

A New Test to Avoid Arterial Complications during Pancreaticoduodenectomy

Marcel Autran C Machado MD¹, Paulo Herman MD¹, André L Montagnini MD¹, Marcelo LV Costa MD¹, Kenji Nishinari MD², Nelson Wolosker MD², Marcel CC Machado MD, FACS¹

¹Department of Abdominal Surgery and ²Department of Vascular Surgery, Cancer Hospital, São Paulo, Brazil

Corresponding Author: Marcel Autran C. Machado, MD, Al. Casa Branca 438 # 101 - 01408-001

São Paulo, Brazil

Tel: +55 11 3253 0670, Fax: +55 11 3253 0670, E-mail: dr@drmarcel.com.br

SUMMARY

Celiac trunk or superior mesenteric artery stenosis are usually innocuous conditions. In such patients, arterial blood supply to the stomach, spleen, liver and bowel is sustained through extraordinarily well-developed pathways through the pancreas. If division of these collateral vessels is necessary during a surgical procedure such as pancreaticoduodenectomy, life-threatening celiac organ or bowel ischemia may occur.

The authors describe a new test, using pancreatic inflow occlusion, to reliably identify celiac trunk or superior mesenteric artery stenosis.

The authors describe two cases of celiac axis occlusion and one case of superior mesenteric artery stenosis. In all three presented cases the gastroduodenal artery clamping test was negative and

ischemia was only noticed after pancreatic section, suggesting that in severe occlusions this test may fail in diagnosing the vascular abnormality. All patients were successfully treated by revascularization with no operative mortality.

If the diagnosis is unsuspected and in cases where appropriate angiographic studies have not been obtained before pancreatic resection, a test occlusion of the gastroduodenal artery should always precede its ligation. However, this test may not be effective in all cases and in instances where high suspicion of celiac axis or mesenteric stenosis is present, other maneuvers, such as pancreatic inflow test, could be helpful for the diagnosis of these rare and morbid situations.

KEY WORDS:

Celiac trunk stenosis; Superior mesenteric artery occlusion; Pancreas; Technique

ABBREVIATIONS:

Polytetrafluoroethylene (PTFE); Computed Tomography (CT); Magnetic Resonance Imaging (MRI)

INTRODUCTION

Celiac trunk occlusion has been described in 2 to 3% of all pancreaticoduodenectomies (1,2). Superior mesenteric artery stenosis or total occlusion is extremely rare but may also be present and its incidence rate is still unknown. In either situation, arterial blood supply to the upper abdominal viscera and bowel is sustained through extraordinarily well-developed collateral pathways through the pancreas communicating those arterial systems. Therefore, with the sacrifice of these collateral pathways during pancreaticoduodenectomy, some patients may develop upper abdominal viscera or bowel ischemia following the procedure.

To avoid arterial complications during pancreatic resection, Bull *et al.* (3) recommended an occlusion test of the gastroduodenal artery before its ligation because it represents the communication between celiac axis and superior mesenteric artery. Hepatic arteries are palpated before and after the test occlusion. In the occasional patient in whom the pulse diminishes during occlusion or if there is evidence of abdominal visceral ischemia, revascularization of the celiac or superior mesenteric artery circulation may be required.

This article describes three cases in which this test was negative but pancreatic head resection was followed by visceral ischemia. We report two cases of

celiac axis occlusion and an unusual case of superior mesenteric artery stenosis that were treated by revascularization. No other case of severe bowel ischemia during pancreaticoduodenectomy due to superior mesenteric artery stenosis was found in the English literature. This article proposes a new test to identify artery occlusions avoiding these situations.

SURGICAL TECHNIQUE

Case Reports

Case 1: A 56-year-old woman presented with a four-month history of upper abdominal pain, diarrhea and diabetes mellitus of recent onset. Abdominal ultrasound and CT scan disclosed a solid heterogeneous tumor in the uncinate process of the pancreas. During celiotomy, there was no evidence of extra-pancreatic disease and a resectable tumor was found in the uncinate process of the pancreas. A large gastroduodenal artery was encountered arising the suspicion of celiac trunk stenosis. The gastroduodenal artery occlusion test was negative, therefore, a pancreaticoduodenectomy was carried out. However, right after pancreatic resection, the liver, stomach, pancreatic remnant and spleen were noted to be pale and obviously ischemic. The reestablishment of celiac circulation was achieved by an end-to-end anastomosis between the middle colic artery and the gastroduodenal artery stump according to the previously published

technique (4). Liver, stomach and spleen promptly resumed their normal appearance. The patient had an uneventful recovery. Late postoperative Doppler ultrasound indicated normal celiac vascularization. The patient ultimately died of systemic recurrence of the pancreatic cancer two years after the operation.

Case 2: A 45-year-old man with chronic pancreatitis was admitted for pancreaticoduodenectomy. During operation, gastroduodenal artery was also enlarged and, as in the case described above, the gastroduodenal artery occlusion test was negative. Immediately after pancreatectomy, the upper abdominal viscera became ischemic. The celiac trunk circulation was reestablished by an end-to-end anastomosis between middle colic and gastroduodenal arteries. The patient presented pancreatic leakage with spontaneous resolution in immediate postoperative period. Late Doppler ultrasound showed normal celiac circulation. The patient is still alive six years after surgery.

Case 3: A 74-year-old man with a two-month history of abdominal pain, jaundice and weight loss was referred for treatment. Abdominal ultrasound disclosed a solid tumor in the head of the pancreas measuring 4cm associated to a dilated pancreatic duct



FIGURE 1 Intraoperative view of a latero-lateral anastomosis between superior mesenteric and common hepatic arteries with PTFE graft. Note the large peripancreatic collateral (arrow). pr: pancreatic remnant; pv: portal vein.

FIGURE 2

Schematic illustration of a latero-lateral anastomosis between superior mesenteric and common hepatic arteries with PTFE graft. The large collateral artery is indicated (large arrow). The superior mesenteric artery stenosis is shown (small arrow).

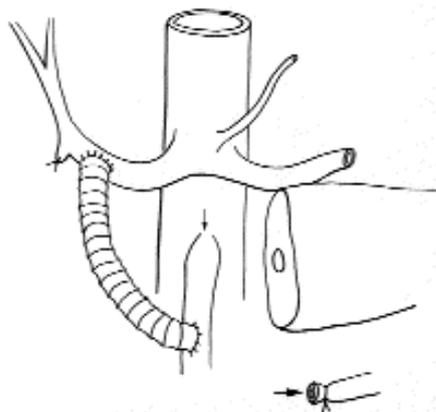


FIGURE 3 Angio CT scan shows a patent PTFE graft in the postoperative period.

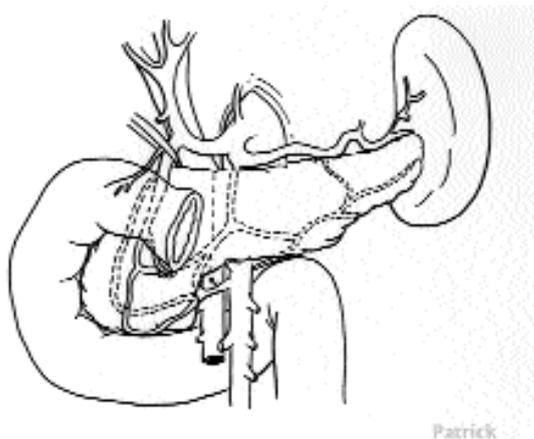


FIGURE 4 Illustration shows the gastroduodenal artery occlusion test and the arterial irrigation of the pancreas. The interrupted line over the pancreas indicates the point of pancreatic clamping (Figure 5).

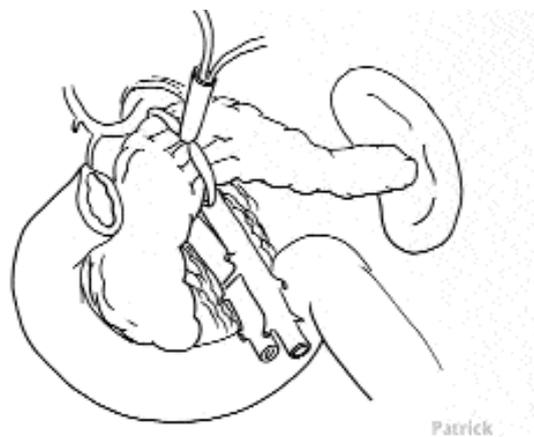


FIGURE 5 Pancreatic clamping is accomplished by placing a cardiac tape at pancreatic neck after the portal vein tunnel dissection. This maneuver should be complementary to the gastroduodenal artery occlusion test.

(10mm). CT scan showed a solid tumor in the head of the pancreas. The patient underwent a duodenopancreatectomy. During surgery, the gastroduodenal artery was enlarged which arose the suspicion of celiac trunk stenosis. The gastroduodenal artery occlu-

sion test was negative. However, immediately after pancreaticoduodenectomy, the entire bowel was noted to be ischemic. There was no pulse in the superior mesenteric artery. One branch of the superior mesenteric artery was opened and a Fogarty catheter was passed till the aorta, showing complete stenosis of the superior mesenteric artery ostium. We tried to use the middle colic artery but it was not suitable for an end-to-end anastomosis with the gastroduodenal artery as described earlier. Reestablishment of the superior mesenteric artery circulation with a venous or Polytetrafluoroethylene (PTFE) graft between this artery and the aorta was impossible due to the presence of a complete atherosclerotic and calcified aorta. A latero-lateral anastomosis between the superior mesenteric and common hepatic arteries was then performed with PTFE graft (**Figures 1 and 2**). The patient had an uneventful postoperative course. Postoperative CT scan showed a patent bypass (**Figure 3**). The patient is alive without any evidence of disease after 3 months of follow-up.

Technique

We propose a possible way of enhancing the gastroduodenal trial clamping test sensitivity by a concomitant temporary occlusion of the pancreatic flow. This is accomplished by placing a cardiac tape at the pancreatic neck after the portal vein tunnel dissection. *This maneuver objectivises the interruption of possible collateral pathways between vessels at pancreatic body and the splenic artery system*

(**Figures 4 and 5**).

All cases presented an abnormally large gastroduodenal artery and this finding strongly indicates the presence of an enlarged pancreatic collateral system, probably through pancreatic transverse arteries (**Figure 4**). In this situation, a detailed intraoperative search for celiac axis or superior mesenteric artery stenosis must be carried out.

DISCUSSION

Pancreaticoduodenectomy is the most effective treatment for periampullary neoplasms. Though, due to its technical challenges, few centers in the world have acquired large experience with acceptable morbidity and mortality rates (5). However, even in these centers complications may occur. One of the most dra-

matic intraoperative complications involves hepatic and mesenteric ischemia at the time of pancreatic resection. Celiac axis and superior mesenteric artery stenosis are frequently asymptomatic because the large pancreaticoduodenal arcades provide effective blood flow between the two vessels. During pancreaticoduodenectomy, when this collateral circulation is suddenly interrupted, severe organ ischemia takes place.

The importance of pre- and intraoperative maneuvers to identify these vascular abnormalities has been reported (1-3,6). Angiography by CT or MRI remains the best technique to map splanchnic vascular anatomy but is not routinely performed (6). Doppler ultrasonography has a limited role due its low specificity (7). The intraoperative gastroduodenal artery occlusion test has been considered in the literature as an effective test for the diagnosis of this arterial stenosis (1,3).

In all three presented cases the gastroduodenal artery clamping test was negative and ischemia was only noticed after pancreatic section, suggesting that in severe occlusions this test may fail in diagnosing the vascular abnormality.

The end-to-end middle colic and gastroduodenal artery anastomosis was an effective option of vascular bypass procedure in the first two cases of celiac trunk obstruction. The same technique could be equally efficient in the setting of superior mesenteric artery stenosis. Considering that in the majority of the cases stenotic mesenteric lesions occur in its aortic ostium, the retrograde filling of middle colic artery promptly reestablishes blood flow in mesenteric distal branches. This procedure may not be suitable in obese patients with a thick mesocolon and care must also be taken to avoid colonic devascularization during middle colic artery mobilization (4). In the third case where the abdominal aorta was extensively atherosclerotic and not suitable for an anastomosis and the middle colic artery was abnormally thin and could not be employed, a PTFE bypass graft was used between the common hepatic and superior mesenteric arteries. This procedure proved to be effective.

We conclude that the gastroduodenal artery occlusion test may not be effective in all cases and in cases with high suspicion of celiac axis or mesenteric stenosis, other maneuvers, such as pancreatic inflow test could be helpful for the diagnosis of these rare and morbid situations.

REFERENCES

- 1 **Berney T, Pretre R, Chassot G, Morel P:** Le risque ischémique en cas d'obstruction du tronc coeliaque chez les patients devant subir une duodenopancreatectomie. Enquete multicentrique et revue de la litterature. *Ann Chir* 1999; 53(4):273-279.
- 2 **Miyata M, Takao T, Okuda A, Sasako Y, Sunada S:** Pancreaticoduodenectomy for periampullary cancer associated with celiac occlusion: a case report. *Surgery* 1988; 103:261-263.
- 3 **Bull DA, Hunter GC, Crabtree TG, Bernhard VM, Putnam CW:** Hepatic ischemia, caused by celiac axis compression, complicating pancreaticoduodenectomy. *Ann Surg* 1993; 217(3):244-247.
- 4 **Machado MC, Penteado S, Montagnini AL, Machado MA:** An alternative technique in the treatment of celiac axis stenosis diagnosed during pancreaticoduodenectomy. *HPB Surg* 1998; 10(6):371-373.
- 5 **Cameron JL, Pitt HA, Yeo CJ, Lillemoe KD, Kaufman HS, Coleman J:** One hundred and forty-five consecutive pancreaticoduodenectomies without mortality. *Ann Surg* 1993; 217(5):430-435.
- 6 **Volpe CM, Peterson S, Hoover EL, Doerr RJ:** Justification for visceral angiography prior to pancreaticoduodenectomy. *Am Surg* 1998; 64(8):758-761.
- 7 **Roobottom CA, Dubbins PA:** Significant disease of the celiac and superior mesenteric arteries in asymptomatic patients: predictive value of Doppler sonography. *AJR Am J Roentgenol* 1993; 161(5):985-988.