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Hepatic perfusion changes in an experimental model of acute pancreatitis: Evaluation by perfusion CT

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ABSTRACT

Purpose: It is known that acute pancreatitis may cause secondary changes in several organs. Liver is one of these involved organs. In different experimental studies hepatic damages were shown histopathologically in acute pancreatitis but there are a few studies about perfusion disorders that accompany these histopathologic changes. Perfusion CT (pCT) provides the ability to detect regional and global alterations in organ blood flow. The purpose of the study was to describe hepatic perfusion changes in experimental acute pancreatitis model with pCT.
Materials and methods: Forty Sprague–Dawley rats of both genders with average weights of 250 g were used. Rats were randomized into two groups. Twenty rats were in control group and 20 in acute pancreatitis group. pCT was performed. Perfusion maps were formed by processing the obtained images with perfusion CT software. Blood flow (BF) and blood volume (BV) values were obtained from these maps. All pancreatic and liver tissues were taken off with laparotomy and histopathologic investigation was performed. Student's *t* test was used for statistical analyses.
Results: In pCT we found statistically significant increase in blood volume in both lobes of liver and in blood flow in right lobe of the liver ($p < 0.01$). Although blood flow in left lobe of the liver increased, it did not reach statistical significance.
Conclusion: The quantitative analysis of liver parenchyma with pCT showed that acute pancreatitis causes a significant perfusion changes in the hepatic tissue. Systemic mediators seem to be effective as well as local inflammatory changes in perfusion changes.

1. Introduction

It is known that acute pancreatitis may cause secondary changes in several organs. Liver is one of these involved organs. In several experimental studies hepatic damages were shown histopathologically in acute pancreatitis [1–3]. Perfusion CT is a non-invasive method of revealing blood perfusion data of many tissues and lesions [4]. To date, perfusion imaging of the liver has been described in evaluation of cirrhosis, primary and metastatic liver malignancy, infectious hepatobiliary disease and many physiologic and iatrogenic causes [4]. Hepatic perfusion abnormalities have also been described in acute pancreatitis by dynamic two-phase CT [5]. The purpose of this study was to describe hepatic perfusion changes in an experimental acute pancreatitis model with perfusion CT. This is the first study in literature where changes of liver tissue secondary to pancreatitis are evaluated by perfusion CT in an experimental model.

2. Materials and methods

All the necessary approvals for the experimental processes were granted by the ethic committee of the faculty of the medicine, Celal Bayar University, Manisa, Turkey. Forty Sprague–Dawley rats of both genders with average weights of 250 g were included. Rats were randomized into two groups. Twenty rats were included in the acute pancreatitis group and 50 μg/kg caerulein was given intraperitoneally (five times/h) in order to create acute pancreatitis. The control group consisting of 20 rats were given 0.1 ml of 0.9% NaCl intraperitoneally (five times/h). Six hours after the intraperitoneal injections 24 G branules were placed into the femoral veins. CT imaging was performed by Siemens emotion single slice CT scanner. The imaging parameters were: FOV: 12 cm; 120 kV; 80 mA s,

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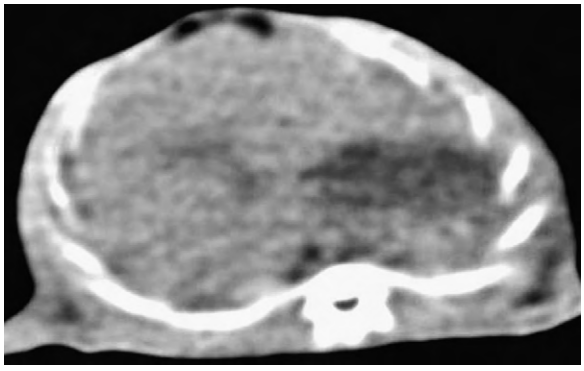

Fig. 1. Precontrast CT scan of the upper abdomen performed to choose an appropriate slice including the aorta, portal vein and liver parenchyma.

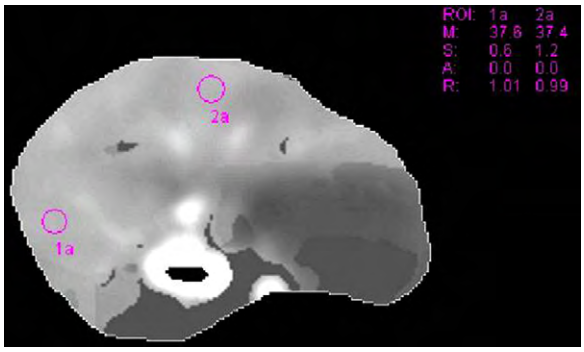

Fig. 2. Perfusion maps were formed by processing the obtained data with pCT software. Relative blood flow (rBF) and relative blood volume (rBV) values were obtained from these maps using two different ROIs, one from the right, and the other from the left lobe of the liver.

matrix 512 × 512, slice thickness: 5 mm. Precontrast CT scan of the upper abdomen was performed to choose a single slice including the aorta, portal vein and liver parenchyma (Fig. 1). Dynamic CT was performed following administration of contrast agent (Iohexsol, 1 ml/kg with diluted concentration of 33% at a speed of 0.15 ml/s via FV). Fifty images were obtained from the chosen level 1/s beginning 5 s after the administration of contrast agent. Perfusion maps were formed by processing the obtained data with pCT software (Siemens). Relative blood flow (rBF) and relative blood volume (rBV) values were obtained from these maps (Fig. 2). The blood samples were taken from FV of rats for amylase studies. The rats were sacrificed at the end of the experiment. All pancreatic and liver tissues were taken off with laparotomy and histopathologic investigation was performed. Pancreatic scoring on

Table 1
Summarized both histopathological and laboratory changes. Significant histopathological and laboratory changes were detected in the pancreatitis group (asterisks indicate $p < 0.01$).

	Control group ($n = 20$)	Pancreatitis group ($n = 20$)
Amylase (U/L)	905 ± 52	117,347 ± 11,827*
Pancreatitis score	2.80 ± 0.23	7.70 ± 0.46*
Hepatic inflammation score	4.55 ± 0.46	7.70 ± 0.37*

Table 2
CTP blood volume and blood flow parameters showed increase in rBV in both lobes of liver and increase in rBF in right lobe of the liver. Although rBF in left lobe of the liver increased, it did not reach statistical significance (asterisks indicate $p < 0.01$).

	Right lobe		*Left lobe*	
	Control	Pancreatitis	Control	Pancreatitis
	($n = 20$)	($n = 20$)	($n = 20$)	($n = 20$)
Blood volume, rBV	152 ± 12	240 ± 18*	147 ± 13	225 ± 17*
Blood flow, rBF	32.35 ± 5.97	67.15 ± 12.60*	37.85 ± 7.88	51.10 ± 6.36

microscopic examinations evaluate acinar cell degeneration, interstitial edema, leucocyte infiltration, vasocongestion and hepatic scoring on microscopic examinations evaluate hepatocyte degeneration, sinusoidal dilatation, focal necrosis, central vein congestion, Kupffer cell proliferation. Each was rated from 0 to 3 degrees the sum of each rate determined the pancreatic and hepatic scores. Student's *t* test was used for statistical analyses of the findings. *p* value <0.05 was consider significant.

3. Results

Significant histopathological and laboratory changes were detected in the pancreatitis group (Table 1). Both histopathological and laboratory results demonstrate pancreatitis and inflammation of liver. Table 2 summarized the rBV and rBF parameters of the both right and left lobes. pCT data showed increase in rBV in both lobes of liver ($p < 0.01$) and increase in rBF in right lobe of the liver ($p < 0.01$). rBV and rBF mapping showed these findings qualitatively (Figs. 3 and 4). Although rBF in left lobe of the liver increased, it did not reach statistical significance.

4. Discussion

Conventional diagnostic imaging techniques provide limited evaluation of tissue characteristics beyond morphology. Perfusion imaging has potential to improve this shortcoming. It provides the ability to detect regional and global alterations in organ blood flow quantitatively [4]. For perfusion CT examination, a dynamic series

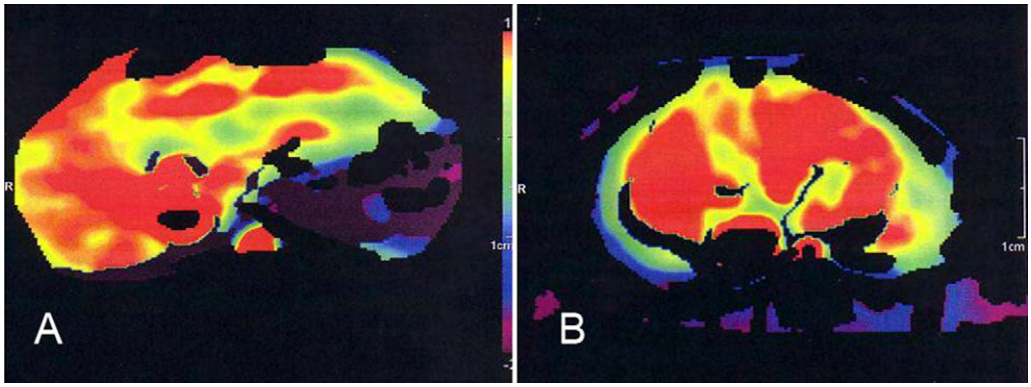

Fig. 3. Relative blood volume (rBV) mapping. (A) Control group and (B) pancreatitis group. The color map indicates increase of rBV of the liver in both lobes.