Postgastrectomy Changes in the Pancreatic Volume at Computed Tomography Examinations

Bilgisayarlı Tomografi Incelemelerinde Gastrektomi Sonrası Pankreas Hacim Değişiklikleri

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ABSTRACT

Objective: We aim to determine the volume changes of the pancreas after gastrectomy by using volumetric computed tomography (CT) measurements.
Methods: Thirteen patients (8 men, 5 women, age range: 42 y – 76 y) who were diagnosed with gastric cancer and underwent gastrectomy (2 subtotal, 11 total) were included in this retrospective study. Pancreatic volumes were measured in preoperative ($Pvol_{pre}$) and postoperative (3rd month ($Pvol_{1stFU}$), 7-11th month ($Pvol_{2ndFU}$), and 18-60th month ($Pvol_{3rdFU}$) follow-up) contrast-enhanced CT examinations. To calculate the pancreatic volume, first, we manually drew the outermost margins of the pancreas and cut the volume, then we used a threshold method to exclude fat densities that infiltrated the pancreas. We used the Shapiro -Wilk test for normality, Levene test for homogeneity and one-way ANOVA test for comparing multiple groups. The significance level of 0.05 is used.
Results: Pancreatic volumes decreased significantly within the 3rd month after the surgery in all of the patients ($Pvol_{pre}$: 87,6 cc, $Pvol_{1stFU}$: 60,4 cc, p=0.044). The differences in the pancreas volumes between first, second and third follow-up examinations were not significant (p > 0.05 for all).
Conclusion: This study demonstrated that pancreas volume significantly decreases after gastrectomy and the decrease could be well documented with volumetric CT. The decrease in the volume is more evident in the 3rd month follow up period. A radiologist should be aware of an expected decrease in the volume of the pancreas in the follow-up after gastrectomy.

Key Words: pancreas, gastrectomy, postgastrectomy, multidetector computed tomography, volumetric computed tomography, organ volume

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ÖZET

Amaç: Gastrektomi sonrası pankreas hacim değişikliklerini hacimsel bilgisayarlı tomografi (BT) ölçümleri ile saptamayı amaçladık.
Yöntem: Bu çalışmaya gastrik kanser tanısı almış ve gastrektomi yapılmış 13 hasta dahil edildi (8 erkek, 5 kadın, yaş: 42 y- 76 y). Cerrahi öncesinde ($Pvol_{pre}$) ve cerrahi sonrasında (3. ay ($Pvol_{1stFU}$), 7-11.ay ($Pvol_{2ndFU}$), ve 18-60. ay ($Pvol_{3rdFU}$)) elde edilmiş kontrastlı BT incelemelerinde pankreas hacim ölçümleri yapıldı. Pankreas hacmini hesaplamak için, ilk olarak pankreasın dış sınırı çizilip hacimden çıkarıldı, sonrasında pankreasa infiltre olmuş yağ dokusu eşik dansite değeri kullanılarak ekarte edildi. İstatistik yöntem olarak, normalite için Shapiro -Wilk testi, homojenite için Levene testi ve ikiden fazla sayıda grubu karşılaştırmak için tek yönlü ANOVA testi kullanıldı. <0.05 değeri istatistiksel olarak anlamlı kabul edildi.
Bulgular: Cerrahi sonrası üçüncü ay kontrollerinde, pankreas hacimleri hastaların tamamında istatistiksel olarak anlamlı bir şekilde azalmıştı ($Pvol_{pre}$: 87,6 cm^3 , $Pvol_{1stFU}$: 60,4 cm^3, p=0.044). Birinci, ikinci ve üçüncü kontrol BT incelemelerinde ölçülen pankreas hacimleri arasındaki fark istatistiksel olarak anlamlı bulunmadı (p > 0.05).
Sonuç: Bu çalışma gastrektomi sonrasında pankreas hacminin azaldığını ve bu azalmanın BT ile saptanabildiğini göstermiştir. Pankreas hacmindeki azalma en belirgin olarak cerrahi sonrası 3. ayda gözlenmiştir. Bu konuda radyologların farkındalığının artması önemlidir.

Anahtar Sözcükler: pankreas, gastrektomi, gastrektomi sonrası, çok kesitli bilgisayarlı tomografi, hacimsel bilgisayarlı tomografi, organ hacmi.

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INTRODUCTION

Gastrectomy is a frequently performed procedure in the treatment of gastric cancers, gastric ulcers, and obesity (1). Although until now there are no studies regarding pancreatic volume and tissue enzyme concentration changes in the human pancreas, the mechanism of adaptation following total gastrectomy seems to be similar in humans when compared to animals as far as postprandial cholecystokinin (CCK) levels are concerned (2). It also depends on the type of surgery especially depends on duodenal preservation (3).

Gastrin -endogenous or exogenous- seems to be responsible for pancreatic growth and regeneration after partial pancreatectomy (4-6). Pancreatic volume loss may be due to decreased plasma gastrin levels after surgery.

In this retrospective study, we aimed to determine the pancreatic volume changes by using follow-up computed tomography (CT) scans of patients who had gastrectomy.

METHODS

The local Institutional Review Board approved this retrospective study. The study population of this retrospective study constituted 38 gastrectomized patients that had a diagnosis of gastric cancer and underwent a follow-up abdomen CT examination in our institution between January 2016 - April 2016.

We excluded 25 patients of which; 1 patient whose procedure included distal pancreatectomy, 10 patients were not followed regularly, 14 patients had no preoperative CT scans.

Thirteen patients (8 men, 5 women, age range: 42 y – 76 y) who were diagnosed with gastric cancer and underwent gastrectomy (2 distal subtotal, 11 total), had preoperative and regular postoperative follow-up scans were included in this retrospective study.

Pancreatic volumes were measured in preoperative and postoperative (3rd, 7th -11th, and 18-60th-month follow-up) periods via contrast-enhanced CT examinations. CT examination was performed with a 64 detector CT scanner (Lightspeed VCT, GE Healthcare, Milwaukee, WI, USA).

Examination parameters were as follows: beam collimation of 0.625 mm × 64, a pitch of 0.984; tube potential of 120 kVp and a gantry rotation time of 0.6 seconds. Automated tube current modulation method was used.

Iohexol and Ioversol (Omnipaque 300mg/mL, Amersham Health, Carnegie Center, Princeton, USA and Optiray 300 mg/ml, Mallinckrodt INC., St. Louis, USA) were used as an intravenous contrast material in the examinations. Contrast material followed by 40 ml saline was given at a speed of 3 mL/sec by using an IV line (20G) placed in the antecubital vein.

A radiologist performed the measurements in a workstation (Advantage Windows 4.4, GE). Window level and width were set at 300 HU and 50 HU respectively and settings were changed where necessary.

To calculate the pancreatic volume, we manually drew the outermost margins of the pancreas avoiding vascular structures and cut the volume, then a threshold method was used to exclude fat densities that infiltrated the pancreas. We set a threshold of 30 HU (Fig.1).

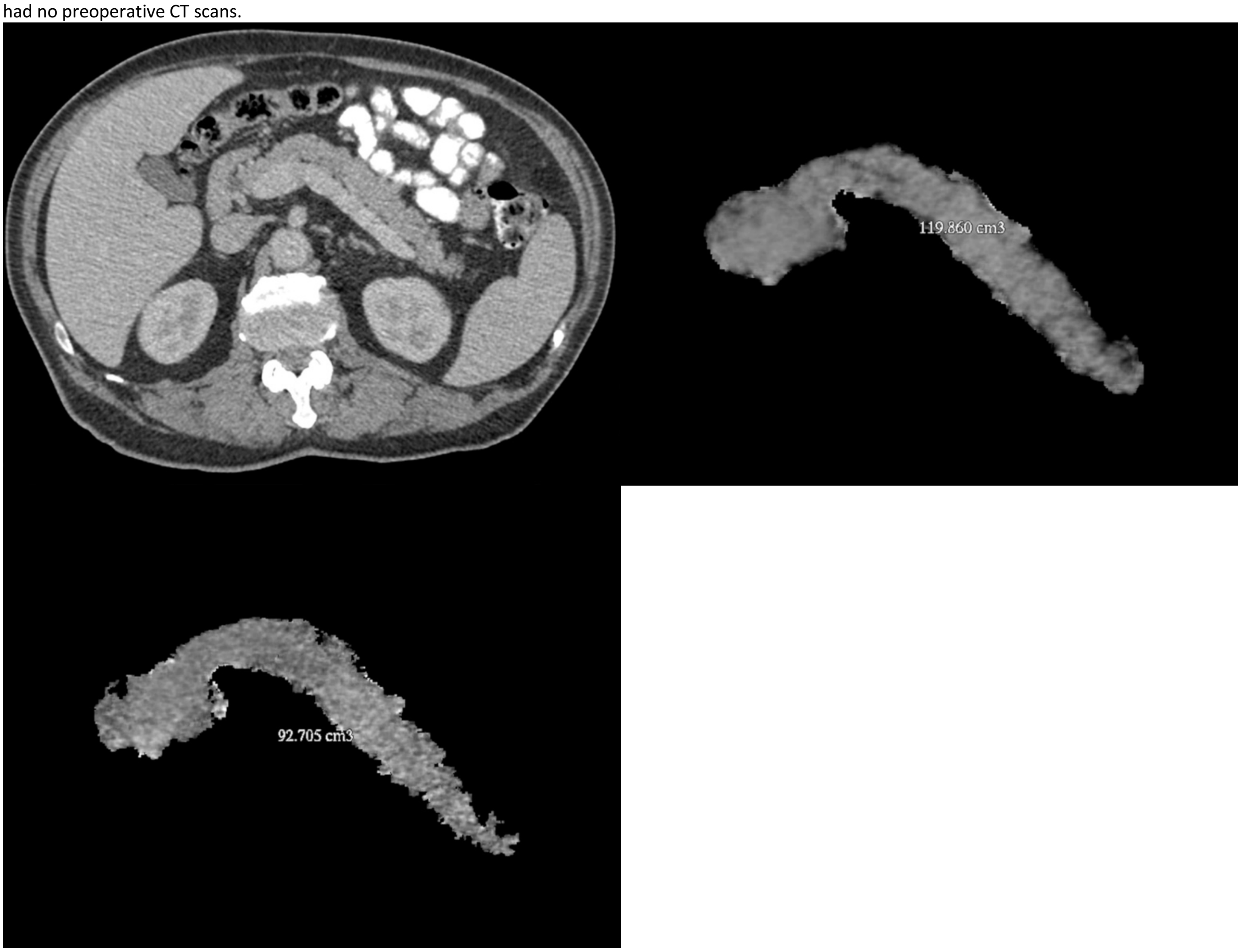

Figure 1. 70-year old male patient diagnosed with gastric cancer.
A) Preoperative contrast-enhanced axial abdomen CT scan, B, C) Manually outlined and cut pancreas, automatically computed volume before and after applying 30HU threshold

Statistical analysis

We used the Shapiro-Wilk test for normality, Levene test for homogeneity and one-way ANOVA test for comparing multiple groups. Tukey HSD was used as a post-hoc test. The significance level was set at 0.05 (Statistical Package for the Social Sciences, Version 17.0; SPSS, Chicago, Illinois).

RESULTS

Pancreatic volumes were decreased significantly within a 3rd month after gastrectomy in all of the patients ($Pvol_{pre}$: 87,6 cc, $Pvol_{3m}$:60,4 cc, p=0.044). Although there was a gradual decrease in the means of the volumes during the follow-up period the differences among the first, second and third follow up examinations were found to be insignificant ($p > 0,05$) (Table 1).

Table 1: Patient characteristics and measurements:

Number of patients	13 (8 men, 5 women)
Age	56.3, 42-76y †
$Pvol_{pre}$ (cc)	87.6 ±22.6, (49.2-132) *
$Pvol_{1stFU}$ (cc)	60.4 ±23.1, (25.3-115) *
$Pvol_{2ndFU}$ (cc)	58.0 ±25.0, (26.9-119) *
$Pvol_{3rdFU}$ (cc)	41.1 ±32.4, (11-118) *

Note. — † Data are mean and range. * Data are mean ± standard deviation, with a range in the parentheses. $Pvol_{pre}$: Preoperative; $Pvol_{1stFU}$: 3rd month follow up; $Pvol_{2ndFU}$: 7-11th month follow up, $Pvol_{3rdFU}$: 18-60th month follow up

One patient was diagnosed with pancreatic cancer during the follow-up period (Fig. 2).

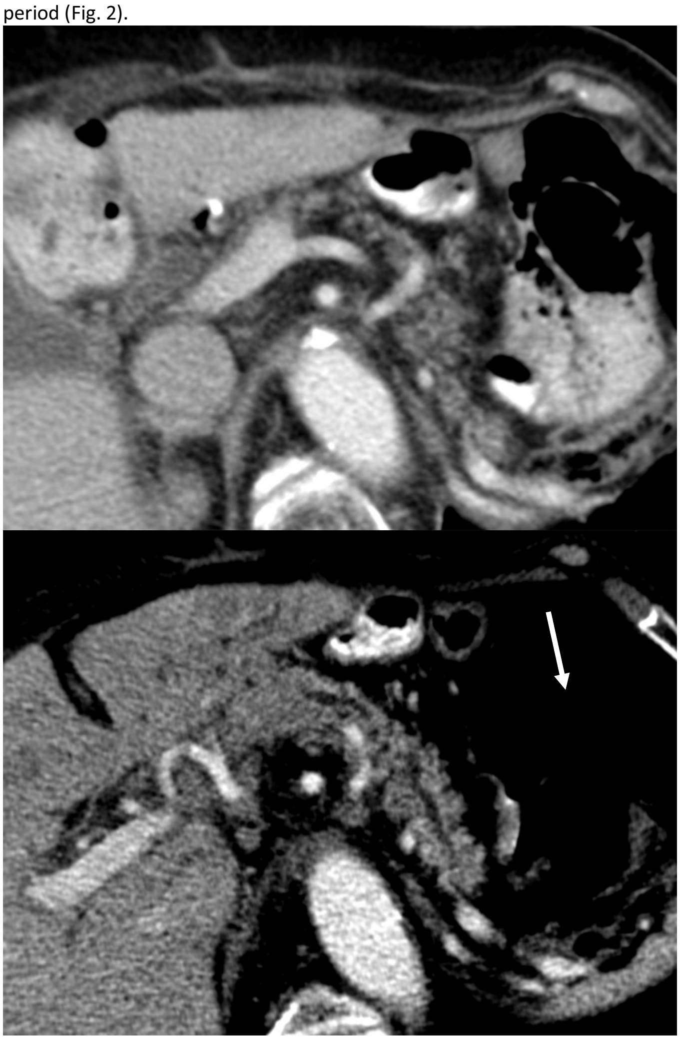

Figure 2. 77-year old female patient, diagnosed with gastric cancer. A) The second follow-up contrast-enhanced axial abdomen CT scan: pancreatic fatty atrophy is seen. B) The third follow-up contrast-enhanced axial abdomen CT scan: pancreas parenchyma is denser compared with the former image, the pancreatic duct is dilated and ends abruptly at the neck of the pancreas (white arrow). The patient was diagnosed with pancreas cancer.

DISCUSSION

Gastrectomy is the treatment of choice in gastric carcinoma. This operation is also used to treat life-threatening obesity, peptic ulcers, esophageal cancers and non-cancerous tumors of the stomach.

Johnson showed that (5), the weight of the pancreas significantly reduced by antrectomy in rats. Pentagastrin injection returned pancreas weight to control levels, as well as perfusion of the duodenum with hydrochloride, increased DNA synthesis and the total weight of pancreas. Our results were concordant with their findings. We showed a significant decrease in volumetric CT measurements.

However, in humans, total gastrectomy has been shown to increase postprandial CCK release (7, 8). As it has been postulated before CCK may be responsible for the adaptation of exocrine pancreas after stomach removal (9). It is known that CCK increases pancreatic RNA & DNA content and DNA synthesis (4).

Several reports are indicating an increased incidence of pancreatic cancer after total/subtotal gastrectomy in the literature (10-12).

An increase in pancreatic cancer incidence after gastrectomy has been controversial. In a study, Watapana et al (8) showed that partial gastrectomy promotes experimental pancreatic carcinogenesis in laboratory animals and postulated a combination of increased postprandial CCK release and n-nitroso compound exposure may explain the increased incidence of pancreatic cancer in humans after subtotal gastrectomy.

It has been shown that pancreatic hyperplasia is induced after total gastrectomy in rats. Laboratory studies have shown that baseline and postprandial gastrin levels diminished up to %70 while postprandial CCK levels are increased up to %72. CCK produced in discrete endocrine cells that line the mucosa of the small intestine is the major hormone responsible for gallbladder contraction and pancreatic enzyme secretion (8). In addition, CCK regulates bowel motility and has growth-promoting effects on the pancreas in certain animals (8, 13). Analyzing basal and postprandial hormones trophic potency is attributed to increased postprandial CCK.

In the long term follow-up of the patients, with the increased blood levels of postprandial CCK pancreatic volume increases due to the trophic effect of CCK, and this trophic effect may lead to pancreatic carcinogenesis.

Further studies that will use the volumetric CT in search of the pancreatic malignancy incidence in postgastrectomy patients can be designed. We recommend that any increase in the postgastrectomy volume of the pancreas should arouse suspicion of pancreas malignancy and be studied accordingly.

This study has limitations. First, the number of patients was small. Second, the study was limited by its retrospective nature and a large number of patients lost to follow-up. Larger, prospective, randomized, controlled studies that also include hormone levels such as CCK and gastrin are warranted.

CONCLUSION

This study demonstrated that pancreas volume significantly decreases after gastrectomy and the decrease could be well documented with volumetric CT. The decrease in the volume is more evident in the 3rd month follow up period. A radiologist should be aware of an expected decrease in the volume of the pancreas in the follow-up after gastrectomy.

Conflict of interest
No conflict of interest was declared by the authors.

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