

ORIGINAL ARTICLE

Impact of pancreaticoduodenal arcade dilation on postoperative outcomes after pancreaticoduodenectomy

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Abstract

Background: The aim of this study was to investigate the impact of pancreaticoduodenal arcade (PDA) dilation on postoperative outcomes after pancreaticoduodenectomy.

Methods: Consecutive patients submitted to pancreaticoduodenectomy between 2008 and 2016 underwent preoperative multi-detector computed tomography, the images of which were re-reviewed. The patients were categorized according to the grade of PDA dilation into 3 groups (remarkably-dilated, slightly-dilated, and non-dilated).

Results: Among the 443 patients, 25 patients (5.6%) were categorized as remarkably-dilated PDA and 24 patients (5.4%) as having slightly-dilated PDA. The patients with remarkably-dilated PDA had undergone pancreaticoduodenectomy with additional surgical maneuvers to restore celiac arterial flow as needed, and had an uneventful postoperative recovery relative to those with non-dilated PDA. In contrast, patients with slightly-dilated PDA underwent only pancreaticoduodenectomy without additional surgical maneuvers, and developed clinically relevant postoperative pancreatic fistula (POPF) more frequently than those with non-dilated PDA (42% vs. 21%, $P = 0.021$). Moreover, slightly-dilated PDA was shown to be an independent risk factor for clinically relevant POPF (odds ratio = 2.719, $P = 0.042$).

Discussion: For patients with PDA dilation requiring pancreaticoduodenectomy, a preoperative evaluation of the vascular anatomy, intraoperative assessment of the celiac arterial flow, and additional surgical maneuvers might be necessary to reduce the risk of postoperative complications.

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Introduction

The pancreaticoduodenal arcade (PDA) is an arterial anastomotic network between the superior mesenteric artery (SMA) and the celiac artery (CA) that provides a peripheral blood supply to the pancreatic head. In patients with celiac axis stenosis (CAS), antegrade blood flow from the CA is decreased, and retrograde blood flow from the SMA through the PDA is relatively increased to compensate for the loss of blood flow from the CA. As a consequence of this imbalance in blood flow, the PDA becomes dilated in patients with CAS.^{1–3} Most patients with CAS

are asymptomatic; however, in patients with CAS who require pancreaticoduodenectomy, the interruption of the PDA during the procedure can cause the discontinuation of the blood supply to the area originally maintained from the SMA through the PDA, leading to various postoperative complications.^{4–8}

Recent advances in multi-detector computed tomography (MDCT) have enabled CAS or PDA dilation to be detected more clearly; previously, these conditions could only be visualized using angiography, which is a more invasive imaging modality.^{1–5,9–11} However, several studies have demonstrated that the

diagnosis of CAS based only on MDCT is still unreliable because the contours of the CA are influenced by respiratory fluctuation and mild stenosis of the CA is hardly detected.^{10,12} Meanwhile, PDA dilation on MDCT can be consistently diagnosed by the visualization of the PDA between the SMA and CA, since the PDA is not normally visualized in healthy individuals.² Therefore, an MDCT finding of “PDA dilation”, instead of “CAS”, appears to reflect a pancreaticoduodenal hemodynamic alteration directly.¹⁰

Although several papers have investigated the pathophysiology or treatment strategy for patients with CAS,^{1–4,6–11,13–17} no previous studies have focused on the presence or grade of PDA dilation. Thus, a definition of PDA dilation has not been established. Moreover, the relationship between preoperative imaging findings of PDA dilation and postoperative complications after pancreaticoduodenectomy has not been evaluated. The aim of this study was to investigate the impact of PDA dilation on postoperative outcomes in patients who had undergone pancreaticoduodenectomy.

Methods

Patients

A total of 444 patients underwent pancreaticoduodenectomy for a periampullary tumor at the National Cancer Center Hospital East between June 2008 and July 2016. All the patients were preoperatively examined using contrast-enhanced MDCT of the abdomen. Of those 444 patients, one patient with SMA stenosis was excluded. The clinicopathological data were reviewed from the medical records. The indications and surgical strategy for individual patients were discussed and decided through multidisciplinary conferences involving surgeons, oncologists, and

radiologists. This study protocol was approved by the institutional review board of the National Cancer Center, Japan.

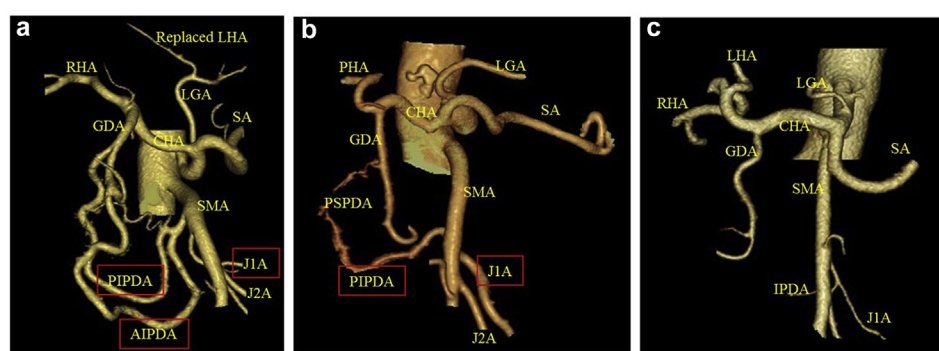
Detection of PDA dilation or CAS and definitions of PDA dilation grades

The images from preoperative 2-mm sliced contrast-enhanced MDCT (Aquilion; Toshiba Medical Systems Corporation, Ohtawara, Japan) were evaluated retrospectively for all the patients. PDA dilation was defined as complete visualization (continuity) of the arterial communication between the inferior pancreaticoduodenal artery (IPDA) and the gastroduodenal artery (GDA) on both 2-mm sliced axial and coronal arterial phase images. In all the patients whom PDA dilation was detected using MDCT, the presence of CAS was evaluated using multiplanar reformatted imaging. The rate of stenosis of the CA was measured using digital calipers and was quantified as a percentage relative to the diameter of the normal CA.

The grade of PDA dilation was categorized as “remarkably-dilated PDA”, “slightly-dilated PDA”, or “non-dilated PDA” based on the comparison of the vascular diameters between the PDA and a root of the first jejunal artery (J1A), as shown in Fig. 1. During the study period, all the cases with remarkably-dilated PDA were noted preoperatively during multidisciplinary conferences; however, none of the slightly-dilated PDA cases were noted preoperatively. All the MDCT images were re-reviewed by an experienced radiologist (T.K.) who was blinded to the clinical course of the study patients.

Definition of postoperative complications

All postoperative complications occurring within 90 days after surgery were recorded. If a patient required readmission because of any postoperative complication including those after 90



CHA, common hepatic artery; PHA, proper hepatic artery; RHA, right hepatic artery; LHA, left hepatic artery; GDA, gastroduodenal artery; LGA, left gastric artery; SA, splenic artery; SMA, superior mesenteric artery; IPDA, inferior pancreaticoduodenal artery; J1A, first jejunal artery; J2A, second jejunal artery; AIPDA, anterior inferior pancreaticoduodenal artery; PIPDA, posterior inferior pancreaticoduodenal artery; PSPDA, posterior superior pancreaticoduodenal artery

Figure 1 The grade of the pancreaticoduodenal arcade (PDA) dilation was determined by comparing the vascular diameters of the branches of the inferior pancreaticoduodenal artery (IPDA) (anterior IPDA or posterior IPDA) and the first jejunal artery (J1A). (a): If the diameter of the branch of the IPDA was greater than that of the J1A, it was categorized as “remarkably-dilated PDA”. (b): If the diameter of the branch of the IPDA was smaller than that of the J1A, it was categorized as “slightly-dilated PDA”. (c): No visualization of the PDA was classified as “non-dilated PDA”

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