Diagnostic Accuracy of MRI for Preoperative Staging of Pancreatic Carcinoma: Tendency for Understaging

T.A. BLEY1, M. UHL1, P. SIMON2, J. MAYERLE2, N.A. GHANEM1, B. GEML1, U. SAUERESSIG1 and M. LANGER1

1Department of Diagnostic Radiology, University-Hospital, Freiburg; 2Department of Gastroenterology, Endocrinology and Nutrition, Ernst-Moritz-Arndt-Universität, Greifswald, Germany

Abstract. Objective: To evaluate the diagnostic accuracy of magnetic resonance imaging (MRI) for preoperative staging in pancreatic carcinoma. Materials and Methods: MRI investigations, including MR-angio and MR-cholangiopancreatography (MRCP) of 19 patients who underwent surgery for pancreatic carcinoma were retrospectively evaluated by two radiologists. The size, localization of the tumor and possible infiltration of neighboring organs, as well as the presence of enlarged lymph nodes, were determined to define a preoperative, radiological TN stage. Lymph node metastasis was defined as peripancreatic lymphoma greater than 10 mm. Our findings were correlated to postoperative diagnosis. Results: The T-stage was correctly evaluated in 52.6% of the cases (10/19). Understaging took place in 31.6% (6/19) and overstaging in 15.8% (3/19). In three cases of understaging, a micro-infiltration of the peripancreatic tissue was not visible in MRI. Pathologically enlarged lymph nodes were correctly found in 63.2% of the cases (12/19). Overstaging took place in 21.1% of the cases (4/19) and understaging in 15.8% (3/19). Conclusion: MRI for preoperative staging of pancreatic carcinoma showed a tendency to understage tumor size in this study population. Especially in cases of small tumor size, micro-infiltration of peripancreatic tissue or the common bile duct may not be detected by MRI. Concerning N-stage, the 95% confidence interval reveals a distribution of over- and understaged.

Pancreatic cancer is a disease with poor prognosis, being the fourth most common cause of cancer-related deaths in Western countries (1). Ninety percent of all pancreatic cancers are histologically ductal adenocarcinomas that are associated with a poor median survival of less than 6 months in patients with unresectable tumors (2). The main reason for the poor prognosis of pancreatic cancer is its tendency to form early metastases before clinical symptoms arise and before the tumor is detectable by diagnostic imaging techniques. Therefore, detection of pancreatic cancer in an early stage with small tumor size and absence of metastases is needed for potential cure with surgery (3). However, in 80% of patients with pancreatic cancer, only palliative treatment options are available (4). In order to determine surgical respectability and, therefore, the patient’s prognosis, a correct staging of the tumor including possible infiltration of neighboring organs and the presence of metastases is crucial. A combination of magnetic resonance imaging, MR-angiography and three-dimensional MR-cholangiopancreatography (MRCP) gives information about diagnosis, tumor stage and assessment of resectability in a single MR investigation of less than 45 min acquisition time (5). Recently, many studies have been published which compared the diagnostic value of CT and MRI in detecting pancreatic carcinoma. These demonstrated the good diagnostic sensitivity and specificity of both methods (6-8). However, some authors claim that MRI-technology will replace most other staging methods because of the possibility to avoid endoscopy, vascular cannulation, allergic reactions and X-radiation (9).

The aim of this study was to evaluate the diagnostic accuracy of MRI for preoperative staging in histologically proven pancreatic carcinoma. The focus was set on pancreatic carcinoma of an early and surgically treatable stage.

Materials and Methods

Patients. The study population consisted of 19 patients (eight female, eleven male; age range = 47-76 years, mean age = 62.8 years) with histologically proven and surgically treatable pancreatic carcinoma. Patients with an advanced, initially non-resectable tumor stage were not included in the study. All patients underwent preoperative staging investigations by MRI. All patients were preoperatively evaluated as surgically treatable and underwent...
resection of the pancreatic carcinoma within 6-42 days (mean = 16 days) after the MRI examination.

**Magnetic resonance imaging.** MRI was performed using a 1.5T superconducting magnetic resonance unit (Magnetom Vision or Symphony, Siemens AG, Erlangen, Germany). A standard phased-array coil with four elements (Siemens Medical Systems) was used. The following sequences were acquired: Axial T2-weighted turbo-spin-echo (TSE) in breath hold technique (TE 138, TR 2900, slice thickness 6 mm, one acquisition, field of view (FOV) 215x350, matrix 116x256, TA 0:15 min); axial T1-weighted spoiled gradient echo 2D (TE 4.1, TR 94, slice thickness 6 mm, one acquisition, FOV 215x350, matrix 116x256, TA 0:15 min) before and after application of gadopentetate dimeglumine intravenously (i.v.) in a dose of 0.1 mmol/kg (either Magnevist, Schering or Omniscan, Nycomed); coronal T2-weighted TSE (TE 125, TR 4275, slice thickness 6 mm, one acquisition, FOV 215x350, matrix 116x256, TA 0:15 min); coronal T1-weighted TSE (TE 4.1, TR 86, slice thickness 6 mm, one acquisition, FOV 215x350, matrix 116x256, TA 0:15 min) before and after application of i.v. contrast agent.

MRCP images were acquired with half-Fourier single-shot TSE sequences (flip angle of 180°, matrix size of 256 x 240, acquisition time of 2 seconds per section) (10). The total examination time (patient-in-room-time) was approximately 35-40 minutes.

**Image analysis.** Two radiologists, with thorough experience in diagnostic radiology (mean 7.5 years), retrospectively evaluated the MRI scans in a consensus methodology. Both readers had no previous knowledge of the cases, and neither knew the results of other studies such as ERCP and angiography. Histological findings were used as gold standard for an intra-individual comparison with the radiological findings concerning tumor size and occurrence of lymph node metastases.

According to the TNM Classification of the International Union Against Cancer (UICC), T- (tumor) and N-stages (lymph node) were determined. Therefore, the localization and size of the tumor were evaluated as well as the presence of infiltration of neighboring organs. A tumor of less than 2 cm restricted to the pancreas revealed stage T1, a tumor greater than 2 cm restricted to the pancreas revealed stage T2. If the tumor directly infiltrated the duodenum, the common bile duct or peripancreatic fatty tissue, a stage T3 was found. Infiltration of the stomach, colon and/or mesenteric vessels led to stage T4 (Figure 1). Tumor size was measured using axial or coronal T1-w imaging.

In order to determine the N-stage, peripancreatic lymph nodes of 10 mm or greater were evaluated as pathologically enlarged. If no regional lymph node was enlarged stage N0 was diagnosed. A single enlarged regional lymph node revealed stage N1a, multiple enlarged lymph nodes led to stage N1b.

Integrity and possible congestion of the pancreatic duct and common bile duct were evaluated using MRCP imaging.

**Results**

**Histological findings.** According to the pathological findings 84.2% of the pancreatic tumors were adenocarcinomas (16/19), 10.5% were adenosquamous carcinomas (2/19), and in 1 case (5.3%) a papilla carcinoma was diagnosed; 15.8% of the tumors (3/19) were highly-differentiated, resulting in G1 grading; 57.9% (11/19) were intermediate-differentiated G2 and 26.3% (5/19) were poorly-differentiated leading to G3 grading (Table I).

In 89.5% (17/19) of the cases, the tumor was located in the head of the pancreas, while in 10.5% (2/19) it was located in the body. No pancreatic mass occurred in the tail of the pancreas in the study population.


**Discussion**

The poor prognosis of pancreatic cancer may be improved by earlier detection of the disease. The aim of this study was to evaluate the accuracy of MRI for preoperative staging of pancreatic carcinoma with a focus on surgically resectable carcinomas.
Figure 1. Contrast-enhanced axial (right) and coronal (left) T1-weighted fat-saturated MRI shows pancreatic mass of more than 2 cm (arrows), tumor invasion in the peripancreatic fatty tissue (arrowhead) and the congested common bile duct (bold arrow) are clearly visible (UICC T4-stage). Histology revealed a pT4-Stage.

Figure 2. Contrast-enhanced axial (top row) and coronal (bottom row) T1-weighted fat-saturated MRI shows pancreatic mass of less than 2 cm (arrows), peripancreatic tumor invasion is not detectable (radiological UICC T1-stage). Histology revealed micro-focal infiltration of peripancreatic fatty tissue leading to a pT3-Stage. Please note the congested pancreatic duct (arrowhead).
The results show a tendency for understaging concerning T-stage. In 3 cases, severe radiological understaging took place compared to the histological gold standard: in all 3 cases a pT3-stage carcinoma was determined to be a T1-stage tumor by MRI findings. A closer look at the TNM staging of the IUCC criteria may explain this severe discrepancy: a carcinoma less than 2 cm within the pancreatic head is considered stage T1. If infiltration of the common bile duct or peripancreatic tissue is found, the tumor is determined as T3 stage, regardless of size. Tiny micro-infiltration may not be detectable in MRI and may not result in changes of the MRCP appearance of the common bile duct. In such cases understaging would occur.

In 3 cases of our study population, the tumor was less than 2 cm, and a micro-infiltration of the peripancreatic fatty tissue was not detectable in MRI. These tumors were staged as T1 in MRI, but histology revealed pT3 (Figure 2). Nishiharu et al. prospectively evaluated MRI examinations of patients suspected of having pancreatic cancer. As a secondary study objective, they evaluated the detection of peripancreatic tumor invasion. Concerning this matter, their two observers had a sensitivity of 75% and 87% and specificity of 63% and 64%, respectively (12). Since our study was a retrospective evaluation, we did not calculate sensitivity and specificity. The 3 severely understaged cases, however, indicate that we encountered the same problems leading to low specificity: in cases of small tumor size, MRI may not reveal any peripancreatic tissue alterations at all. If irregular signal intensity of the peripancreatic tissue is found, it may be difficult or even impossible to differentiate peripancreatic tumor infiltration from desmoplastic reaction. Furthermore, chemical shift artefacts between pancreas parenchyma and peripancreatic fatty tissue as well as motion-, pulsation- and susceptibility artefacts may impair the image quality of MRI.

No case of undetectable micro-infiltration of the common bile duct was encountered in our study population. Nevertheless, this may be another reason for falsely staging a pT3 tumor as T1-stage in MRI. More severe understaging would take place if micro-infiltration of the portal vein or the superior mesenteric vessels was overseen. Infiltration of the major vessels would lead to a T4 stage. If surgery is performed by experienced surgeons, infiltration of the portal or superior mesenteric vein is not a criterion for non-resectability (13), nevertheless, it appears to mean a poorer prognosis for the patient’s outcome (14). Therefore, the question of infiltration of the major mesenteric vessels and the portal vein is most crucial for the surgeon.

References


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