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Accuracy of abbreviated protocol of magnetic resonance cholangio-pancreatography in the diagnosis of choledocholithiasis

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ABSTRACT – Background – Abbreviated magnetic resonance imaging protocols have emerged to reduce the examination time of the long protocols eliminating unnecessary pulse sequences to answer a targeted clinical question, without compromising diagnostic information. **Objective –** The objective of this study was to evaluate the diagnostic accuracy of an abbreviated magnetic resonance cholangiopancreatography (A-MRCP) protocol in patients with suspected choledocholithiasis. **Methods –** This retrospective study evaluated patients (ages 10 + years) that performed consecutive MRCP examination from October 2019 to June 2020, with the clinical suspicion of choledocholithiasis. Readers first evaluated the biliary tree using a four-sequence A-MRCP protocol and later reviewed the entire conventional eleven-sequence MRCP. Presence of choledocholithiasis, stone size, common bile duct caliber, and additional findings were evaluated. **Results –** A total of 148 patients with MRCP were included (62.8% female, mean 50.9 years). The prevalence of choledocholithiasis was 32.2%. The accuracy of the abbreviated MRCP protocol for choledocholithiasis was 98.7%. There was no difference between the performance of the abbreviated and conventional MRCP image sets for detection of choledocholithiasis (kappa=0.970), with a sensitivity of 98% and a specificity of 99%. There was excellent inter-reader agreement evaluating for choledocholithiasis on both imaging sets of MRCP protocols (kappa values were 0.970). **Conclusion –** An abbreviated MRCP protocol to evaluate for choledocholithiasis provides similar diagnostic over the conventional MRCP protocol, offering potential for decreased scanning time and improved patient tolerability.

Keywords – Choledocholithiasis; MRCP; abbreviated protocols; magnetic resonance cholangiopancreatography.

INTRODUCTION

Gallstones affects about 10 to 15% of the adult population and is the main cause of hospitalization related to gastrointestinal diseases[1,2]. The incidence of choledocholithiasis estimated is around 10–15% of patients with biliary stone disease[3,4]. The diagnosis of choledocholithiasis is based on clinical suspicion (biliary colic, jaundice, and cholangitis), biochemical analysis (elevated levels of direct bilirubin and alkaline phosphatase) and findings in imaging exams[5].

Endoscopic retrograde cholangiopancreatography (ERCP) is the gold standard test for both diagnosis and treatment of common bile duct stones, with a high diagnostic accuracy of 98%[6]. As it is an invasive method, it is associated with the risk of complications, most commonly pancreatitis, cholangitis, hemorrhage, and intestinal perforation, with complication rates of 5 to 10% and mortality of 0.02 to 0.50%[7,8]. Endoscopic ultrasound is also used for the diagnosis of choledocholithiasis, with diagnostic accuracy greater than 95%, with lower complication rates than ERCP. However, its results are operator-dependent, have a high cost and are not widely available in clinical practice[9].

The American Society of Gastrointestinal Endoscopy recommends for patients with intermediate pre-test probability of choledocholithiasis (10–50%) that the preferential evaluation is by imaging method to better select patients for therapeutic ERCP[10]. Therefore, magnetic resonance cholangiopancreatography (MRCP) is the imaging method of choice in the diagnosis of choledocholithiasis with sensitivity of 81–100% and specificity of 85–100%[11].

MRCP has advantages such as technical versatility, multiplanar capacity, greater differentiation of soft tissues and the potential to evaluate choledocholithiasis with accuracy in an acute picture of cholecystitis or pancreatitis. Unlike ERCP and endoscopic ultrasound, MRCP is a rapidly performed noninvasive imaging method without exposing patients to ionizing radiation or iodate contrast[5].

MRCP uses strongly T2-weighted pulse sequences to increase the relative contrast of the bile and pancreatic ducts. Techniques with and without apnea are used, obtaining images with acquisition in second (2D) or third dimension (3D). MRCP FSE 3D offers higher signal-to-noise and contrast-noise ratio and isotropic voxels, improving the post-processing of maximum intensity projection (MIP). T2-weighted pulse sequences are also included in the choles-

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tasis evaluation protocol, providing baseline images for biliary tree evaluation. T1-weighted images and diffusion are also performed to evaluate the structures of the upper abdomen.

The longtime of examination and interpretation of images, as well as the high cost, represent obstacles to the use of magnetic resonance imaging (MRI). In addition, especially patients hospitalized or with severe clinical conditions find it difficult with breathing instructions (regular breathing for respiratory trigger or apnea) and with the long examination time required for high-resolution imaging[12].

Abbreviated MRI protocols have emerged to reduce the examination time of the long protocols eliminating unnecessary or redundant pulse sequences, without compromising diagnostic information. A short, focused MRI protocol to answer a targeted clinical question may improve the patient experience, MRI workflow and reduce costs[12].

Many institutions have already adopted or are researching abbreviated MRI protocols for surveillance of hepatocarcinoma and liver metastases, breast cancer, ovarian and pancreatic cysts follow-up, and adrenal incidentalomas, for example[12-15]. Perhaps there is a lack of reported studies evaluating the diagnostic utility and accuracy of an abbreviated MRCP protocol.

The aim of this study was to evaluate the accuracy of the abbreviated MRCP protocol in patients with suspected choledocholithiasis.

METHODS

This was a retrospective cross-sectional study. The study protocol was approved by the Research Ethics Committee of the Pontifical Catholic University of Rio Grande do Sul (Reference no. 10477), in Southern of Brazil. All the authors signed a confidentiality agreement to ensure the anonymity of the data obtained from the electronic medical records of the hospital. The article was prepared in accordance with The Strengthening the Reporting of Observational Studies in Epidemiology statement.

The study included patients 10 years old or above that performed consecutive MRCP examination from October 2019 to June 2020, with the indication of possible choledocholithiasis at the imaging center. Patients with painless jaundice, known malignancy or metastatic disease, or medical conditions known to predispose patients with jaundice were excluded.

Demographic and clinical data were collected from the patient electronic records. The MRCP examinations were performed by two board-certified radiologists, with at least 10 years of experience.

MRI technique

MRCP were performed on 1.5T clinical scanners (General Electric, Chicago, IL) using a torso phase-array coil, and sequences included: axial T1-weighted imaging without intra venous (IV) contrast administration, three planes T2-weighted imaging, axial diffusion-weighted imaging. Also, MRCP was performed using 2D and 3D techniques. The MRI parameters in are shown in TABLE 1. Presence of choledocholithiasis, stone size, common bile duct caliber, and additional findings were evaluated. Stones were diagnosed at MRCP as rounded, or faceted areas of signal void surrounded by high signal bile and its maximum diameter measured (FIGURE 1).

MR assessment

First, the radiologists reviewed the sets of images of the abbreviated protocol that included coronal FIESTA fat saturated, axial T2 SSFSE, respiratory triggered coronal oblique 3D MRCP and 2D thick-slab MRCP. After 1 week of the abbreviated protocol being applied, the radiologists revised the conventional MRCP protocol which also included coronal T2 SSFSE, sagittal and axial FIESTA, axial T2 FSE with respiratory gating and fat saturation, axial T1 in-phase and out-of-phase and axial LAVA fat-suppressed imaging without IV contrast. The two MRCP protocols were compared for the presence or absence of choledocholithiasis and additional findings.

Statistical analysis

To assess agreement between observers and between protocols regarding numerical variables, the intraclass correlation coefficient (ICC) was applied. Values below 0.5 indicate poor agreement, between 0.5 and 0.75 indicate moderate agreement, between 0.75 and 0.9 good agreement and above 0.9 excellent agreement[16].

TABLE 1. Magnetic resonance imaging parameters in protocol for acute biliary obstruction.

Sequence	TR (ms)	TE (ms)	Slice thickness (mm)	Intersection gap (mm)	Matrix size	FOV (cm)
Axial SSFSE	597	99	5	6	192 x 256	36
Coronal SSFSE	632	99	5	6	256 x 192	48
Axial Fiesta	3726	1672	5	6	256 x 192	36
Coronal Fiesta	4221	1904	6	7	288 x 192	48
Sagital Fiesta	4058	1824	6	7	288 x 192	48
Axial T2 FSE	4000	92	5	6	288 x 288	48
DWI	3971	62	5	6	128 x 80	36
T1 in-phase	150	4392				
T1 out-of-phase	150	2144	5	6	192 x 256	36
T1 Lava	6188	3126	5	2.5	192 x 288	36
3D MRCP*	3000	696	1.4	0.7	288 x 288	36
2D MRCP thick-slab	2334	1235	40	1	288 x 256	36

MRCP: magnetic resonance cholangiopancreatograph. *coronal oblique plane

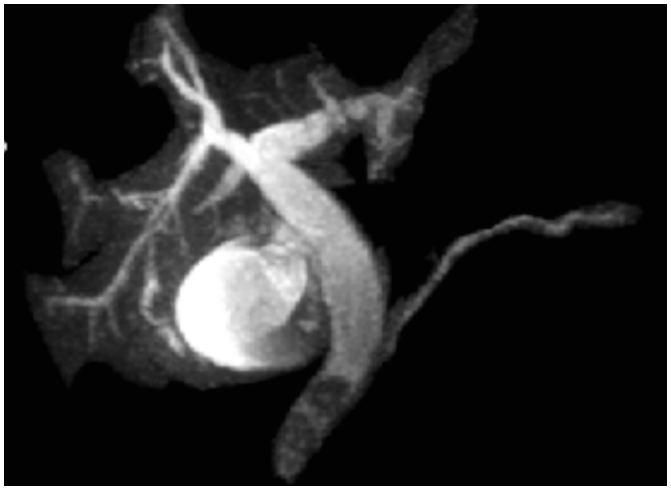

FIGURE 1. Coronal maximum intensity projection (MIP) reformat shows filling defects in the dilated distal common bile duct, corresponding to biliary stones.

For stone size, Bland-Altman plots were also performed to complement the ICC.

To assess agreement between observers and between protocols regarding categorical variables, the kappa coefficient was used[17]. The level of significance adopted was 5% (P<0.05) and the analyzes were performed using the SPSS (Statistical Package for the Social Sciences) version 21.0.

RESULTS

One-hundred forty-eight patients with MRCP were included in this study, including 93 (62.8%) females, with mean age 50.9±18.7 years (range 11 and 90 years). The prevalence of choledocholithiasis was 32.2%.

The accuracy of the abbreviated MRCP protocol for choledocholithiasis was 98.7%. There was no difference between the performance of the abbreviated and conventional MRCP image sets for detection of choledocholithiasis (TABLE 2). Cohen kappa coefficient value indicates excellent agreement between the protocols (kappa=0.970), with a sensitivity of 98% and a specificity of 99%.

There was excellent agreement between observers for all parameters evaluated in the abbreviated and conventional protocol (TABLE 3).

Stone size also showed excellent agreement between protocols, with a mean difference of 0.34 mm between protocols. In only two cases there was a statistically significant disagreement (4.3%), exceeding the 95% limits of agreement stipulated by Bland and Altman (FIGURE 2). False-positive result occurred in one case, demonstrated in FIGURE 3.

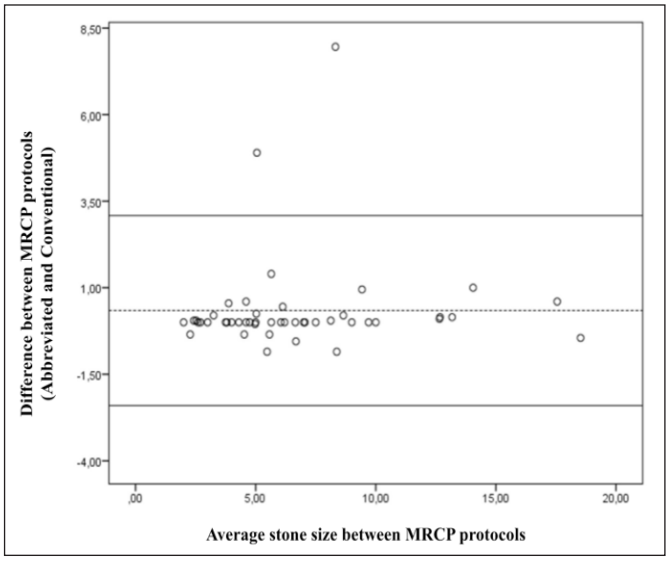

FIGURE 2. Bland-Altman chart to assess the agreement between the protocols regarding the stone size. The dashed line represents the mean difference between the protocols (0.34) and the lower and upper lines represents the 95% limits of agreement (-2.404 to 3.084).

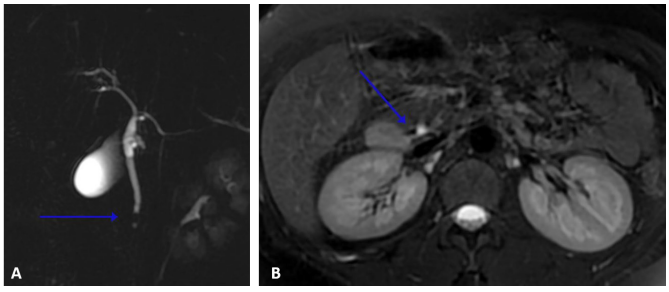

FIGURE 3. Magnetic resonance cholangiopancreatography (MRCP) protocol for choledocholithiasis: A) Abbreviated protocol B) conventional protocol.

TABLE 2. Agreeement between abbreviated and conventional MRCP protocols.

Variables	Abbreviated MRCP	Conventional MRCP	Agreement measure	*P*
Choledocholithiasis – n (%)	49 (32.2)	49 (32.2)	K=0.970	<0.001
Stone size (mm) – mean ± SD	6.87±3.94	6.53±3.86	ICC=0.967	<0.001

MRCP: magnetic resonance cholangiopancreatograph; K: kappa agreement coefficient; ICC: intraclass correlation coefficient; SD: standard deviation.

TABLE 3. Agreement between Observer A and B in the abbreviated MRCP protocol.

Variables	Observer A	Observer B	Agreement measure	*P*
CHD measure (mm) – mean ± SD	6.47±3.30	5.35±3.07	ICC=0.961	<0.001
Choledocholithiasis (mm) – n (%)	49 (32.2)	50 (32.2)	K=1000	<0.001
Stone size (mm) – mean ± SD	7.87±4.70	5.53±3.90	ICC=0.801	<0.001

MRCP: magnetic resonance cholangiopancreatograph; K: kappa agreement coefficient; CHD: common hepatic duct; ICC: intraclass correlation coefficient.

Additional findings identified in the conventional MRCP protocol are demonstrated in TABLE 4. Hemorrhagic renal cyst accounted for 7.2 % (11/152) of findings, while liver nodule accounted for 5.9% (9/152) of findings, and lesions in other organs, such as evidence of acute pancreatitis and periportal lymphadenopathy, accounted for less than 5% of the cases.

TABLE 4. Additional findings identified only in the conventional magnetic resonance cholangiopancreatograph protocol.

Additional findings	n (%)
Hemorrhagic renal cyst	11 (7.2)
Hepatic nodule	9 (5.9)
Periportal lymphadenopathy	8 (5.3)
Pancreatitis	8 (5.3)
Hepatic iron overload	4 (2.6)
Portal vein thrombosis	4 (2.6)
Other findings	<5

N: sample size.

DISCUSSION

The A-MRCP protocol demonstrated high accuracy compared to conventional MRCP protocol for the detection of common bile duct stones, suggesting no compromise in diagnostic test performance, with similar results to other studies using abbreviated MRCP protocols[1,18]. The high sensitivity and specificity are in line with those previously described, varying from 95 to 100%[6].

This result may be attributed to the reduced number of sequences needed to be interpreted and tailored to answer the specific clinical question of acute biliary obstruction.

A-MRCP had one false negative case, a patient that had a small stone in the ampullary region, missed because of the lack of contrast between the stone and surrounding high signal bile outlining the stone. The only one false-positive result occurred due to a peri-ampullary duodenal diverticulum being mistaken for an ampullary stone. This problem is common in the routine interpretation of MRCP exams. Perhaps axial images through the ampulla are suggested to minimize this issue, as already discussed in previous studies[11].

There were no differences in accuracy regarding the biliary stone size, reinforcing the excellent performance of A-MRCP regardless of stone size. Also, there was agreement for biliary duct dilatation in both protocols. In our study the prevalence of common bile stones in patients with suspected choledocholithiasis was similar as previously reported by Kim et al.[19].

There was excellent inter-reader agreement in all parameters evaluated in the abbreviated and conventional protocol, which shows high accuracy of A-MRCP despite reader expertise.

Non biliary additional findings are common in the MRCP exams, as reported in previous study examining the performance of a non-contrast MRCP[18]. Additional findings identified only by the full study occurred in more than one third of the cases, perhaps the most frequent were considered low risk for patient harm and would therefore be unlikely to warrant characterization during the acute setting.

The study limitations were its retrospective design and somewhat small size. Since a was a retrospective study we it was not feasible to evaluate the real life exam time saving benefit of the abbreviated MRCP protocol.

The findings apply to patients with colic pain or pancreatitis, with the suspicion of choledocholithiasis, and results should not be generalized to patients with asymptomatic cholestasis with a potential malignancy, or other primary cause of symptoms. Also, the study includes patients of only one center and our findings may not be extend to a more diverse population.

MRCP protocols may differ by institution, and we did not valuate the contribution of each imaging plane or pulse sequences or compare their performance.

In conclusion, the reported results have shown similar accuracy for the abbreviated MRCP protocol and the conventional MRCP protocol to detect common bile duct stones, suggesting that patients with suspicion for choledocholithiasis may benefit from shortened examinations.

A full set of contrast-enhanced MRI of the abdomen could be subsequently performed for the non-emergent assessment of indeterminate lesions or incidental findings.

Prospective studies in larger cohorts are essential to validate and confirm the strength of abbreviated MRCP protocols, as well as to establish real time and cost savings, as well as the most efficient pulse sequences to evaluate the biliary system.

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Authors' contribution

Agostini AFP: data collection, research execution, text writing, statistical analysis, writing review. Hochhegger B: research execution, text writing, statistical analysis, writing review. Forte GC: data collection, text writing, statistical analysis, writing review. Susin LA: research execution, text writing, writing review. Difini JPM: research execution, text writing, writing review.

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RESUMO – Contexto – Protocolos abreviados de ressonância magnética (RM) surgiram a fim de reduzir o tempo de exame, eliminando sequências de pulso desnecessárias para responder a uma questão clínica específica, sem comprometer o diagnóstico. **Objetivo –** O objetivo do estudo foi avaliar a acurácia diagnóstica de um protocolo abreviado de colangiopancreatografia por ressonância magnética (colangioRM) em pacientes com suspeita de coledocolitíase. **Métodos** – Estudo retrospectivo, com pacientes acima de 10 anos que realizaram exame de colangioRM, entre outubro de 2019 a junho de 2020, com suspeita clínica de coledocolitíase. Os observadores, radiologistas especialistas, primeiro avaliaram a árvore biliar usando um protocolo abreviado de colangioRM composto por quatro sequências de pulso e, posteriormente, revisaram o protocolo convencional de colangioRM de 11 sequências. A presença de coledocolitíase, o tamanho do cálculo, o calibre do ducto hepático comum e achados adicionais foram avaliados. **Resultados** – Um total de 148 pacientes foram incluídos, sendo 62,8% do sexo feminino, com média de 50,9 anos de idade. A prevalência de coledocolitíase foi de 32,2%. A acurácia do protocolo abreviado de colangioRM para coledocolitíase foi de 98,7%. Não houve diferença entre o desempenho dos protocolos abreviado e convencional de colangioRM para a detecção de coledocolitíase (k=0,970), com uma sensibilidade de 98% e uma especificidade de 99%. Além disso, observou-se excelente concordância entre observadores na avaliação de coledocolitíase em ambos os protocolos de colangioRM (k=0,925). **Conclusão** – O protocolo abreviado de colangioRM apresentou excelente acurácia para o diagnóstico de coledocolitíase quando comparado ao protocolo convencional.

Palavras-chave – Coledocolitíase; colangioRM; protocolo abreviado; colangiopancreatografia por ressonância magnética.

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