Contribution of magnetic resonance cholangiopancreatography to the management of patients with suspected common bile duct stones

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SUMMARY

Objectives — To evaluate the value of magnetic resonance cholangiography (MRC) as a systematic first-line investigation in the management of patients with suspected common bile duct stones.

Methods — Ninety-nine consecutive patients with clinical suspicion of choledocholithiasis were prospectively explored by MRC. All MRCs were interpreted by two radiologists with knowledge of the patient’s clinical condition and laboratory results. In case of discrepancy, a third opinion was obtained to reach consensus. The definitive diagnosis was established on the basis of endoscopic exploration of the common bile duct (n = 40), clinical and biological follow-up at 6 months (n = 55) or other investigations (n = 4). The clinician’s level of confidence, management options implemented, and impact of management decisions were assessed to contribute the MRC. The diagnostic accuracy of MRC for common bile duct stones was also determined.

Results — At the observed level of confidence (85.9%), MRC identified a differential diagnosis in 7.1% of patients avoiding unnecessary endoscopic exploration in 59.6%. Systematic first-line MRC enabled appropriate management in 83.8% of patients. The sensitivity, specificity, and positive and negative predictive values of MRC for the diagnosis of common bile duct stones were 95.7%, 98.7%, 95.7% and 98.7%, respectively, with excellent inter-observer agreement (kappa = 0.915).

Conclusion — Magnetic resonance cholangiography can be used to efficiently screen patients who may need further invasive exploration of the common bile duct. It specifically identifies patients requiring therapeutic ERCP.

The full text of this article is available in English, free of charge, on the web on: www.e2med.com/gcb.
The purpose of this study was to assess the diagnostic value of magnetic resonance cholangiography and evaluate its contribution to the management of patients with suspected common bile duct stones.

Patients and methods

Patients

This prospective descriptive study, conducted between March 1, 2000 and February 28, 2001, included 108 consecutive patients with suspected CBDS (table I) who were scheduled for direct exploration of the common bile duct (ERCP or EUS). The cohort included 58 women and 50 men, mean age 59 years (range: 24-96). Patients with a contraindication for magnetic resonance imaging (pacemaker, intraocular metallic implant) or whose initial differential or positive diagnosis of CBDS had been established on the basis of ultrasound or computed tomography findings were not included.

Among these 108 patients, nine were excluded from the analysis (two early deaths due to causes unrelated to biliary or pancreatic disorders and seven patients lost to follow-up).

MR cholangiography

TECHNIQUE

MRC was performed on a 1.5 Tesla imager (Siemens, Symphony, Erlangen, Germany) with a phase-array coil after six standardized positioning sequences (table II).

IMAGE ANALYSIS

MRC images were analyzed prospectively and independently by two experienced radiologists aware of the patient’s clinical and biological status. In case of discrepancy, a third opinion was obtained from another experienced radiologist to reach a consensus. MRC was considered positive for common bile duct calculi when the following criteria were present: low intensity intraductal signal surrounded by a high intensity liquid signal.

INTERPRETATION (table III)

MRCs were interpretable for all 99 patients. The two radiologists were in agreement for 96 patients: diagnosis of CBDS in 22 patients, normal exploration in 67 patients, other diagnosis in seven patients (sclerosing cholangitis in two, malignant stenosis of the common duct in three, ampullary tumor in one, and radiation-induced stricture of the CBD in one). The first two radiologists were in disagreement for three patients; the third radiologist retained the diagnosis of choledocolithiasis in one patient and decided the MRC was normal in two. Consequently, interpretation of the MRC results was: CBDS in 23 patients, another diagnosis in seven, and a normal common bile duct in 69.
**Contribution of magnetic resonance cholangiopancreatography to the management of patients with suspected common bile duct stones**

### Definitive diagnosis (table IV)

The definitive diagnosis was established after direct exploration of the common duct in 40 patients (ERCP in 35 patients, and EUS in five). The time interval between MRC and ERCP was 4.1 days (3 days or less for 64% of patients). It was 12.6 days between MRC and EUS. Another technique was performed to establish the definitive diagnosis in four patients (surgery in two and liver biopsy in two). For the other 55 patients, objective confirmation of the suspected diagnosis was not obtained. For these patients, the managing surgeons and endoscopists established the definitive diagnosis on the basis of the clinical course and laboratory findings over the next six months, considering that any residual stone would become symptomatic within this period. Patients who were free from relapse at six months were considered to have CBDs at inclusion. Conversely, patients who experienced recurrent symptoms were considered to have CBDs at inclusion.

The definitive diagnosis was CBDs in 23 patients. ERCP confirmed the presence of a stone in the common bile duct in 22 patients whose MRC was positive for CBDs. Among these 22 patients, endoscopic extraction of the stone was unsuccessful in one; the procedure was complicated by duodenal perforation and conversion to open surgery was necessary to extract the stone. One normal MRC was considered to be a false negative in a patient who developed a new episode of acute pancreatitis one month later.

The other diagnoses (n = 7) suggested by the MRC findings were all confirmed later. ERCP was performed in two patients to treat malignant stricture of the common bile duct. EUS was performed to confirm the diagnosis of ampullary tumor and search for extension in one patient and liver biopsy confirmed the diagnosis of sclerosing cholangitis in two patients. Surgery was performed in two patients with stenosis of the common bile duct.

The common bile duct was considered to be normal in 69 patients. In 11 of these patients (one with an MRC diagnosis of CBDs and ten with normal MRC), subsequent ERCP failed to reveal obstruction of the common duct. In four patients, EUS performed after a normal MRC failed to identify an abnormality. Fifty-four patients remained asymptomatic during the six-month follow-up period.

### Assessment criteria and statistical analysis

#### Contribution of MRC performed on 1st intention

**Level of confidence**

The value of a complementary examination depends on whether it influences management decisions. The clinician must therefore have confidence in the results of the examination. The level of confidence can thus be measured by comparing real management decisions with those which would have been expected based on the results of the examination. Real management decisions were considered to be in agreement with expected decisions if:

- direct exploration of the common bile duct was performed after MRC diagnosis of CBDs,
- simple surveillance was prescribed after a normal MRC,
- management was modified after discovery of another diagnosis at MRC.

Real management decisions were considered to be in disagreement with expected decisions if:

- direct exploration of the common duct was performed despite a normal MRC,
- a patient with CBDS was not treated,
- a patient with another disease was given adapted treatment,
- a patient without common bile duct obstruction did not undergo further complementary explorations after MRC,
- the rate of therapeutic endoscopic procedures.

The overall quality of diagnostic and therapeutic management was assessed in light of the definitive diagnosis.

#### Diagnostic and/or therapeutic contribution

The contribution of MRC performed on 1st intention was assessed on the basis of:

- the number of differential diagnoses retained and confirmed,
- the rate of “avoided” endoscopic explorations (all patients having been initially scheduled for ERCP),
- the rate of therapeutic endoscopic procedures.

The diagnostic value of MRC for choledocholithiasias was assessed by determining the sensitivity, specificity and positive and negative predictive values of the examination for the entire cohort. All patients free of symptoms during the follow-up period were considered to be free of CBDs at inclusion. Conversely, patients who developed symptoms were considered to have CBDs at inclusion.

Inter-observer agreement (two experienced radiologists) was determined to measure reproducibility, and thus whether MRC is an observer-dependent examination. The kappa coefficient, which takes into consideration the predictable “random” component of agreement, was calculated to assess the degree of divergence between the two radiologists (table V).

### Table IV. — Definitive diagnosis.

<table>
<thead>
<tr>
<th>Diagnostic technique</th>
<th>CBDS</th>
<th>No obstruction</th>
<th>Other diagnosis</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>ERCP</td>
<td>22</td>
<td>11</td>
<td>2</td>
<td>35</td>
</tr>
<tr>
<td>EUS</td>
<td>0</td>
<td>4</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Follow-up</td>
<td>1</td>
<td>54</td>
<td>0</td>
<td>55</td>
</tr>
<tr>
<td>Other techniques</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>23</td>
<td>69</td>
<td>7</td>
<td>99</td>
</tr>
</tbody>
</table>

### Table V. — Kappa coefficient of agreement.

<table>
<thead>
<tr>
<th>AGREEMENT</th>
<th>κ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>&gt; 0.8</td>
</tr>
<tr>
<td>Good</td>
<td>0.8-0.61</td>
</tr>
<tr>
<td>Fair</td>
<td>0.6-0.41</td>
</tr>
<tr>
<td>Mediocre</td>
<td>0.4-0.21</td>
</tr>
<tr>
<td>Poor</td>
<td>0.2-0</td>
</tr>
<tr>
<td>Very poor</td>
<td>&lt; 0</td>
</tr>
</tbody>
</table>

Results

Contribution of first-line MRC (figure 1)

LEVEL OF CONFIDENCE

For 85 patients (85.9%) the clinician adjusted diagnostic and therapeutic management decisions in compliance with information provided by MRC:
— for 23 patients, ERCP was performed after MRC showed evidence of CBDS,
— for 7 patients, management was modified because MRC gave the diagnosis of another condition,
— for 55 patients, clinical and biological surveillance was prescribed because the MRC was normal.

For 14 patients, (14.1%), the diagnostic and/or therapeutic approach was different than would be expected from the MRC results. ERCP (n = 10) or EUS (n = 4) was performed to search for CBDS despite the fact that the MRC was considered normal. Six of these patients had acute pancreatitis and underwent endoscopic sphincterotomy during the ERCP procedure which did not reveal CBDS.

Contribution of MRC in patient management with suspected choledocholithiasis

MRC revealed another diagnosis in 7 patients (7.1%), four of whom did not require complementary endoscopic exploration (2 patients with sclerosing cholangitis and two with common bile duct stenosis). For the 3 other patients, the MRC results guided subsequent therapeutic ERCP (insertion of stents in 2 patients with malignant stricture) and preoperative EUS in one patient with a ampullary tumor.

The scheduled ERCP was not performed in 59 patients after the MRC results were known. For 55 patients, physicians prescribed simple clinical and biological surveillance because the MRC was normal. The management strategy was modified in 4 patients because MRC revealed another diagnosis. The rate of “avoided” endoscopic explorations was 59.6%, with a 1% complication rate.

Forty patients underwent endoscopic exploration after MRC. For 23 of them, the endoscopic procedure was performed because MRC had led to the diagnosis of choledocholithiasis, which was confirmed in 22 and successfully treated in 21. For three patients, the endoscopic procedure was performed after MRC yielded a differential diagnosis. An endoscopic procedure was also performed in 14 patients with a normal MRC; all 14 procedures (ten ERCP and four EUS) failed to reveal obstruction. The rate of “useful” endoscopic procedures was thus 62.5% (25/40) (figure 2).

In light of the definitive diagnosis, the overall quality of diagnostic and therapeutic management was assessed as follows: management decisions were appropriate in 83 patients (83.8%).
— Twenty-two patients underwent extraction of CBDS after MRC diagnosis (21 by ERCP with endoscopic sphincterotomy and one by open surgery after failure of endoscopic extraction);
— Fifty-four patients had no further exploration after MRC demonstrated the absence of choledocholithiasis, simple surveillance was prescribed, without any complication;
— Seven patients received adapted treatment after MRC identified a differential diagnosis.

Management decisions were inappropriate in 16 patients (16.2%):
— One patient developed recurrent acute pancreatitis one month after a normal MRC. This MRC was considered to be a false negative leading to insufficient treatment.
— Fifteen patients who did not have common bile duct obstruction underwent unnecessary direct exploration of the common bile duct after a normal MRC. In one patient, the ERCP performed seven days after MRC had yielded the diagnosis of CBDS did not reveal evidence of obstruction. In 14 patients, first-line MRC was normal and the second-line endoscopic procedure failed to reveal evidence of obstruction. The secondary exploration did not modify management decisions and was considered to be redundant.

Accuracy of MRC for the diagnosis of choledocholithiasis

The sensitivity, specificity, and positive and negative predictive values of MRC for the diagnosis of choledocholithiasis were 95.7%, 98.7%, 95.7% and 98.7% respectively (table VI). Inter-observer agreement was excellent (kappa coefficient for the diagnosis of CBDS = 0.915).

Discussion

Our findings confirm the contribution of MRC performed on 1st intention in patients with suspected common bile duct calculi.
Due to the non-invasive nature of MRC, clinicians might have been inclined to include an excessive number of patients, leading to possible over-selection. However, the prevalence of CBDS in our cohort (23.2%) was very similar to that reported in earlier series devoted to the diagnostic value of ERCP and EUS, ruling out this type of bias. Since multiple factors are considered when choosing the appropriate treatment for patients with cholelithiasis, we used adapted assessment criteria (results of secondary endoscopic examinations; clinical course and laboratory results during follow-up) to determine whether the MRC diagnosis of common duct obstruction was confirmed or not. The diagnostic value of endoscopic procedures is well established but the sensitivity of ERCP varies between 84 and 95% and that of EUS between 84 and 100%, depending on the series [4, 7, 30-36]. Since the diagnostic accuracy of MRC is similar to that of endoscopic explorations, it did not appear necessary to propose direct endoscopic exploration systematically for patients with a normal MRC. In 36% of our patients, factors related to hospitalization and equipment availability led to a delay of more than 48 hours for patients whose suspected common bile duct obstruction was considered to be the least likely.

The very good diagnostic accuracy of MRC and its minimal operator dependence were confirmed by our data which showed excellent inter-observer agreement (kappa = 0.915). The diagnostic value of MRC is better than ERCP for non-selected patients since the rate of contraindications and the rate of unsuccessful procedures is higher for ERCP than MRC [29, 37].

In addition to diagnostic accuracy, our study demonstrated that MRC on 1<sup>st</sup>-intention provides a significant contribution to diagnostic and therapeutic decision making. With a high level of clinicians’ confidence (85.9%), first-line MRC is very useful for improving selection among patients with suspected cholelithiasis since the management of 83.8% of patients who underwent MRC was adapted to their condition, with appropriate abstention from endoscopic exploration in 59.6%. Despite its good diagnostic accuracy, MRC, like endoscopic procedures, does not alleviate the risk of missing a small stone. This risk common to MRC and endoscopic procedures should however be balanced against the intrinsic risk of endoscopic exploration.

The discovery of a differential diagnosis at MRC (7% in our cohort) affects diagnostic and therapeutic decisions. In patients with non-lithiastic obstruction, MRC provides a more precise locoregional analysis than ERCP [24, 29, 37-39], allowing an adjustment of the diagnostic and/or therapeutic strategy to achieve optimal management (endoscopic prosthesis insertion, surgery, radiological drainage, EUS to search for extension of an ampullary tumor).

Therapeutic ERCP was performed after the first-line MRC for nearly one-third of our patients, who had either CBDS or another disease. These patients thus underwent a supplementary exploration in comparison with routine management practices. This implies additional cost which is undoubtedly counterbalanced by savings allowed by the efficacy of MRC to select patients who do not require further endoscopic exploration.

For 16 patients diagnostic management was inappropriate. In 14 cases (87.5%) it was due to a complementary endoscopic exploration after a normal MRC. The complementary endoscopic exploration did not appear to add any element affecting subsequent therapeutic decisions. Some of these endoscopic explorations may have been prescribed in order to perform endoscopic sphincterotomy in patients with acute pancreatitis. It is known however that this procedure loses its therapeutic efficacy if the patient does not have CBDS [40-42].

We only had two patients whose MRC led to inappropriate management. For one, complementary ERCP failed to identify a 3-mm stone observed on the MRC. This stone may have migrated spontaneously as do 38 to 66% of ductal stones, irrespective of size; silent migration of small stones (< 3 mm) is not uncommon [43, 44]. The second patient experienced a recurrent episode of acute pancreatitis after a normal MRC. This may have been a manifestation of a residual stone or a new migration since the risk of recurrent migration is 30 to 60% [40].

If all therapeutic decisions had been based on the MRC results, only 26 endoscopic explorations would have been performed. This attitude would have given a rate of “useful” endoscopy of 96% (25/26), without increasing morbidity.

Overall, when first-line MRC demonstrated the absence of CBDS, fewer complementary invasive explorations were performed without significant increase in the rate of secondary complications due to a missed diagnosis of cholelithiasis. This constitutes significant progress in the management of patients with suspected common bile duct stones since endoscopic exploration is more costly than MRC which involves less risk [45-47]. It would be interesting to compare cost effectiveness.

**REFERENCES**


