Magnetic Resonance Cholangiopancreatography
After Failed or Incomplete Endoscopic Retrograde Cholangiopancreatography

Zastosowanie cholangiopankreatografii rezonansu magnetycznego w przypadku nieudanej lub niekompletnej wstecznej endoskopowej cholangiopankreatografii

Abstract
Background. MRCP is a new noninvasive technique for examining the biliary and pancreatic ducts without the need for contrast medium and without any known side effects. MRCP could replace diagnostic ERCP and other invasive bile and pancreatic duct examination methods.

Objectives. Evaluation of the usefulness of MRCP to delineate bile and pancreatic ducts and depict pathological fluid collection in the biliopancreatic region in patients after failed or incomplete ERCP.

Material and Methods. MRCP was performed in 36 patients who had previously undergone an attempted ERCP. However, with ERCP complete duct visualization was obtained in only 17 patients, but it failed in 6 patients and opacification was incomplete in 13. MRCP was done using a 1.5-T Picker Edge Eclipse system (EXPRESS, TR: ±, TEeff: 268 ms, ETL: 200, slice thickness: 50–70 mm, matrix: 336 × 512, FOV: 38 cm).

Results. Complete visualization of the ducts was obtained with MRCP in all 36 patients, whereas ERCP was successful in only 21 cases. In 6 patients, MRCP showed pseudocysts missed by ERCP. In 15 patients, no further invasive procedures were needed after MRCP.

Conclusions. MRCP is a valuable diagnostic tool for evaluating patients after failed or unsuccessful ERCP. MRCP is a noninvasive technique that may avoid the use of other, invasive procedures (Adv Clin Exp Med 2009, 18, 3, 297–302).

Key words: MRCP, ERCP, bile ducts, pancreatic ducts.

Streszczenie
Wprowadzenie. MRCP jest nowoczesną, nieinwazyjną metodą diagnostyki dróg zółciowych i przewodu trzustkowego, która nie wymaga podania środków kontrastowych i nie daje powikłań. MRCP może zastąpić diagnozochroniczną ERCP i inne inwazyjne metody diagnostyki dróg zółciowych i przewodu trzustkowego.

Cel pracy. Ocena uwidocznienia dróg zółciowych i przewodów trzustkowych oraz patologicznych zbiorników płynowych w ich okolicy w badaniu MRCP u pacjentów po nieudanym lub niekompletnym ERCP.

Material i metody. Badanie MRCP wykonano u 36 pacjentów, u których wcześniej podjęto próby wykonania ERCP, przy czym jedynie u 17 pacjentów (47,2%) w ERCP uzyskano pełny obraz badanych przewodów, u pozostałych 19 pacjentów bądź nie udało się wykonać ERCP (6 pacjentów), bądź jego obraz był niekompletny (13 chorych). Badania wykonano z użyciem aparatu Picker Edge Eclipse (sekwencje EXPRESS, TR: ±, TEeff: 268 ms, ETL: 200, grubość warstw: 50–70 mm, matryca: 336 × 512, pole widzenia: 38 cm).

 Wyniki. U wszystkich 36 pacjentów (100%) w MRCP uzyskano kompletne obrazy badanych przewodów, podczas gdy w ERCP udało się to jedynie w 21 przypadkach. U 6 chorych w MRCP uwidoczono pseudotorbiele, które nie były widoczne w ERCP. U 15 pacjentów na podstawie wyniku MRCP podjęto decyzję o niewykonywaniu dalszych inwazyjnych zabiegów.

Wnioski. MRCP jest skuteczną metodą diagnostyczną u pacjentów po nieudanym lub niekompletnym ERCP.
There are numerous traditional imaging methods used to examine bile and pancreatic ducts, including oral cholecystography, intravenous cholangiography, endoscopic retrograde cholangiopancreatography (ERCP), percutaneous transhepatic cholangiography (PTC), and intra- and post-surgical cholangiography. Each, however, has some limitations. Oral and intravenous cholecystography frequently yields images of insufficient quality, and ERCP and PTC are invasive procedures which may lead to complications. Intra- and post-surgical cholangiography are available only for patients undergoing surgery [1–3].

ERCP is the most commonly used traditional method for the diagnostics and therapy of the bile and pancreatic ducts. It was first performed by McCune et al. in 1968 [4]. It consists of introducing a fiberscope into the duodenum, finding the orifice of the common bile and pancreatic ducts, catheterization, and introducing contrast medium. Classic X-ray images are then taken using an appropriate time sequence. ERCP provides detailed visualization of the bile and pancreatic ducts, providing images of very high spatial resolution. As a therapeutic method, it allows Vater’s papilla incision and the removal of concrements from the common bile duct [5]. In bile duct stenosis it allows their dilation using inflatable balloons or the introduction of stents. Moreover, it allows direct the visualization and taking of a biopsy of the Vater’s papilla area [6]. The method is, however, burdened with numerous possible complications. The procedure requires sedation, endoscopy, introduction of a catheter into the bile ducts, and the direct application of contrast medium. Pancreatitis or cholangitis as well as allergic reactions to the applied iodine-based contrast media are encountered in approx. 5–8% of ERCP cases. In therapeutic procedures, additional risks include bile duct perforation, bleeding, and infection. Diagnostic ERCP is associated with a 0.96% mortality rate, which increases to 2.3% if the procedure is combined with sphincterotomy. Moreover, technical problems during the procedure mean that complete visualization of the bile and pancreatic ducts is achieved in only 80–90% of cases [7, 8].

As a therapeutic method, ERCP is and will remain the method of choice in the coming years. However, because of its invasiveness and risk of associated complications, as a diagnostic method it should be replaced by other, noninvasive methods in many patients [8–10].

The development of diagnostic techniques based on magnetic resonance allowed the introduction of a new imaging method, magnetic resonance cholangiopancreatography (MRCP). The method allows obtaining images of quality comparable to those obtained by invasive methods. Compared with the previously used methods it is noninvasive. It does not require the administration of contrast media or patient sedation [1–3]. MRCP is based on fast spin-echo sequences (FSE) with a very long effective echo time (pseudoecho) of 140–240 milliseconds. This results in obtaining strongly T2 time-dependent images in which only structures with long transverse relaxation time are visualized. That ensures strong contrast between strong signals from stationary or slowly moving fluids in the bile and pancreatic ducts and weak signals from soft tissues, concrements, and blood flowing in vessels [1–3, 11, 12].

The first MRCP applications described by Wallner et al. in 1991 used sequences of gradient echoes (steady-state free precession, SSFP) [7]. They allowed the detection of dilated bile and pancreatic ducts. However, because of their low spatial resolution, they were insufficient for the visualization of non-dilated ducts. Moreover, they were highly susceptible to motion artifacts (intestinal peristalsis, abdominal integument movements, aorta pulsation) and magnetic field inhomogeneity (loss of signal caused by the presence of metal clips or duodenal air). Moreover, it was necessary for the patient to hold a breath for as long as one minute during the examination. Because of these considerations, they were replaced by FSE sequences, which are a variation of traditional spin-echo sequences [13, 14]. FSE sequences were first used for MRCP imaging in 1994 by Takehara et al. [15]. Compared with gradient sequences, they allow visualization of both dilated and regular bile and pancreatic ducts [16]. The next advance was the application of single-shot FSE by Laubenberger in 1995. The use of single-shot shortens the sequence significantly, to 4 seconds in the case of a thick-layer technique, and significantly improves spatial resolution [17]. The next step was the introduction of a semi-Fourier acquisition technique in place of the previously used Fourier transformation [18]. This allowed limiting the time necessary to obtain a single scan to 2 seconds in the case of the thick-layer technique and to 18 seconds for thin layers. The semi-Fourier image transformation technique is currently recognized as the best available method [19, 20].
In the multisection technique it is possible to obtain thick source images and reconstructing them, most commonly using maximum intensity projection (MIP). This allows the reconstruction of three-dimensional (3D) images. With this technique, high-definition images are obtained, but small pathological lesions may be invisible in the resulting reconstructions, which is a result of signal averaging of adjacent layers. Therefore, in the multisection technique there is always the necessity to analyze the initial scans. The thick-layer projection technique is an alternative. It shortens the scanning time significantly [1, 20, 21]. Respiratory movement-related artifact reduction is obtained by the repetition of single acquisition, currently not commonly used. Respiratory gating is most commonly used, consisting of gathering information on the same respiratory cycle phase with the examination performed while the patient holds a breath. Some authors suggest administration of hyoscine butylbromide (Buscopan) or glucagon directly before the examination to reduce intestinal peristalsis.

Generally, patients do not require any special preparation for MRCP. The only recommendation is restraining from food and drink for approximately six hours before the examination. This allows emptying the stomach and duodenum, improving the quality of the resulting images and, in case of a need for classic MRI scans, it allows safe administration of contrast medium. No MRCP-associated side effects have been noted. Besides the general contraindications for MRI, there are no specific contraindications for MRCP. The examination is absolutely forbidden in patients with ferromagnetic vascular clips and pacemakers. Moreover, it may prove difficult to complete in patients with ferromagnetic implants causing artifacts in the porta hepatis area and in individuals suffering from claustrophobia. Claustrophobic patients may be examined under general anesthesia or using modern open MRI systems [1, 2, 18].

Material and Methods

One hundred sixteen MRCP examinations were performed at the Chair and Department of Radiology, Wroclaw Medical University. Thirty-six patients were selected from that group in whom MRCP was preceded by an attempt to perform an ERCP examination. That group of patients was analyzed. The study group of 36 patients included 21 males (58.3%) and 15 females (41.7%). The patients’ ages ranged between 19 and 71 and the average was 48 years.

The examinations were conducted using Picker Edge Eclipse 1.5-T equipment. The patients fasted for six hours before the examination. The procedure started with three pilot scans in FSE sequence. The first scan, the so-called localizing one, was performed in the sagittal plane and the following ones in the axial and frontal planes. The proper epigastric region scans in FSE sequence were then performed in the axial projection, covering the region from the hepatic vault to the inferior limit of the pancreas. Two projections in T1 and T2 sequences were taken. The MRCP images were obtained using a single-shot method, with the semi-Fourier transformation of the resulting image using the parameters presented in Table 1.

**Table 1. MRCP scan parameters**

<table>
<thead>
<tr>
<th>Sequence</th>
<th>Express</th>
</tr>
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<tbody>
<tr>
<td>Repetition time – TR (ms)</td>
<td>∞</td>
</tr>
<tr>
<td>Effective time echo – TEff (ms)</td>
<td>268</td>
</tr>
<tr>
<td>Echo train length – ETL</td>
<td>200</td>
</tr>
<tr>
<td>Slice thickness (mm)</td>
<td>50–70</td>
</tr>
<tr>
<td>Matrix</td>
<td>336–512</td>
</tr>
<tr>
<td>Field of view – FOW (cm)</td>
<td>38</td>
</tr>
</tbody>
</table>

Results

In the group of 36 patients in whom ERCP was attempted, the examination was completely unsuccessful in 6 cases (16.6%). In all cases this was due to failure to find the orifice of Vater’s papilla or difficulties encountered with its catheterization. In 7 cases (19.4%), incomplete visualization of the bile and pancreatic ducts were obtained. In 4 patients (11.1%) ERCP yielded a complete depiction of the bile and pancreatic ducts, consistent with the cholangiopancreatogram obtained in MRCP. The ERCP examination, however, failed to visualize pathological fluid collection within or around the pancreas, which was found on MRCP images. In 2 patients (5.5%) ECRP allowed an incomplete depiction of the bile and pancreatic ducts and failed to reveal pancreatic pseudocysts visible on MRCP images (Fig. 1a).

Overall, incomplete cholangiopancreatograms from ERCP (incomplete visualization of the examined ducts or failure to show a pancreatic pseudocyst) were obtained for 13 patients (36.1%). In 17 patients (47.2%) ERCP yielded complete visualization of the bile and pancreatic ducts, fully compatible with the result obtained from MRCP.

MRCP gave a complete image of the bile and
pancreatic ducts in all 36 cases (Fig. 1b). In 15 patients in whom MRCP was performed, the decision was made not to perform any other invasive procedures, saving those patients from the risk of developing iatrogenic complications.

**Discussion**

The comparison of ERCP and MRCP has been the subject of numerous studies and discussions among physicians of various specialties. ERCP allows obtaining very-high-quality images of the bile and pancreatic ducts. It is, however, an invasive method burdened with the risk of complications [6–10]. MRCP yields images of quality comparable to that of ERCP but is also an examination safe for the patient [22, 23]. MRCP does not require finding and catheterizing Vater’s papilla or contrast medium administration into the examined ducts. In the event of difficulty related to bile and pancreatic duct orifice catheterization, or if both ducts have separate orifices on the major and minor Vater’s papilla, when only the bile duct or the pancreatic duct may be catheterized, MRCP is a method allowing complete visualization of the ducts. Moreover, the visualization of individual sections of the ducts using MRCP does not depend on the possibility of contrast medium penetration, as is the case with ERCP. MRCP reveals natural fluids, such as bile and pancreatic juice. Therefore, if there is an obstruction preventing contrast medium from penetrating during ERCP, MRCP allows visualization of the ducts both distally and proximally to the place of obstruction. As a result, if ERCP yields incomplete visualization, showing only part of the ducts, MRCP allows visualization of the ducts in their entirety [1, 24].

In a study by Soto et al., MRCP allowed complete visualization of the bile and pancreatic ducts in all 37 patients after failed or incomplete ERCP. No abnormalities in the examined ducts were found in 11 patients, saving them from invasive procedures (PTC, laparotomy) and reducing the risk of iatrogenic complications [25]. Similar results were obtained by Fulcher et al. from analyzing 27 patients after failed or incomplete ERCP. In all cases, MRCP yielded valuable diagnostic
images that could be the basis for qualifying the patients for conservative therapy or invasive procedures [26]. Reinhold et al., analyzing a large group of 159 patients, found 10 cases of failed ERCP, corresponding to 6% of patients, and 3 cases of failed MRCP, corresponding to 2% of patients [27].

The results of the present study demonstrated that MRCP is a valuable imaging method for evaluating patients after failed or inadequate ERCP. Simultaneously, MRCP, as a noninvasive technique, may prevent other, invasive procedures, decreasing the potential number of iatrogenic complications, shortening hospitalization time, and thus reducing therapy-associated costs. In a study by Varghese et al., only 12 of 59 patients who underwent MRCP after failed or inadequate ERCP were subsequently treated surgically [28].

The present study found 13 cases of incomplete bile and pancreatic duct visualization with ERCP, corresponding to 36.1% of patients with attempted ERCP. ERCP failed in 6 patients (16.6%). This high ratio of incomplete and failed ERCP examination is the result of a diagnostic scheme adopted by numerous domestic clinics and hospitals stating that ERCP is the preferred diagnostic procedure. MRCP is still often a procedure reserved for patients in whom other diagnostic procedures, including ERCP, were insufficient for making a diagnosis.

References


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