Purpose

The pancreaticoduodenectomy (PD) is the standard surgical approach for both benign and malignant lesions of the pancreatic head and the periampullary region. This is a surgery burdened by considerable technical difficulties and postoperative complications are very important.

The pancreatic fistula is a severe and frequent complication after PD and despite improvements in surgical technique and postoperative management that have drastically reduced the mortality and morbidity, postoperative fistula remains one of the most common major complications. In order to prevent the formation of pancreatic fistula after PD, there have been identified many risk factors.

These include preoperative risk factors (age, sex, BMI, comorbidity, biliary drainage), intraoperative (consistency of the organ, pancreatic duct size, vascularity of the residual pancreas, type of anastomosis and use of stents, occlusion of the pancreatic duct, operative time, blood loss), and postoperative risk factors (delay in drain removal, drug treatment).

Despite the presence of numerous studies in the literature about it, there are currently no good strategies in the prevention of fistula before it materializes.

Advances in anesthesiology techniques and perioperative management have reduced mortality to less than 5% for the PD but morbidity remains high and close to 50% in large series. The decisive factor in determining patient outcome remains pancreatico-digestive anastomosis. Sepsis and hemorrhage caused by pancreatic fistulas are associated with a mortality rate of 20% -40%.

The vascularity of the abdominal organs is derived mostly from the celiac and superior mesenteric artery. The region of the pancreatic head is the site of communication between these two arterial systems through the gastroduodenal artery and pancreaticoduodenal arcades. A PD routinely includes the section of these arteries. In most patients, the blood supply remains adequate after section of these vessels, but those with hemodynamically significant stenosis of the celiac axis (CA) or superior mesenteric artery, may develop vascular insufficiency that can lead to serious visceral complications. Ischemic complications after PD, due to a stenosis or intraoperative trauma to the superior mesenteric artery or hepatic artery, may lead to anastomotic dehiscence, necrosis, hepatic or intestinal complications, all with a high mortality rate.

The incidence of ischemic complications and the prevalence of arterial stenosis has so far been little studied. Most of these studies suggest that the need to identify pre-existing arterial stenosis is based on the use of invasive procedures such as arteriography.
Recently, some works have appeared that evaluate the value of multislice CT in the identification of these strictures.

The occlusion or stenosis of the CA may be caused by extrinsic compression by the arcuate ligament, or from atherosclerotic plaque, by perivascular lymphadenopathy, or by the tumor itself.

The CA occlusion occurs in a variable percentage of cases from 1 to 12.5% in the general population according to different study.

A recent review of 400 asymptomatic patients in Korea showed a stenosis of the CA 7.3%, mostly due to the arcuate ligament.

While the stenosis or occlusion can be radiologically significant, patients usually do not have abdominal pain.

Identify the stenosis is crucial before making a PD because the collateral circulation is removed during surgery.

The purpose of this study is to evaluate retrospectively the CT angiography of 74 consecutive patients investigated before PD to highlight a possible stenosis of the celiac trunk and to correlate these results with the outcomes of the intervention of resection.
Methods and Materials

We have performed a retrospective analysis of all patients that underwent surgery of PD at the Department of General Surgery of our Hospital between 2006 and 2010.

We identified patients who developed postoperative pancreatic fistula and their characteristics were compared with those who did not develop a fistula.

We reviewed the medical records of patients and analyzed in detail their clinical course and management.

We considered a sign of pancreatic fistula value of amylase in the fluid drainage from the third postoperative day when it was three times higher then the normal value in serum, regardless of the amount of fluid drained in accordance with the definition of pancreatic fistula dell'ISGPF (International Study Group on Pancreatic Fistula Definition). In addition, patients with fistula were considered all those who underwent interventional radiology or surgical drainage of localized collections rich in amylase near to pancreatic anastomosis. From the review of patient records, we obtained the following information:

- preoperative diagnosis
- final pathology
- type of anastomosis
- operative time
- duration of hospitalization
- need for reoperation or interventional radiology
- the 'use of somatostatin on amylase level of drainage
- the duration of the fistula
- bleeding
- other major complications and mortality.

The duration of the fistula was defined as the time between the day of surgery and the day on which the last drain was removed (or drains placed surgically or by interventional radiology).

The operative mortality was estimated from the deaths been caused in the first thirty days of surgery or at least during the same hospitalization for PD.

Stenosis of the CA is defined as a reduction in diameter > 50% of the size expected at the same level (ECST criteria).
Stenosis, when present is characterized in its variants as ab extrinsic stenosis; compression by the arcuate ligament of the diaphragm and in stenosis due to atherosclerotic plaque at the origin of the vessel. The Wirsung size is also determined.

The abdominal CT angiography examinations were performed with 64-slice CT scanner (Aquilion 64 Toshiba, Tokyo, Japan).

The CT exams were performed in an interval of time between 42 and 3 days before surgery.

The angiographic acquisition is extended from a plane passing through the diaphragm to the iliac crests, and is synchronized with a bolus tracking technique (with threshold of 150 HU).

We administered an average of 100 ml contrast medium (iomeprolo 350; Iomeran, Bracco, Milan, Italy) at a flow rate of 3.5 - 4 ml / s using dual-head automatic injector (Stellant, Medrad in Indianola USA) followed by 40 ml of solution saline with the same flow through technique "Bolus Chaser"; further abdominal scans in the portal and late phase have been performed, when necessary, to appropriately define the patient's pathology.

The acquisition protocol provides a scan with slice thickness of 64 x 0.5 mm and further subsequent image reconstruction with a thickness of 5 mm, for the evaluation of primary disease.

The images were transferred to dedicated workstation (Aquarius WS, Terarecon USA) and evaluated by performing multiplanar reconstruction (MPR), curved multiplanar (cMPR) and three-dimensional (3D VR).

The celiac and superior mesenteric artery are considered: normal (Fig. 1), extrinsic stenosis by arcuate ligament defined as a stenosis of the proximal celiac trunk (within first 5 mm) (Fig. 2), or intrinsic stenosis by atherosclerosis plaque (Fig. 3).
Results

Our experience is based on 74 patients, 45 men and 29 women.

The rate of fistula between the two groups was not significant (p=0.6).

The mean age of patients was 67 years, with a range of 47-88 years.

The fistula was achieved in 9 patients over 65 years (23%) and in 9 patients under 65 years (52%). The difference in the rate of pancreatic fistula between the two groups was not significant (p = 0.1).

In 35 patients the BMI was greater than 25 kg/m2 and in 39 patients was less than 25 kg/m2; the pancreatic fistula was achieved in 14 patients with BMI> 25 and 6 patients with BMI <25. Patients with BMI> 25 showed a more frequent association with the formation of pancreatic fistula (p=0.01).

The fistula symptom was obstructive jaundice in 32 patients, and in 16 (50%) of these had to endoscopic placement of a biliary stent, while in 5 cases (15%) was placed percutaneous trans-hepatic drainage.

Comparing the histopathological diagnosis with the rate of pancreatic fistula, the fistula was achieved in 7 patients (54%) with adenocarcinoma of the pancreatic head, 3 patients (23%) with carcinoma of the ampulla of Vater (%) and 5 patients with cholangiocarcinoma (7%).

No fistula was observed in patients operated on for chronic pancreatitis or other indications. Only the BMI> 25 kg/m2 has proved to be a significant factor in fostering the development of pancreatic fistula.

CTA RESULTS IN EVALUATION OF CA:

In total 46 patients were included in the CT evaluation because 28 of them had not been scanned by a thin layer CT.

We identified 17 (33%) stenosis of the CA.

10 (23%) given by the arcuate ligament (Fig. 1), and 7 (16%) caused by atherosclerotic plaque (Fig. 2-3), in one case were both the plaque, is the ligament. In 13 cases (30%), patients with celiac axis stenosis, have developed a pancreatic fistula. This finding was also statistically highly significant (p <0.0001).
The calier of the Wirsung duct was measured on preoperative CT images. In 2 patients with Wirsung duct <3 mm was achieved anastomotic fistula. There was no statistical significance (p = 0.14).
Fig. 1: Fig. 1: stenosis due to arcuate ligament.

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**Fig. 2:** Fig. 2: stenosis due to atherosclerotic plaque.

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Fig. 3: Fig. 3: stenosis due to calcific plaque.

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Conclusion

The pancreaticoduodenectomy is a technically difficult surgery with a relatively high rate of mortality (3% -5%) and complications (20% -40%). The pancreatic fistula is the most frequent complication after this type of surgery and his presence are connected most of the other complications. The rate of pancreatic fistula in the literature varies from 2% to 22%.

In addition to clinical and laboratory factors detectable, have been recently proposed radiological and histopathological findings on surgical samples that seem to have a significant correlation with the incidence of postoperative fistula.

CTA is proposed for the analysis of celiac artery to assess the presence of celiac stenosis before the surgery. This is present in the general population 1 to 12.5% of cases. This patients should be identified before proceeding with the surgery of pancreaticoduodenectomy.

Some authors, having found a significant correlation between stenosis of the celiac artery and postoperative ischemic complications. Preoperative arterial recanalization interventions or intraoperative section of the arcuate ligament can reduce the incidence of ischemic complications and therefore also of anastomotic fistulas. The results of this approach seem to be positive.

There's no significant difference in the incidence of fistulas among patients with Wirsung diameter greater than or less than 3 mm.

By the evidence of literature and personal experience is not yet possible to identify certain risk factors for the occurrence of pancreatic fistula in patients operated for pancreaticoduodenectomy. The importance of stenosis and celiac-mesenteric fat infiltration of the pancreas seems to demonstrate the importance of these two factors in the occurrence of postoperative fistula.

If further studies confirm this trend, we must pay more attention to these factors before embarking on an intervention of pancreaticoduodenectomy. We must address the cause of celiac-mesenteric artery stenosis in order to ensure adequate vascularization of the pancreatic stump. With regard to the detection of this fatty pancreas as an extemporaneous examination may lead to a choice in favor of a more aggressive pharmacological prophylaxis or the use of aids such as anastomotic stent.