PERFORMANCE OF MAGNETIC RESONANCE CHOLANGIOGRAPHY AT THE CLINIC CENTER

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ABSTRACT

Objectives: To define diagnostic performance of magnetic resonance cholangiography (MRC) at the Clinic Center (Hospital de Clínicas) and to compare it with data reported in international bibliography.

Methods: A retrospective study was undertaken; 126 MRC examinations were done to 126 patients within the period December 2010-July 2013. The results were correlated with endoscopic retrograde cholangiopancreatography (ERCP), surgical findings and clinical outcome.

Results: These MRC examinations were evaluated for sensitivity (S), specificity (Sp), positive predictive value (PPV) and negative predictive value (NPV). Regarding general biliary tract pathology, S amounted to 97%, Sp to 83%, PPV to 73% and NPV, to 98%; in patients with clinical suspicion for lithiasis the values found were 94% for S, 81% for Sp, 65% for PPV, and 97% for NPV. The incidence of anatomical variants was found to be 17.5%.

Conclusion: MRC was shown to perform well as a diagnostic procedure for common bile duct (CBD) pathology and choledocholithiasis in our center. S values, as well as NPV ones, agreed with values reported elsewhere.

Key words: magnetic resonance cholangiography, biliary tract, choledocholithiasis.
INTRODUCTION

MRC is a non-invasive imaging technique that exploits intrinsic contrast differences between fluid-filled abdominal structures and adjacent tissues, by means of heavily T2-weighted sequences. The key factor is that fluids like bile or pancreatic juices present with a high-intensity signal on the T2-weighted images while static inside the biliary tract or the pancreatic duct, or moving slowly down those structures. (1)

MRC offers some advantages: it does not use ionizing radiation, it does not require contrast medium and it is not modified by alterations in bile secretion. Besides, the present state of development of MR allows for shorter exposure times (approximately 15 minutes). (2) It has proved to be quite useful in the diagnosis of biliary complications in patients with liver transplants or biliary-intestinal bypass operations. (3) As an additional advantage, this method permits evaluation of the biliary tract above and below the point of obstruction. (1)

MRC can not only detect filling defects, it also evaluates duct diameter and number of calculi and their site, as well as anatomical variants of the biliary tree. Furthermore, it is possible to associate an examination of the abdomen if hepatic or pancreatic pathology is suspected. (4)

Since MRC was introduced multiple international studies have demonstrated it is highly sensitive for the diagnosis of biliary tract lithiasis: sensitivity amounts to 90-97%, while specificity lies between 84% and 98%, taking into consideration all series. (5)

One of the main disadvantages of MRC is its low sensitivity for detecting small calculi (sensitivity amounts to 64% for calculi measuring less than 3mm). (2, 3)

MRC, which was introduced in 1991, has had an increase in development in the last few years. (1, 4) It has become the most important alternative non-invasive method to evaluate the biliary tree and the pancreatic duct. (6)

Although ERCP remains the “gold standard” of diagnostic methods for disorders affecting the biliary tree and the pancreatic duct, it is an invasive method, associating considerable morbidity and mortality. This fact, along with its high cost, limits its use. (1, 4) Sensitivity of ERCP for choledocholithiasis amounts to 95%, while its specificity is 100%. It is both diagnostic and therapeutic, because it includes the performance of such procedures as papillotomy, removal of calculi, prosthesis placement, and catheter insertion for drainage (2, 5 and 7); this therapeutic aspect constitutes one of its main advantages when comparing it to MRC.

According to scientific literature, MRC offers high sensitivity as well as high specificity for the diagnosis of biliary obstruction. In that aspect it is as reliable as ERCP, without the risks inherent to the latter. (2) In the last few years technological innovations have achieved a reduction in acquisition times and an improvement in quality on account of better image resolution.
Intraoperative cholangiography (IOC), even if it is a safe method, is not entirely devoid of complication; biliary tract injuries, due to excessive manipulation, have been described in 0.4% of patients. Besides, in 3% of cases it cannot be performed because of difficulties in the cannulation of the cystic duct. (4)

Anatomical variants of the biliary tract occur in more than 37% of patients. The most frequent variants of biliary convergence include union of right posterior duct with right anterior duct, or with left hepatic duct. Another common variant is the so-called “triple confluence”, which consists of the simultaneous drainage of the right posterior hepatic duct, the right anterior one and the left duct into the common hepatic duct. (8)

Regarding the cystic duct, the three commonest anatomical variants are: low insertion of cystic duct into the distal third of the common hepatic duct, medial low insertion (the cystic duct drains into the left side or the medial side of the common hepatic duct), and a long cystic duct running parallel to the common hepatic duct or the choledochus for at least 2cm. (8)

The commonest pancreatic duct variant is pancreas divisum, which presents in 5-14% of the population and results from lack of fusion of the ducts draining dorsal and ventral portions of the pancreas. Most patients with this anomaly are asymptomatic. In a small subgroup of patients, however, it has been suggested as the cause of recurrent pancreatitis and abdominal pain. MRC demonstrates both ductal systems very well, in a non-invasive manner.

At the Clinic Center the MRI scanner was introduced in 2010 and MRC began that very year. No study has been done since to evaluate the diagnostic accuracy of this technique. The objective of the present study is to evaluate MRC results at the University Hospital and correlate them with international data.

**METHODS**

A retrospective study was carried out, with the reports of MRC scans performed at the Department of Clinical Imaging (Clinic Center “Dr. Manuel Quintela”) during the period ranging from December 2010 to July 2013.

Case histories of all patients studied during that period were obtained from the Medical Records Department at the Center. They were analyzed and particular note was made of the liver

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**Figure 1. “True positive for choledocholithiasis”. SM, 67 years old. Coronal slice of volumetric sequence of MRC. Obstructive lithiasis, (approximate size: 18mm), observed at distal choledochus, causing moderate, symmetric and diffuse enlargement of biliary tract, both intra- and extra-hepatic. Choledochus proximal to the obstruction measures approximately 21mm. Distal choledochus is thin.**
function tests, ultrasound findings, CT scan results, ERCP, surgery reports,

Data were tabulated with Microsoft® Excel software.

All MRC examinations were performed in closed circuit in an Avanto 1.5 Tesla MRI scanner from Siemens. A 6-channel phased-array surface coil was used. Fast Spin Echo sequences were done, with T2-weighted fat saturation on the axial plane and SSSFP (True FISP) on the coronal plane without fat saturation, as well as volumetric and radio MRC sequences. Images were analyzed at the Siemens workstation. Multiplanar reconstructions were analyzed in every case, as well as 3D MIPs from data obtained during the volumetric sequence. Examinations were reported by three radiologists who specialize in MRC.

Study period extended from March to October 2013.

On the basis of MRC results and confirmatory complementary studies several values (sensitivity, specificity, positive predictive value and negative predictive value) were calculated for this method and correlated with values reported in scientific literature.

Although some studies were reported to be limited and handicapped by artifacts on account of lack of patient cooperation, all images were deemed to be of diagnostic quality.

One hundred and twenty-six studies were performed in as many patients. Out of that total number, 32 were eliminated from the sample, on account of insufficient data to establish adequate correlation. The remaining sample was made of 94 patients, 62 females (66%) and 32 males (34%), whose ages ranged between 18 and 92 years, the average number of years being 55.

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**Table 1. Indications for MRCs**

<table>
<thead>
<tr>
<th>Indication</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rule out lithiasis in CBD</td>
<td>65</td>
<td>69</td>
</tr>
<tr>
<td>Suspicion of cancer</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>PSC</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>HC</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>SL</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>LT</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>BDA</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Other</td>
<td>12</td>
<td>13</td>
</tr>
</tbody>
</table>

CBD: common bile duct; PSC: primary sclerosing cholangitis; HC: hydatid cyst; SL: surgical lesion; LT: liver transplant; BDA: biliary-digestive anastomosis; other: chronic cholestasis, alterations in liver function tests, etc.
RESULTS

Clinic considerations leading to the request of MRC are described in Table 1. MCR results are described in Table 2.

Out of 94 patients in this study, 26 were diagnosed for choledocholithiasis by MRC. In 17 of them the finding was confirmed, by means of ERCP in 15 cases (Figure 1) and by means of IOC in 2. The size of those stones ranged from 5mm to 18mm (mean: 11.5mmm). Choledocholithiasis was ruled out in 9 patients, by means of ERCP in 7 and in 2 by means of IOC.

The time interval between MRC performance and other confirmatory studies or procedures was checked. Out of a total of 7 patients in whom ERCP ruled out lithiasis, this procedure was done some days later (2, 5, 6, 8, 30 and 50 days, which means 18 days on average). In the 2 cases where IOC ruled out CBP lithiasis, the procedure was carried out 6 days after MRC in one case, and 4 days later in the other case.

We emphasize that in all patients in whom CBD lithiasis was ruled out liver function tests showed a cholestatic pattern and galbladder lithiasis was present.

Table 2. MCR results

<table>
<thead>
<tr>
<th>Result</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>No findings in CBD</td>
<td>53</td>
<td>56</td>
</tr>
<tr>
<td>Choledocholithiasis</td>
<td>26</td>
<td>28</td>
</tr>
<tr>
<td>Neoplasia</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>PSC</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>LT</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Other</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>

CBD: common bile duct; PSC: primary sclerosing cholangitis; LT: liver transplant; other: cholangitis, stenosis of biliary-digestive anastomosis, etc.

Table 3. Global results for the whole group of patients

<table>
<thead>
<tr>
<th>MRC</th>
<th>ERCP, cholangiography, clinical outcome</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>+</td>
<td></td>
<td>41</td>
</tr>
<tr>
<td>-</td>
<td></td>
<td>53</td>
</tr>
<tr>
<td>Totals</td>
<td></td>
<td>94</td>
</tr>
</tbody>
</table>

Table 4. Results for the patient group with clinical suspicion for lithiasis

<table>
<thead>
<tr>
<th>MCR</th>
<th>ERCP, cholangiography, clinical outcome</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>+</td>
<td></td>
<td>26</td>
</tr>
<tr>
<td>-</td>
<td></td>
<td>39</td>
</tr>
<tr>
<td>Totals</td>
<td></td>
<td>65</td>
</tr>
</tbody>
</table>
In two of those patients choledocholithiasis was also visualized by other imaging methods (in one case by abdominal ultrasound, in the other case by MDCT). The stored PACS images were reviewed for 3 patients; in 2 cases choledocholithiasis was clearly present, in another case it was doubtful. In these 3 patients calculus size ranged between 3 and 5mm, which makes migration all the more probable, given the time interval separating MRC and the “gold standard” technique. (Fig. 2)

If we consider the patient group as a whole, disregarding previous clinical data, MRC detected biliary tree pathology with a sensitivity value (S) of 97%, a specificity value (Sp) of 83%, a positive predictive value (PPV) of 73% and a negative predictive value (NPV) of 98%, if we correlate the results with ERCP, IOC and/or clinical outcome. (Table 3)

Out of 94 patients, 7 presented neoplastic disease which was confirmed in every case by operative findings and pathology reports. Out of these 7, 4 had pancreatic tumors (Figure 3), 1 corresponded to a Klatskin tumor (Figure 4) and 2 to gallbladder tumors which infiltrated the CBD. In all these cases biliary tract dilatation of obstructive etiology was observed.

In 2 patients MRC diagnosed PSC, which was confirmed in both, in one instance by means of percutaneous liver biopsy and in the remaining case by case history data and clinical outcome.

In 53 patients no anomalies were to be found in the CBD. This group included such presumptive diagnoses such as gallbladder lithiasis, non-obstructive neoplasms, acute and chronic pancreatitis, liver abscesses (one case) and adenomyomatosis of the gallbladder (one case, too).

In one of the patients whose MRC had been negative for lithiasis, ERCP confirmed the presence of one calculus in the choledochus; this case is the one false negative in this study. The patient
had been sent to rule out residual lithiasis in the CBD after a cholecystectomy.

In the 2 patients with liver transplant the presumptive diagnosis of ischemic cholangitis was confirmed.

Finally, in 4 patients other presumptive diagnoses were likewise confirmed: bacterial cholangitis in one patient, non-obstructive dilatation of the CBD (an IOC finding) and stenosis of biliary-digestive anastomosis.

For the patient group with clinical suspicion for lithiasis, which numbered 65, MRC was 94% sensitive (S), 81% specific (Sp), while PPV was found to be 65% and NPV, 97% (value of p<0.001). (Table 4)

DISCUSSION

Certain difficulties in technique and interpretation can hide or simulate disorders of the pancreatic-biliary system. Both extraductal material (surgical clips, gas inside the digestive system, pulsatile flow of adjacent arteries) and intraductal material (air or blood) can alterate signal intensity in T2-weighted images and simulate biliary obstruction or some intraductal disorder. (1)

Anatomical variants of the biliary tract and congenital pancreatic anomalies were also taken into consideration when reviewing results. Since the parameter for this item is incidence on the population, the whole group under study was taken into account (n= 126). In 22 patients (17.5%) some anatomical variant was found: 3 patients had pancreas divisum, 11 had an abnormal insertion of the cystic duct and 10 had some anomaly of the biliary convergence, which in some cases was associated with some anomaly of cystic duct insertion.
Knowledge of anatomical variants has acquired increasing importance with the advent of laparoscopic surgery of the gallbladder, because their presence may increase the risk of injury to the biliary tract. That knowledge is also very useful in the surgery of tumors of liver and the biliary tract, and is of fundamental importance before liver transplant. (1, 8, 9). Anatomical variants of the biliary tract may be clinically important. Aberrant and/or accessory biliary ducts may predispose to accidental ductal ligature during laparoscopic surgery or they may complicate surgical procedures such as liver transplant. As regards non-invasive evaluation of biliary tract anatomy, MRC is the method of choice. Recent advances in MRC have improved image quality, which contributes to recognize these entities, a basic condition for the avoidance of diagnostic errors, a better surgical planning and the prevention of accidental injury to the CBD. (8)

Many of the aforementioned variants were to be found in the patients of the present study, as was the case for anomalies of the right hepatic duct, the presence of a long cystic running parallel to the hepatocholedochus, and the low insertion of the cystic duct. Global incidence of anatomical anomalies in our study lies somewhat lower than the reported figures. Artifacts induced by metallic clips and partial volume averaging (due to overlapping of pancreatic ducts and duodenum) can restrict identification of those various anatomical variants. (1)

In our sample 3 patients presented with pancreas divisum, amounting to 4% of the population under study.

We emphasize that this study is limited in several aspects: it is retrospective and the sample was smaller as originally...
planned, because no data could be obtained for some patients and in other cases no confirmatory study was available. We attribute low PPV (lower in comparison with international references) to the prolonged interval between MRC and the confirmatory study, which allowed for spontaneous calculi migration into the intestine.

CONCLUSION
This study confirms that MRC can attain good results, matching international references regarding diagnosis of choledocholithiasis and general CBC pathology, with a high NPV.

In spite of aforementioned restrictions this study constitutes the first evaluation of diagnostic accuracy of MRC in our country. We consider that it might kick-start prospective studies on this subject in the future.

REFERENCES