Post surgical injury in the biliary tract: MR imaging with Gd-EOB-DTPA enhanced.

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Learning objectives

Describe the usefulness of hepato-specific contrast Gd-EOB-DTPA enhanced MR cholangiography in the diagnosis of postsurgical lesions in the bile duct illustrating examples obtained in the care activities of our center.
Background

The diagnosis of iatrogenic injuries (post-operative) on biliary tract is often performed traditionally observing persistent secretion of bile from a drainage together with clinical associated of pain, fever and jaundice.
Findings and procedure details

Gd-EOB-DTPA

The hepatocyte-specific contrast agent Gd-EOB-DTPA (gadolinium ethoxybenzyl diethylenetriamine pentaacetic acid) has been developed to improve the detection and characterization of focal liver lesions at magnetic resonance (MR) imaging and the biliary excretion of this agent may be used to evaluate the anatomic structure and function of the biliary tree.

Gd-EOB-DTPA is a conventional nonspecific extracellular contrast agent with highly water-soluble properties and additional property of hepatocyte-specific agent.

Gd-EOB-DTPA readily enters hepatocytes via an organic anion transport system (adenosin triphosphate-dependent organic anion transporting polypeptide 1) and is excreted into the biliary canaliculi by an adenosine triphosphate-dependent glutathione S-transferase that requires adenosine triphosphate for activity. Because of its property of metabolism with partial biliary excretion, Gd-EOB-DTPA has the potential to be a biliary contrast agent.

Intense enhancement of biliary tree has been reported to begin as early as 10 min after contrast material administration in healthy volunteers, and a 20-min delay after Gd-EOB-DTPA injection was reported to be sufficient for biliary evaluation. It must be considered that Gd-EOB-DTPA uptake is mediated by the same transporter that bilirubin transport, hepatocellular phase enhancement and biliary excretion tends to be less intense in patients with hyperbilirubinemia. Because that, in patients with biliary obstruction or diminished hepatobiliary function the contrast agent is excreted much more slowly through the biliary tract making much longer the MR exploration (20-30 min after Gd-EOB-DTPA administration) and subtracting sensitivity because of the poor or naught opacification of the biliary tract. Gd-EOB-DTPA is eliminated in the non-metabolized form in approximately equal proportions via biliary excretion and renal glomerular filtration with subsequent excretion in urine.

Ours protocol for MR cholangiopancreatography with Gd-EOB-DTPA consists in sequences T1-weighted fat saturated GRE and T2-weighted fast spin-echo MR cholangiopancreatography before the injection of contrast agent and sequences after contrast injection, T1-weighted fat suppression arterial, portal and delayed phases GRE, T2-weighted fast spin echo with and without fat saturation, and T1-weighted fat suppression hepatocellular phase GRE in axial and coronal planes 20 minutes after injection.

Hepatobiliary-specific contrast agent for imaging the biliary tree
Contrast enhancement T1-weighted MR cholangiography can be used with conventional T2-weighted MR cholangiopancreatography for postoperative assessment, functional assessment, problem solving in injury of the biliary tract and anatomic special variants. (Figure 1)

**Imaging of iatrogenic injury of the biliary tract**

Iatrogenic injury of the biliary tract especially after laparoscopic cholecystectomy or others kinds of mayor surgery like pancreaticoduodenectomy (Whipple procedure), biliary-enteric anastomosis, mayor liver resection and liver transplantation, is a complex problem for both surgeons and patients.

Most of these lesions are secondary from a laceration, occlusion without tissue loss, thermal injury from electrocautery or ligature of common bile duct confused for the cystic duct. Sometime, is possible that a bile leaks can be seen after traumatic episode.

In fact it is possible that these kinds of complications often are not detected during the surgical procedure and are suspected in the early post operative period, secondary to persistent and profuse bile secretion from a surgically placed drain or clinical observations like jaundice appearance and / or enzymes alterations.

Before images assesment is important to dispose of a surgical report where the surgical procedure and possible incidences are details.

For the detection of biliary leakage, cross-sectional traditional imaging studies including ultrasound, computed tomography and magnetic resonance cholangiopancreatography are employed.

Although these imaging techniques provide highly suggestive findings for a diagnosis of biliary leaks in an appropriate clinical setting, they generally provide non-specific findings ,as well as the presence of a fluid collection in the gallbladder bed or perihepatic region and ascites .

Invasive techniques like percutaneous transhepatic cholangiography (PTC) and endoscopic retrograde cholangiography (ERC) have traditionally been used for the evaluation of bile duct injuries and occasionally its realization is required to confirm the diagnosis by demonstration of active contrast extravasation from the biliary tree.

MR cholangiography enhanced by Gd-EOB-DTPA is an accurate noninvasive technique for assessing bile duct injuries after surgery. In particular, this technique improves the identification and localization of the bile extravasations and allows exact definition of the level of the biliary injury .
Gd-EOB-DTPA-enhanced MR cholangiography allows detection of active bile leakage by direct visualization of contrast material into fluid collections, as well as describing the anatomic site and communication of the leakage from biliary tree. (Figures 2 to 6).

Extravasations of bile can be detected by their characteristic of increase signal such as contrast-enhanced biloma and/or fistula formation. (Figures 7 and 8).

MR cholangiography enhanced by Gd-EOB-DTPA in the study of possible post surgical iatrogenic lesions, allows establish with complete safety difference between a biloma from other hepatic space-occupying lesions like abscess, hematomas or cysts, this differentiation is critical to therapeutic decision making. On delayed post contrast images, the diagnosis of biloma is realized when contrast extravasation is seen through the biliary tree, a finding that is not displayed in the other injuries mentioned. (Figures 9 to 15).

In the evaluation of biliary-enteric anastomosis with this technique is also possible to distinguish, between integrity of sutures, small leakages or complete dehiscence sutures. (Figures 16, 17 and 18).

The main limitation of contrast enhanced MR cholangiography to consider is for the metabolism reasons explained above. In patients with obstructive jaundice and decreased liver function in which due to the metabolism of agent contrast, the excretion of the Gd-EOB-DTPA can be poor and the exploration can results difficult to assess. In cases of high-grade obstruction or hepatic dysfunction no excretion may occur. (Figures 21 and 22).

Another limitation of contrast enhanced MR cholangiography is that it is only a diagnostic procedure and has no therapeutic potential. In current clinical practice patients with a bile leak without significant major duct injury usually only require interventional radiological recourses like placement of a plastic stent, external drainage of the biloma or endoscopic retrograde cholangiopancreatography (ERCP) with sphincterotomy. Conversely a major bile duct injury with significant bile leak normally needs surgical biliary reconstruction if possible and in the most serious cases liver transplantation.
**Fig. 1:** MIP reconstruction of MR colangiography performed with gadoxetic acid show a normal biliary tract.

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Fig. 2: 53 years old male patient, postsurgical cholecystectomy 15 days earlier. T1 weighted fat suppression 15 min after administration of gadoxetic acid, axial (a. image number 2) and coronal (b and c, images numbers 3 and 4). Liquid collection in the gallbladder bed. Extravasation of contrast agent in the surgical bed probably from right intrahepatic biliary radical from the V and VI segments.

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Fig. 3: 53 years old male patient, postsurgical cholecystectomy 15 days earlier. T1 weighted fat suppression 15 min after administration of gadoxetic acid, axial (a. image number 2) and coronal (b and c, images numbers 3 and 4). Liquid collection in the gallbladder bed. Extravasation of contrast agent in the surgical bed probably from right intrahepatic biliary radical from the V and VI segments.

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Fig. 4: 53 years old male patient, postsurgical cholecystectomy 15 days earlier. T1 weighted fat suppression 15 min after administration of gadoxetic acid, axial (a. image number 2) and coronal (b and c, images numbers 3 and 4). Liquid collection in the gallbladder bed. Extravasation of contrast agent in the surgical bed probably from right intrahepatic biliary radical from the V and VI segments.

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Fig. 5: A 67 years old male patient, cholecystectomy 10 days earlier. In a T2 axial image (a, image number 5) perihepatic collection is identified. Following administration of hepatospecific contrast axial T1 fat-suppression images (b, image number 6) with contrast extravasation from the cystic duct to the collection, findings regarding biliary fistula.

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Fig. 6: A 67 years old male patient, cholecystectomy 10 days earlier. In a T2 axial image (a, image number 5) perihepatic collection is identified. Following administration of hepato-specific contrast axial T1 fat-suppression images (b, image number 6) with contrast extravasation from the cystic duct to the collection, findings regarding biliary fistula.

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Fig. 7: A 65 years old man patient with postsurgical changes of extended right hepatectomy. Axial fast spin echo T2 weighted image (a, image number 7) fluid collection in surgical bed. Coronal T1 fat suppression post administration hepatic specific contrast images, (b image number 8) show (adjacent to 4A segment) a fluid collection with a small fluid level inside with a small area of increased signal in relation to small bile leak.

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Fig. 8: A 65 years old man patient with postsurgical changes of extended right hepatectomy. Axial fast spin echo T2 weighted image (a, image number 7) fluid collection in surgical bed. Coronal T1 fat suppression post administration hepatic specific contrast images, (b image number 8) show (adjacent to 4A segment) a fluid collection with a small fluid level inside with a small area of increased signal in relation to small bile leak.

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Fig. 9: A 81 years old man patient cholecystectomy 7 days earlier. Axial in phase and out of phase images (a, image number 9) show in segment 5 liquid collection with hyperintense fluid level inside. Axial T1 fat suppressed with hepato specific contrast, no signs of contrast extravasation are observed in the biliary contrast in late sequence (b, image number 10).

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Fig. 10: A 81 years old man patient cholecystectomy 7 days earlier. Axial in phase and out of phase images (a, image number 9) show in segment 5 liquid collection with hyperintense fluid level inside. Axial T1 fat suppressed with hepato specific contrast, no signs of contrast extravasation are observed in the biliary contrast in late sequence (b, image number 10).

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Fig. 11: A 61 years old patient resection of hepatic metastases of colon carcinoma 20 days earlier. Axial and coronal T2 weighted images (images number 11 and 12) fluid collection in surgical bed, perihepatic and right pleural effusion with compressive atelectasis of lower right lobe. Postoperative hematoma in right adrenal gland. Axial and coronal T1 weighted fat suppressed with hepatospecific contrast show small leakage of bile from the cavity of liver resection metastasis (segment 7). A small defect of diaphragm is identified communicating with pleural effusion (c,d,e images numbers 13,14,15).

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**Fig. 12:** A 61 years old patient resection of hepatic metastases of colon carcinoma 20 days earlier. Axial and coronal T2 weighted images (images number 11 and 12) fluid collection in surgical bed, perihepatic and right pleural effusion with compressive atelectasis of lower right lobe. Postoperative hematoma in right adrenal gland. Axial and coronal T1 weighted fat suppressed with hepato specific contrast show small leakage of bile from the cavity of liver resection metastasis (segment 7). A small defect of diaphragm is identified communicating with pleural effusion (c,d,e images numbers 13,14,15).

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Fig. 13: A 61 years old patient resection of hepatic metastases of colon carcinoma 20 days earlier. Axial and coronal T2 weighted images (images number 11 and 12) fluid collection in surgical bed, perihepatic and right pleural effusion with compressive atelectasis of lower right lobe. Postoperative hematoma in right adrenal gland. Axial and coronal T1 weighted fat suppressed with hepato specific contrast show small leakage of bile from the cavity of liver resection metastasis (segment 7). A small defect of diaphragm is identified communicating with pleural effusion (c,d,e images numbers 13,14,15).

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Fig. 14: A 61 years old patient resection of hepatic metastases of colon carcinoma 20 days earlier. Axial and coronal T2 weighted images (images number 11 and 12) fluid collection in surgical bed, perihepatic and right pleural effusion with compressive atelectasis of lower right lobe. Postoperative hematoma in right adrenal gland. Axial and coronal T1 weighted fat suppressed with hepato specific contrast show small leakage of bile from the cavity of liver resection metastasis (segment 7). A small defect of diaphragm is identified communicating with pleural effusion (c,d,e images numbers 13,14,15).

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Fig. 15: A 61 years old patient resection of hepatic metastases of colon carcinoma 20 days earlier. Axial and coronal T2 weighted images (images number 11 and 12) fluid collection in surgical bed, perihepatic and right pleural effusion with compressive atelectasis of lower right lobe. Postoperative hematoma in right adrenal gland. Axial and coronal T1 weighted fat suppressed with hepato specific contrast show small leakage of bile from the cavity of liver resection metastasis (segment 7). A small defect of diaphragm is identified communicating with pleural effusion (c,d,e images numbers 13,14,15).

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Fig. 16: A 80 years old patient Whipple intervention 7 days earlier. Axial T2 weighted image show postsurgical changes of hepaticojejunal anastomosis and perihepatic fluid (a image number 16). Axial and coronal T1 weighted fat suppressed with hepato specific contrast image exhibit integrity of hepaticojejunal anastomosis. (b,c images number 17 and 18)

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Fig. 17: A 80 years old patient Whipple intervention 7 days earlier. Axial T2 weighted image show postsurgical changes of hepaticojejunal anastomosis and perihepatic fluid (a image number 15). Axial and coronal T1 weighted fat suppressed with hepato specific contrast image exhibit integrity of hepaticojejunal anastomosis.(b,c images number 16 and 17)

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Fig. 18: A 80 years old patient Whipple intervention 7 days earlier. Axial T2 weighted image show postsurgical changes of hepaticojejunal anastomosis and perihepatic fluid (a image number 16). Axial and coronal T1 weighted fat suppressed with hepato specific contrast image exhibit integrity of hepaticojejunal anastomosis.(b,c images number 17 and 18)

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Fig. 19: A 34 years old female patient. Axial T2 weighted image (a, image number 19) present an heterogeneous aspect of pancreatic head and fluid around duodenum, secondary to a previous history of chronic pancreatitis. Coronal T1 weighted fat suppressed hepato specific contrast image show short stenosis of choledochal intrapancreatic segment, whit distal opacification, probably of inflammatory origin in the context of chronic pancreatitis (b, image 20).

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Fig. 20: A 34 years old female patient. Axial T2 weighted image (a, image number 19) present an heterogeneous aspect of pancreatic head and fluid around duodenum, secondary to a previous history of chronic pancreatitis. Coronal T1 weighted fat suppressed hepato specific contrast image show short stenosis of choledochal intrapancreatic segment, whit distal opacification, probably of inflammatory origin in the context of chronic pancreatitis (b, image 20).

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Fig. 21: A 76 years old male patient right hepatectomy 15 days earlier. MR is performed with gadoxetic acid to rule out a biliary fistula. Axial and coronal T1 weighted fat suppressed hepato specific contrast image (a, b, images number 21 and 22). The impaired hepatic function (bilirubin values of 8.5 mg/dl) prevented the biliary clearance of the administered contrast and the images not show opacification of the biliary tract.

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**Fig. 22:** A 76 years old male patient right hepatectomy 15 days earlier. MR is performed with gadoxetic acid to rule out a biliary fistula. Axial and coronal T1 weighted fat suppressed hepato specific contrast image (a, b, images number 21 and 22). The impaired hepatic function (bilirubin values of 8.5 mg/dl) prevented the biliary clearance of the administered contrast and the images not show opacification of the biliary tract.

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Conclusion

Contrast enhanced MR cholangiography with Gd-EOB-DTPA is a non invasive and very useful diagnostic technique to show the biliary anatomy and provides functional information about biliary flow.

Together with traditional sequences in T2-weighted MR cholangiopancreatography it significantly improves the accuracy in detecting bile leakage secondary to post surgical injury and made differential diagnosis whit other surgical or medical complications.

Its limitations include the high cost, long scan time and low profitability in patients with liver failure datas.
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**References**

1) MR Contrast Agents for Liver Imaging: What, When, How
Sunil N. Gandhi, M Michele A. Brown, MD James G. Wong, MD Diego A. Aguirre, MD
2 Claude B. Sirlin, MD
RadioGraphics 2006; 26:1621-1636

2) Value of MR Cholangiography in Patients with Iatrogenic Bile Duct Injury After Cholecystectomy
Alfonso Ragozzino, Rosaria De Riti, Alessandro Mosca, Vittorio Iaccarino Massimo Imbriaco
AJR 2004;183:1567-1572 0361- 803X/04/1836-1567

3) Non-invasive detection of biliary leaks using Gd-EOB-DTPA-enhanced MR cholangiography: comparison with T2-weighted MR cholangiography
Mecit Kantarc & Berhan Pirimoglu & Nevzat Karabulut & Ummugulsum Bayraktutan & Hayri Ogul & Gurkan Ozturk & Bulent Aydinli & Yesim Kizrak & Suat Eren & Sinan Yilmaz

4) Biliary MR Imaging with Gd-EOB-DTPA and Its Clinical Applications
Nam Kyung Lee, MD Suk Kim, MD Jun Woo Lee, MD Suk Hong Lee, MD Dae Hwan Kang, MD Gwang Ha Kim, MD Hyung Il Seo, MD
RadioGraphics 2009; 29:1707-1724