The radiographic assessment of extent of tumor burden and local vascular invasion appears to be enhanced with three-dimensional computed tomography (3D-CT). The purpose of this study was to evaluate the impact of preoperative 3D-CT in determining the resectability of patients with periampullary tumors. Intraoperative findings from exploratory laparotomy were gathered prospectively from 140 patients who were thought to have periampullary tumors and were deemed resectable after undergoing preoperative 3D-CT imaging. CT findings were compared to intraoperative findings, and the accuracy of 3D-CT in predicting tumor resectability and, ultimately, the likelihood of obtaining a margin-negative resection were assessed. Of the 140 patients who were thought to have resectable periampullary tumors after preoperative 3D-CT, 115 (82%) were subsequently determined to have periampullary cancer. The remaining 25 patients had benign disease. Among the patients with periampullary cancer, the extent of local tumor burden involving the pancreas and peripancreatic tissues was accurately depicted by 3D-CT in 93% of the patients. 3D-CT was 95% accurate in determining cancer invasion of the superior mesenteric vessels. Preoperative 3D-CT accurately predicted periampullary cancer resectability and a margin-negative resection in 98% and 86% of patients, respectively. For patients with pancreatic adenocarcinoma (n = 85), preoperative 3D-CT resulted in a resectability rate and a margin-negative resection rate of 79% and 73%, respectively. The ability of 3D-CT to predict a margin-negative resection for periampullary cancer, including pancreatic adenocarcinoma, relies on its enhanced assessment of the extent of local tumor burden and involvement of the mesenteric vascular anatomy. (J GASTROINTEST SURG 2004;8:280–288) © 2004 The Society for Surgery of the Alimentary Tract

KEY WORDS: Periampullary cancer, computed tomography, vascular invasion, resection

Although several imaging modalities are available to evaluate patients with suspected periampullary tumors, including endoscopic ultrasound, endoscopic retrograde cholangiopancreatography, and magnetic resonance imaging (MRI), computed tomography (CT) has evolved as the predominant, single modality for diagnosis and preoperative staging. Many patients with neoplasms arising from the periampullary region, especially pancreatic adenocarcinoma, present with advanced disease that is not amenable to curative resection. Although the surgical management of localized periampullary cancer has
improved over the past two decades, less than 20% of patients with pancreatic adenocarcinoma will have resectable disease at the time of initial diagnosis. In patients with pancreatic cancer, preoperative thin-section, contrast-enhanced CT, when used alone, can accurately predict tumor resectability in 70% to 88% of patients.

The radiographic findings on dual-phase, contrast-enhanced CT that predict unresectability for periampullary tumors include distant extrapancreatic spread, ascites, encasement of the superior mesenteric artery, and occlusion of the superior mesenteric vein–portal vein confluence. Despite the reliability of dual-phase, contrast-enhanced CT to assess extrapancreatic involvement, its accuracy for predicting sublocal vascular invasion remained unreliable until the introduction of multidetector CT technology. This latter technology can be used to generate detailed, volume-rendered helical CT data that can be processed and displayed in three dimensions. Consequently three-dimensional computed tomography (3D-CT) enhances the assessment of vascular invasion by allowing periampullary structures to be viewed in image planes that correspond to the oblique orientation of the pancreas within the retroperitoneum.

Several studies have investigated the accuracy of CT in staging periampullary cancer and predicting tumor resectability. Different scanning techniques and varying degrees of experience with later-generation devices make it difficult to compare CT results between large-volume centers. Also, the designation of unresectability has been poorly defined, particularly by surgeons who advocate aggressive resection even with extensive portal vein involvement.

The goal of preoperative evaluation of periampullary tumors is to identify patients who will most likely achieve a survival benefit as a result of operative intervention. The ultimate goal of preoperative imaging is to predict which patients will eventually undergo a margin-negative resection. Therefore this single-institution, prospective study was performed to evaluate the accuracy of 3D-CT in determining resectability for periampullary neoplasms and specifically for predicting a margin-negative pancreaticoduodenal resection.

MATERIAL AND METHODS

Patients

After obtaining permission from the Johns Hopkins University institutional review board, we began a prospective study to assess patients who were first seen with periampullary lesions at our institution between September 2001 and December 2002. Patients were eligible for enrollment if they underwent surgical exploration for a suspected periampullary mass detected on preoperative imaging with 3D-CT. Intraoperative findings from exploratory laparotomy, performed with intent to proceed to pancreaticoduodenal resection, were then gathered prospectively for 140 patients who were deemed resectable after undergoing preoperative 3D-CT at our institution. Among the patients who were evaluated with 3D-CT preoperatively, the average age was 64 years (range 26 to 87 years), and approximately half of the patients (52%) were male.

Three-Dimensional CT Technique

All 3D-CT studies were performed at The Johns Hopkins Hospital with a Somatom Plus-4 scanner (Siemens, Iselin, NJ) according to a standard protocol. Patients received 750 ml of water 30 minutes prior to helical CT scanning. Scan slices 3 mm thick were acquired 30 seconds (arterial phase) and 60 seconds (venous phase) after the intravenous infusion of 100 to 125 ml of Omnipaque-350 (Nycomed, New York, NY) at 2 to 3 ml/sec. Scanning data were transferred for reconstruction using Reality Engineering software (Silicon Graphics, Mountain View, CA), and images were interpreted by one of two senior radiologists (K.M.H. or E.K.F) who had extensive experience with three-dimensional pancreatic imaging. After retrieving the three-dimensional images from the Reality Engineering software program, radiologists required approximately 5 minutes to interpret the final 3D-CT scans.

CT Interpretation

Two radiologists (K.M.H. and E.K.F) reviewed all of the preoperative 3D-CT scans prior to surgical exploration and prospectively recorded their interpretations for tumor size, location, peripancreatic spread, distant metastases, regional lymphadenopathy (measuring at least 5 mm), and degree (percentage of vessel circumference) of tumor infiltration/encasement into adjacent major vessels (including the superior mesenteric artery (SMA), hepatic artery, celiac axis, superior mesenteric vein (SMV), and portal vein (PV)). The presence of anomalous arterial anatomy was also recorded.

Preoperative imaging with 3D-CT was interpreted as demonstrating a resectable tumor if there was no radiographic evidence of metastatic disease, a clear tissue plane between the tumor and SMA, and ≤180° circumferential involvement of the SMV–PV confluence. Patients with unequivocal metastases to the liver, ascites, invasion into the SMA, or total occlusion...