

## Clinical Studies



# State of the Art 3D MR-Cholangiopancreatography for Tumor Detection

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**Abstract.** *With the use of current multislice techniques for MR cholangiopancreatography various upper abdominal pathologies including pancreatic carcinoma, Klatskin tumor and metastatic spread can be non invasively depicted. Respiratory gating allows free breathing of the patient, which increases patient comfort, while excellent image quality can be achieved. In this concise pictorial report, state of the art MRCP images of various cancer entities including sequence descriptions are presented.*

Magnetic resonance (MR) cholangiopancreatography has become a valuable method for noninvasive diagnostic work-up of biliary and pancreatic disease including various tumor entities (1). Since 1991, a variety of T2-weighted fast spin echo sequences have been applied in a multitude of obliquities in order to depict the intra- and extra hepatic bile ducts and the pancreatic ducts (2-6). In order to further improve this technique, in particular to increase the T2 signal, an evaluation was made of a novel three-dimensional (3D) non-breath-hold turbo spin echo (TSE) sequence with restore magnetization pulse followed by post-processing of the data set using multiplanar thin maximum intensity projection (MIP). With this concise pictorial report, we provide state of the art MRCP images of various cancer entities including detailed information of how these images were obtained.

## Materials and Methods

A novel multislice technique for MR cholangiopancreatography was investigated in five patients with various upper abdominal pathologies including pancreatic carcinoma, Klatskin tumor and

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metastatic spread. MR cholangiopancreatography was performed at 1.5 T (MAESTRO CLASS, Siemens, Erlangen, Germany) with a phased-array body coil. All patients were placed in a supine head-first position with the coil centered on the upper abdomen. Neither bowel preparation nor *i.v.* injection of butylscopolamine or morphine were conducted. The parameters of the tested 3D respiratory-gated T2-weighted TSE sequence with restore magnetization pulse (Siemens, Erlangen, Germany) were the following: TR/TE 1.630/687 ms, slice thickness 1.0 mm, slab 1, slices per slab 60, FoV 300x300 mm<sup>2</sup>, base resolution 256, phase resolution 94%, flip angle 180°, averages 1, acquisition time approximately 5 min, voxel size 1.2x1.2x1.0 mm<sup>3</sup>.

For optimal image quality, it is mandatory that the navigator for respiratory gating is placed with its center over the dome of the diaphragm. Using this technique, free breathing during the entire examination is possible. For post-processing, thin maximum-intensity-projections (MIP) were obtained with interactive image rotation.

## Results

In two patients, pancreatic carcinoma was diagnosed (Figure 1 A,B). One patient had multiple stones within the pancreatic ducts due to chronic pancreatitis and gallstones (Figure 2 A-D). One patient suffered from a Klatskin tumor (Figure 3 A, B). One patient developed metastatic spread from rectal cancer to the bilio-digestive anastomosis after right hemihepatectomy (Figure 4). The 3D-volume rendering technique (Figure 5) demonstrated high-grade stenosis of the pancreatic duct and bile ducts in a patient with pancreatic carcinoma.

In all cases, the novel three-dimensional TSE sequence with restore magnetization pulse depicted the biliary and pancreatic ducts with excellent image quality without motion artifacts.

## Discussion

MR cholangiopancreatography has become a competitive replacement for invasive imaging techniques in a wide variety of pancreatic and biliary applications (5, 7-9). Silva *et al.* (1) routinely used a non-breath-hold three-dimensional

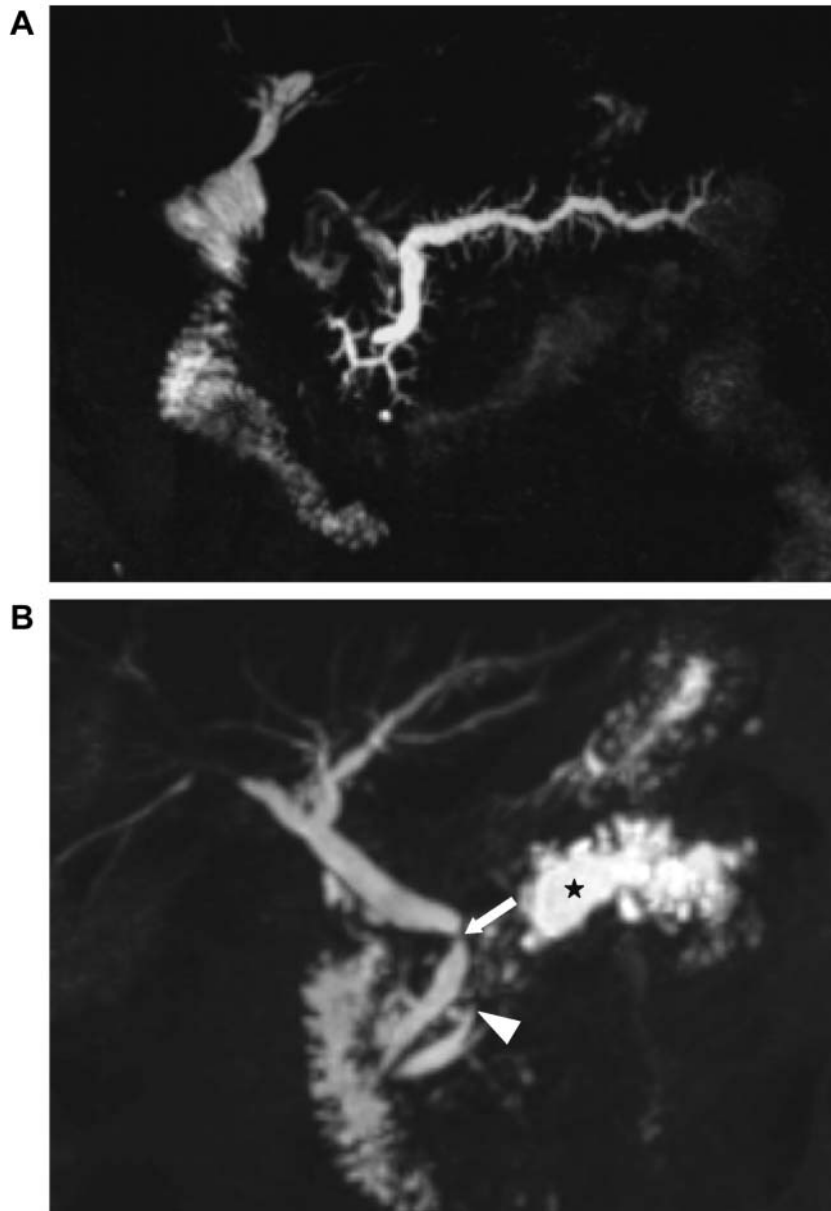


Figure 1. Respiratory-gated 3D T2-weighted TSE with restore magnetization of two patients with histologically proven carcinoma of pancreatic head. (A) MRCP from a 49-year-old man. Oblique coronal thin MIP detects dilatation of the congested major pancreatic duct and its branches distal to tumor stenosis. (B) MRCP from a 72-year-old woman, 20 mm thin MIP reveals tumor occlusion of the major pancreatic duct (arrowhead) and stenosis due to tumor infiltration of the common bile duct (arrow). Note congestion of distal parts of pancreatic ducts (asterisk).

turbo spin echo pulse sequence with a flip angle of  $90^\circ$ . We investigated the feasibility of a novel non-breath-hold three-dimensional MR cholangiopancreatography sequence. The tested modified turbo spin echo sequence for T2-weighted imaging provided an increased signal with low relaxation times (e.g. fluid within the biliary and pancreatic ducts) by applying an additional  $90^\circ$  RF pulse ("restore pulse") at the end of the echo train. Thus, the transverse magnetization

was flipped back into the longitudinal direction which consecutively shortened the spin relaxation time. Therefore, shorter TRs can be used and the acquisition speed can be increased. This technique is well suited for three-dimensional scans with a wide slice coverage over the liver and the pancreas. For three-dimensional scans, it is recommended that TRs greater than 500 ms be used to achieve a good fluid signal. The longer the TR, the more

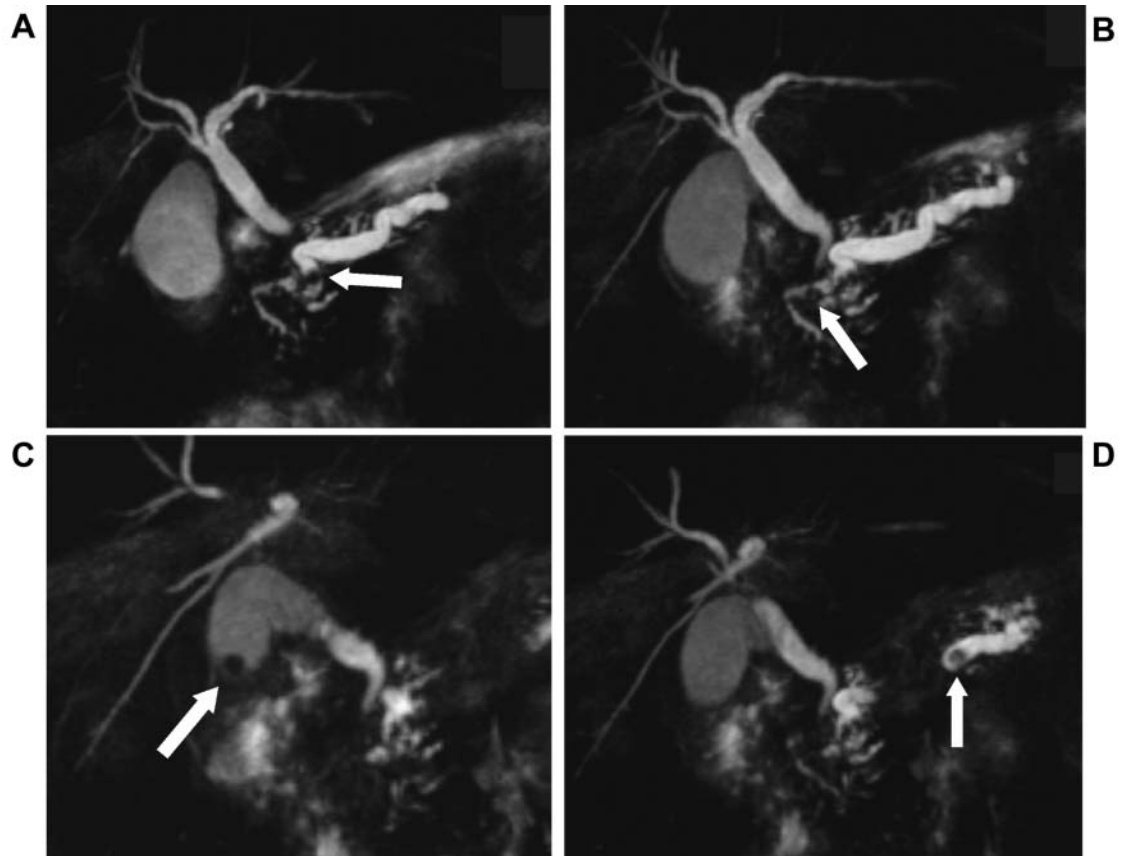


Figure 2. A 33-year-old man with chronic pancreatitis. (A) Respiratory-gated 3D T2-weighted TSE sequence with restore magnetization after coronal 20 mm thin MIP reconstruction shows enlargement of the pancreatic duct within the body and tail. A stone can be seen within the uncinus process (arrow). (B) A second stone is located in the dilated portion of the duct of the pancreatic head (arrow). (C) Another stone is located in the dilated portion of the duct of the pancreatic body (arrow). (D) Additionally, a gallstone can be seen (arrow).

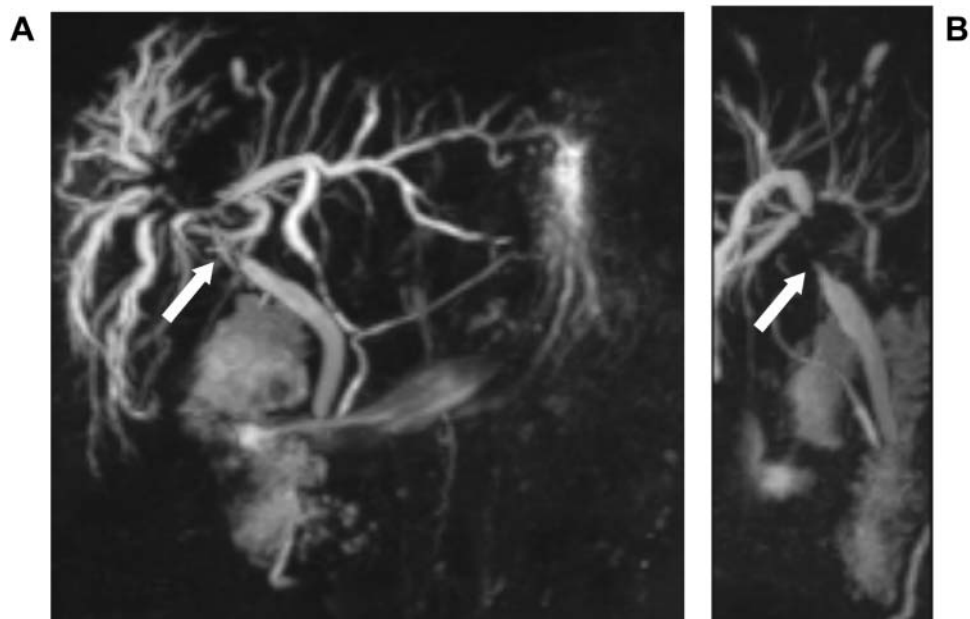


Figure 3. MRCP from a 62-year-old woman with a histologically proven Klatskin tumor. (A) MIP with 100 mm image thickness depicts dilated intrahepatic biliary system due to tumor stenosis (arrow). (B) Oblique sagittal reconstruction clearly depicts concentric stenosis of confluence of hepatic ducts (arrow).

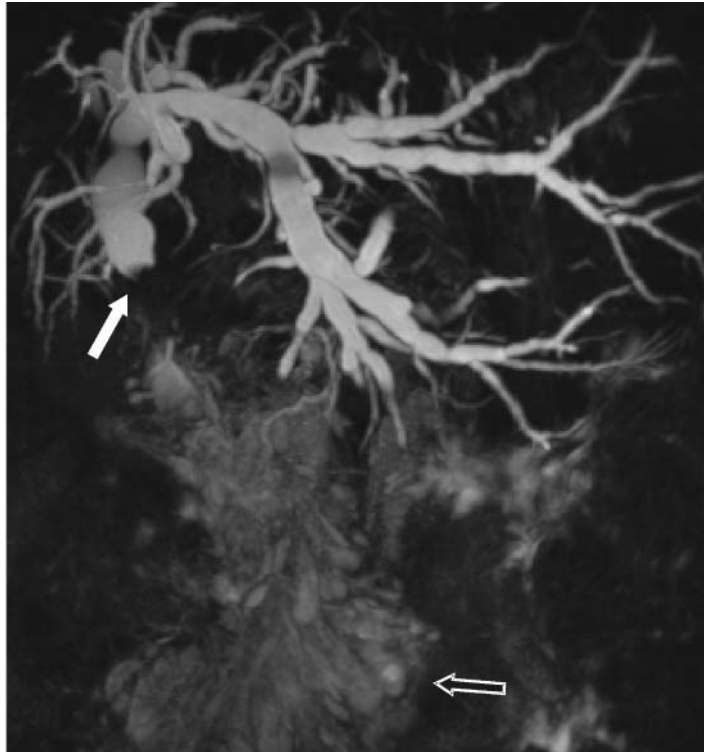


Figure 4. MRCP from a 47-year-old man with metastasis from rectal cancer. Metastatic occlusion of the bilio-digestive anastomosis (bold arrow) one year after right hemihepatectomy. Hepatic ducts are dilated extensively. Note high signal intensity masses within mesenteric fatty tissue due to peritoneal carcinosis (light arrow).



Figure 5. MRCP from a 63-year-old patient with carcinoma of the pancreatic head, distant from the papilla Vateri. The tumor involves the main bile duct. The volume rendering image (VRT) derived from the source data demonstrates high-grade stenosis of the main pancreatic and bile ducts.

T2-weighted the image contrast becomes, which is of great interest when imaging the biliary system.

The standard method of displaying multislice techniques involves subjecting the data-set to a maximal-intensity-projection algorithm in which only the pixel with the highest intensity along a ray perpendicular to the plane of projection is displayed (5). Post-processing of the novel 3D respiratory-gated T2-weighted TSE sequence with restore magnetization pulse is also based on MIP reconstructions. We therefore recommend thin MIP reconstruction of the data-set with interactive image rotation to directly emphasize pathology.

Further clinical evaluation of this new technique for MR cholangiopancreatography is warranted.

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