive of pancreatitis; ultra-sonography (USG) and/or CT suggestive of Ap; and serum amylase/lipase ≥ 3 times the normal value.¹

Patients with a history of pancreatic malignancy and surgery, and those with diabetes mellitus (DM) were excluded.

Pancreas volume was measured using the abdominal CT pancreatitis classification was made using the Balthazar method,¹¹ which is a routine method. PV measurements were made by free-hand technique with Ekinoks (Telemed-Ekinoks Software, Bogazici University Technopark, Istanbul, Turkey, version 1.7, 2017) advanced CT and MRI imaging workstation software. Abscess and necrosis areas were excluded from the measurements. Patients' serum C-reactive protein (CRP) and lipase levels were recorded.

For statistical analysis, normality of continuous variables was examined using the Kolmogorov-Smirnov test. Descriptive statistics of normally distributed variables were expressed as mean $\pm$ standard deviation (SD) and sample t-test was used for comparison between the groups. Descriptive statistics of non-normally distributed variables were shown as median (25-75%), and the Mann-Whitney test was used for comparison between the groups. Since age and PV indicated normal distribution, the correlation between them was studied using Pearson's correlation coefficient. Because CRP was non-normally distributed, the correlation between CRP and PV was examined using Spearman's correlation coefficient. Chi-square automatic interaction detection (CHAID) was used to determine the factors affecting PV in the patient group. Data was compared between the control and the patient groups. According to CHAID analysis, the PV cut-off value was calculated to determine patient grouping based on age <57 years. Receiver operating characteristic (ROC) curve analysis was used to determine the power of PV in distinguishing the patient and control groups. $P < 0.05$ was considered statistically significant.

Results

Of the 183 subjects, 132(72%) were patients with a mean

Table: Demographic data and pancreatic volumes of the patient and control group.

	Control (n=51)	Patient(n=132)	p-value
Age	55.8 $\pm$ 18.6	59.6 $\pm$ 16.5	0.170
Gender (female)	29(56.9%)	80(60.6%)	0.646
Pancreas Volume	79.6 $\pm$ 26.0	98.7 $\pm$ 36.8	<0.001

age of 59.6 $\pm$ 16.5 years, and 51(28%) were controls with a mean age of 55.8 $\pm$ 18.6 years ($p=0.170$). There were 80(60.6%) women in the patients group, and 29(56.9%) in the control group ($p=0.646$). PV was 98.7 $\pm$ 36.8 in the patients group and 79.6 $\pm$ 26.0 in the control group ($p < 0.001$) (Table; Figure 1).

There was a significant correlation between age and PV in the patient group ($r=-0.322$, $p < 0.001$), but no significant difference was found in this regard in the control group ($r=-0.018$ $p=0.898$).

PV was 114.2 $\pm$ 36.6 mL in patients aged 57 years and less, and 87.7 $\pm$ 33.0 mL in those aged over 57 years ($p < 0.001$) (Figure 2).

There was a negative correlation in patients aged >57 years and the control group ($r=-0.236$, $p=0.039$; $r=-0.579$; $p=0.004$, respectively), but no significant correlation was found between age and PV in patients aged <57 years and the control group ($r=0.073$, $p=0.596$; $r=0.147$, $p=0.454$, respectively).

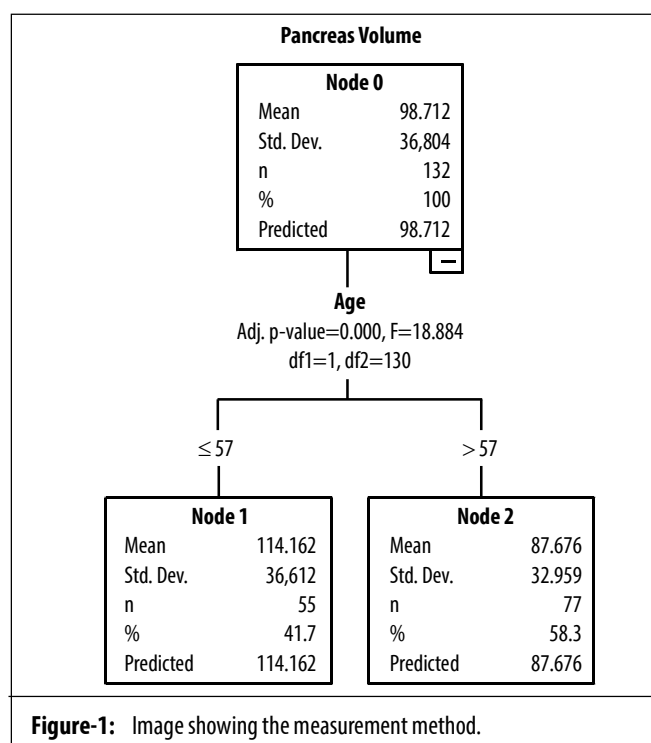




Figure-2: Chi-square automatic interaction detection (CHAID) analysis of the pancreatic volume.

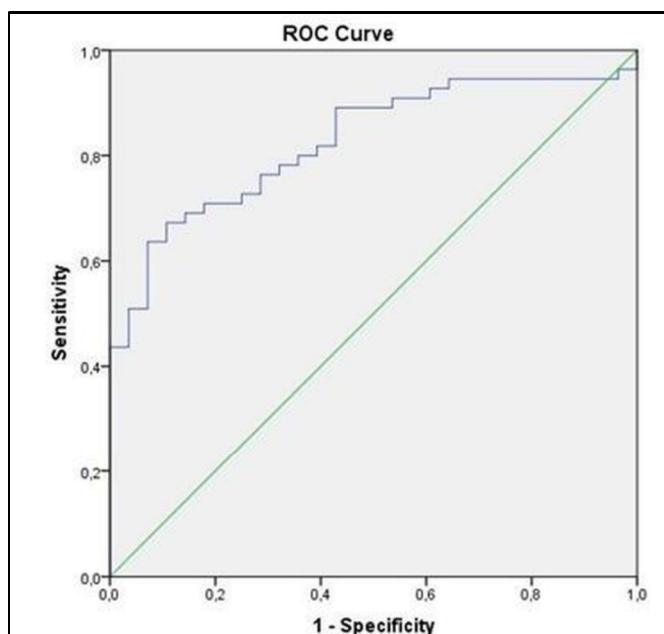


Figure-3: Receiver operating characteristic (ROC) curve analysis of pancreatic volume to distinguish patients and controls aged <57 years.

There was no correlation between the Balthazar grade and volume in patients aged >57 years ($r=-0.089$, $p=0.441$), while a significant correlation was found in patients aged <57 years ($r=0.329$, $p=0.014$).

CRP level was significantly higher in patients aged <57 years 43.0 (range: 14-138) than in the control group 3.5 (2-6.5) ($p<0.001$). A significant correlation was observed between CRP and PV ($r=0.352$, $p=0.008$). There was a significant difference in the patients group according to

the PV cut-off value as the CRP level was 18 (range: 3.8-50.5) in patients with $PV \leq 95.05\text{mL}$, and 66mL (range: 24-153) in patients with $PV > 95.05\text{mL}$.

According to ROC analysis, when the PV cut-off value was 95.055mL, sensitivity was 70.91% (95% confidence interval [CI]: 57.1-82.4) and specificity was 82.14% (95% CI: 63.1-93.9) (Figure 3). The positive likelihood ratio (+LR) was 3.97 (95% CI: 1.8-8.9), and the negative likelihood ratio (-LR) was 0.35 (95% CI: 0.2-0.6). Positive predictive value (PPV) was 88.6% ($n=39$) and negative predictive value (NPV) was 59% ($n=23$).

Discussion

The study found a correlation between age and PV which decreased with the age of the patients compared to the control group, and when PVs were classified according to age, the PV of patients was 98.7 ± 36.8 with a statistical finding of 57 years.

Prognosis of AP changes with the severity of the disease. Approximately 75-80% of the cases progress mildly and can be improved only with intravenous (IV) fluid therapy and supportive care. The remaining cases show progression with mortality and serious complications by 30-50%.¹² Therefore, early diagnosis of the disease and determination of therapeutic strategy depending on the severity of the disease is of paramount importance.¹³ Various scoring systems are used in order to determine the severity of the disease. However, none of these scoring systems can determine the severity within the first hour of the presentation. Easy-to-use and inexpensive indices that will determine the severity of the disease and give information about the prognosis within a few minutes are needed. We believe that PV measurement from abdominal CTs performed in ER on patients with abdominal pain and suspected of AP would be helpful both in ruling out the other diagnoses and the initiation of early treatment.

The results reported in literature are controversial in terms of the correlation between PV and age. Meier et al.¹⁰ stated that "some publications report a significant inverse correlation between pancreatic volume and age in healthy individuals, while others do not report such as correlation". In the past, PV measurements have been made mostly using autopsies or retrospective CT screening that involves radioactive agents.¹⁴ These studies found PV to be $72.4 \pm 25.8\text{mL}$ and $79.2 \pm 24.1\text{mL}$ in healthy adults aged 20-60 years.¹⁵ In the present study, PV was $79.6 \pm 26.0\text{mL}$ in patients aged 18-95 years. Although a decrease was

observed in PV in the control group with age, no statistically significant correlation was observed.

Contrast-enhanced abdominal CT (CECT) has an important place in the diagnosis of pancreatitis and the determination of severity, and it has been involved in the Pancreatic Diagnosis Criteria.¹ In a prospective study on this topic, CECT of 202 patients was evaluated and specificity rates were reported as 92% and 100%.¹⁶ In 1985, Balthazar et al. developed an assessment system known as Balthazar classification, which is based on a general assessment of the dimensions, contour and density of the gland and peri-pancreatic anomalies in prediction of the severity of the disease.¹⁷ In 1990, Balthazar validated the CT severity index of acute pancreatitis by combining the original grading system he developed with the presence and grade of pancreatic necrosis.^{18,19}

PV is known to increase in AP cases.²⁰ In our study, consistent with the literature,²⁰ PV was higher in AP patients compared to the control group.

We found a moderate negative correlation between PV and age in patients aged <57 years. According to the ROC analysis performed to examine the power of PV to distinguish between patient and control subjects, when the cut-off value of the volume was 90.055, sensitivity was 70.91%, and specificity was 82.14%. The +LR value was 3.97, and the -LR was 0.35. PPV was 88.6%, and NPV was 59%.

In the analysis made to determine presence of the correlation between PV and the severity of pancreatitis, a moderate positive correlation was found between the Balthazar score and PV in patients aged <57 years ($p < 0.001$). While the Balthazar grade and CT severity index were increased, i.e. the severity of the disease was increased, PV was also found increased, suggesting that PV may be useful in the prediction of AP severity.

CRP is valuable in acute response, especially because of its short half-life^{21,22} and CRP is often used during admission and subsequent follow-up of AP patients. In our study, a moderate positive correlation was observed between CRP and PV in patients aged <57 years ($p = 0.008$). This supports the findings that PV is also associated with the severity of the disease.

The current study has some limitations as it excluded patients with malignancy, pancreatic surgery and DM. Also, post-recovery control pancreas CT scan was not

performed.

Conclusion

High PV with pancreatitis was observed in patients aged <57 years. The measurement of PV may be helpful for physicians in early diagnosis, determination of the severity of the disease, prognosis, therapy planning and referral of patients considered to be carrying AP risk.

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