

Magnetic resonance cholangiopancreatography for the detection of pancreatic duct stones in patients with chronic pancreatitis

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CONCLUSION: MRCP is strongly suggested for the detection of PDS in patients with gastrointestinal symptoms, intermittent abdominal pain, DM/IGT and positive B-mode ultrasound results.

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Key words: Chronic pancreatitis; Pancreatic duct stone; Magnetic resonance cholangiopancreatography; B-mode ultrasound; Logistic regression

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Abstract

AIM: To assess the role of magnetic resonance cholangiopancreatography (MRCP) in detection of pancreatic duct stones (PDS) in patients with chronic pancreatitis (CP).

METHODS: Clinical data of 78 CP patients who were treated at the First Affiliated Hospital of Xi'an Jiaotong University (China) between January 2004 and July 2008 were retrospectively analyzed. A predictive model of pancreatic duct stones was established through logistic regression and its effectiveness was verified. Among these patients, MRCP was performed in 60 patients who served as a control group, while 44 patients with a higher predictive value than the entry threshold of the predictive model served as an experimental group.

RESULTS: The positive rate of PDS in the 78 patients with CP was 19.2% (15/78). The predictive entry threshold of the predictive model was 5% ($P < 0.05$). The possibility of existence of PDS could be predicted according to the following 4 indexes: gastrointestinal symptoms, intermittent abdominal pain, diabetes mellitus (DM)/impaired glucose tolerance (IGT) and positive B-mode ultrasound results. The incidence of PDS in the experimental group was higher than that in the control group ($P < 0.05$).

INTRODUCTION

Pancreatic duct stone (PDS) is a severe complication of patients with chronic pancreatitis (CP)^[1]. It has been reported that 30% of CP patients are complicated by PDS^[2]. Conventional examinations are not conclusive for the diagnosis of PDS. To confirm the existence of PDS, imaging examinations, including B-mode ultrasound, computed tomography (CT), endoscopic retrograde cholangiopancreatography (ERCP) and magnetic resonance cholangiopancreatography (MRCP) have been extensively used in the diagnosis of PDS^[3-7]. Among them, MRCP is most widely used in clinical practice for the differentiation diagnosis of PDS, pancreatitis, pancreatic tumor, pancreatic cyst and congenital diseases due to its non-invasiveness, high accuracy and repeatability^[8-10]. It has been reported that MRCP has a sensitivity of 91.6%, an accuracy of 95.6%, and a specificity of 100% for the detection of PDS^[11]. In this study, 78 patients with CP were analyzed retrospectively through a predictive model of PDS based on logistic regression for the rational application of MRCP in detection of PDS.

MATERIALS AND METHODS

Patients

This study included 78 CP patients at the age of 13-66 years (42 males, 36 females, with a median age of 42 years) who were treated at the First Affiliated Hospital of Xi'an Jiaotong University (China) between January 2004 and July 2008. Among them, 60 patients who underwent MRCP served as a control group, while 44 patients with a higher predictive value than the entry threshold of our predictive model served as an experimental group. The study was approved by the Review Board of Xi'an Jiaotong University and written informed consent was obtained from each patient to participate in this study.

Clinical assessment

Clinical data of the 78 patients at admission were analyzed, including gender, age, history of drinking, clinical symptoms (intermittent abdominal pain with or without back pain, progressive emaciation, steatorrhea, cholelithiasis, abdominal distention, anorexia, nausea, vomiting, fever and jaundice), laboratory findings (blood glucose, serum and urine amylase), and the results of B-mode ultrasound examination (pancreatic duct stones or pancreatic duct dilation). The results of MRCP (PHILIPS Intera 1.5T MR scanner) of the 60 patients in experimental group were also collected.

Age over 65 years and less than 65 years was defined as elderly and non-elderly, respectively. History of drinking included alcoholism (> 1 year and > 150 g/d) and non-alcoholism. Hypoglossal temperature over 37.4°C was defined as fever. Pancreatic duct dilation was diagnosed if the main pancreatic duct diameter was greater than 3 mm in the head and 2 mm in the body or tail of pancreas.

Statistical analysis

Stepwise logistic regression was used to evaluate the factors concerned using SPSS 13.0 for windows. PDS was defined as a dependent variable. "Gender, age, history of drinking, clinical symptoms, laboratory findings and the result of B-mode ultrasound examination" were defined as independent variables. The relative risk was used to express the relation between PDS and each factor (95 % CI). A multivariate logistic regression model was established to obtain the forecasting indexes of PDS. Then a predictive model was established and the prominence of each independent variable was verified with the Wald method.

Primary screening for PDS was performed in the 78 patients using the predictive model. Patients with a higher predictive value than the entry threshold of the predictive model were included in experimental group. Differences in the diagnostic value of MRCP for PDS between experimental and control groups were analyzed by binomial distribution test.

RESULTS

Fifteen of the 78 patients were finally diagnosed with PDS. PDS was found in 10 of the 60 patients who

Table 1 Correlation between each factor and PDS

Index	Odds ratio (95% CI)	P
Sex	2.47 (1.19, 5.01)	< 0.05
Age	0.54 (0.13, 1.69)	0.95
Drinking history	2.81 (1.25, 6.04)	0.54
Intermittent abdominal pain	6.42 (3.09, 13.72)	< 0.01
Aggravated emaciation	10.62 (4.92, 26.24)	< 0.01
Steatorrhea	1.31 (0.58, 2.78)	0.65
Cholelithiasis	3.54 (1.72, 6.29)	< 0.01
Gastrointestinal symptoms	5.20 (2.63, 12.44)	< 0.01
Fever	0.67 (0.20, 1.98)	< 0.96
Jaundice	9.84 (4.31, 23.47)	< 0.01
DM/IGT	11.24 (6.58, 25.63)	< 0.01
Serum and urine amylase	1.26 (0.53, 2.42)	0.72
Result of B-mode ultrasound	13.64 (6.36, 28.63)	< 0.01

Table 2 Correlation between 4 indexes and PDS

Index	Odds ratio (95% CI)	Wald	P
Intermittent abdominal pain	3.83 (1.37, 8.06)	20.23	< 0.05
Gastrointestinal symptoms	4.78 (2.26, 10.14)	23.18	< 0.05
DM/IGT	4.34 (1.85, 8.47)	24.56	< 0.01
The result of B-mode ultrasound examination	12.64 (5.72, 22.39)	29.81	< 0.01

underwent MRCP. The false positive rate of MRCP in the 60 patients was 0% as confirmed at intraoperative examination. Among the other 5 PDS patients diagnosed with B-mode ultrasound or CT (pancreatic dilation or stones) and verified during operation, no PDS was found in 1 at MRCP.

Relation between PDS and indexes

Binary logistic regression revealed that there were a significant relation and a high relative risk between the occurrence of PDS and the 4 indexes including positive result of B-mode ultrasound examination, diabetes mellitus (DM)/impaired glucose tolerance, progressive emaciation and jaundice (Table 1).

Multivariate logistic regression analysis showed that PDS was closely related with the 4 indexes including gastrointestinal symptoms (abdominal distention, anorexia, nausea and vomiting), intermittent abdominal pain, DM/IGT and the positive result of B-mode ultrasound (Table 2). The incidence of PDS was 2%-95% (negative vs positive indexes), and increased to 16% when the result of B-mode ultrasound was positive. If the result of B-mode ultrasound was not taken into account, the corresponding incidence of PDS would be 11%-16% for the other two positive indexes and 5%-7% for the single positive index, suggesting that a threshold of 5% could be recommended as the predictive entry threshold for the selection of patients serving as a experimental group (Table 3). The relation between the predictive model and the final diagnosis is shown in Table 4.

Incidence of PDS in different groups

The 44 patients including 15 PDS patients with a

Table 3 Incidence of PDS (%)

Positive indexes(gastrointestinal symptoms, DM/IGT, intermittent abdominal pain)	B-mode ultrasound	
	Negative	Positive
1	5-7	38-41
2	19-23	76-82
3	54	95

higher predictive value than the entry threshold of the predictive model served as the experimental group (Table 4). Considering the high sensitivity and accuracy of MRCP, we assumed that the 4 PDS patients who did not undergo MRCP would have positive results of MRCP, thus increasing the accuracy and reliability of statistical results. Under such conditions, the positive diagnostic rate of MRCP for PDS was significantly different in experimental and control groups (31.8% *vs* 16.7% or 14/44 *vs* 10/60) according to the binomial distribution test.

DISCUSSION

CP, a kind of segmental or diffuse inflammation induced by various causes in pancreatic tissue, presents with recurrent or persistent abdominal pain and progressive dysfunction of pancreas, leading to permanent loss of endocrine and exocrine pancreatic function^[12-14]. Early pathological changes in pancreatic tissue include focal fat necrosis, fibrosis of leaflet and duct, and protein thrombus or stones in side branches of the main pancreatic duct. Dilated or obstructed pancreatic duct, eosinophilic protein thrombus and stones can be found in the progressive stage of PDS in the main pancreatic duct.

The incidence of PDS is less than 1% in normal population, while it is about 30% in CP patients^[2]. PDS can lead to the damages of pancreatic tissues and corresponding clinical symptoms^[15-18]. It was reported that 12%-22.2% of PDS patients finally develop pancreatic adenocarcinoma^[19,20]. Therefore, early diagnosis of PDS is of very important clinical significance.

Traditionally, biliary tract disease is the main cause of CP in China^[21,22]. With the improvement in living standard, alcoholism is the exceeding biliary tract disease and has become the primary cause of CP. Actually, alcoholism in many countries, especially in developed countries, is the most frequent cause of CP. It has been shown that 70%-80% of CP patients have chronic alcohol drinking history^[23-26], and the mortality of alcoholic CP patients has increased to approximately 50% in the past 20 years^[25]. However, in our present study, the incidence of alcoholism-related CP (25.8%) was lower than that of biliary tract disease-related CP (38.1%). We assumed that it might be due to the relatively lower living standard in local areas.

In our study, 100% of patients with PDS had abdominal pain, 66.7% had abdominal distention and nausea, 53.3% had DM/IGT. The relation between these clinical manifestations and PDS was confirmed by multivariable logistic regression analysis. On the other

Table 4 Relation between the prediction model and the final diagnosis

Incidence of PDS in the prediction model (%)	<i>n</i>	Final diagnosis		
		Non-stones	Stones	PDS incidence (%)
< 5	34	34	0	0
5-7	26	24	2	7
19-23	5	4	1	20
38-54	2	1	1	50
76-95	11	0	11	100

hand, as a primary screening method for PDS, B-mode ultrasound has a relatively high sensitivity and specificity. Thus, a predictive model based on the above indexes was established and the predictive entry threshold was set at 5%, and MRCP was recommended as a routine examination for patients with a higher predictive value than the entry threshold.

By analyzing the data through our predictive model, we found that PDS was closely correlated with the 4 indexes (gastrointestinal symptoms, intermittent abdominal pain, DM/IGT and the result of B-mode ultrasound examination). Due to the existence of PDS and calcification, pancreatic duct pressure increases and the pancreatic secretion decreases or loses. Therefore, clinical symptoms such as gastrointestinal symptoms, intermittent abdominal pain, and DM/IGT occur in patients with PDS. Also, direct and/or indirect signs of PDS could be roughly detected by B-ultrasonography. If only one of the indexes is positive, the damage to pancreatic tissue is not serious, and the incidence of PDS is low.

In conclusion, MRCP is strongly recommended for the final diagnosis of PDS in patients with gastrointestinal symptoms, intermittent abdominal pain, DM/IGT and positive B-ultrasonography result.

COMMENTS

Background

Pancreatic duct stone (PDS) is a severe complication of chronic pancreatitis (CP). It was reported that 30% of CP patients are complicated by PDS. At present, the diagnosis of PDS depends on some imaging examinations, such as B-mode ultrasound, computed tomography (CT), endoscopic retrograde cholangiopancreatography (ERCP) and magnetic resonance cholangiopancreatography (MRCP), etc.

Research frontiers

Compared with other imaging techniques, MRCP is easy to perform and has no contraindication. It could provide detailed information about pancreatic duct and common bile duct. Therefore, MRCP is widely applied in the diagnosis of PDS.

Innovations and breakthroughs

In this study, a predictive model was established in an attempt to increase the diagnosis rate of PDS by MRCP. The result supports application of MRCP in detection of PDS.

Peer review

The authors established a predictive model for PDS in CP patients and verified that 4 indexes were closely correlated with PDS, which may elevate the diagnosis rate of PDS.

REFERENCES

- 1 König A, König U, Gress T. [Diagnostics and therapy of

- chronic pancreatitis] *Internist (Berl)* 2008; **49**: 695-707; quiz 708-709
- 2 **Maydeo A**, Soehendra N, Reddy N, Bhandari S. Endotherapy for chronic pancreatitis with intracanalicular stones. *Endoscopy* 2007; **39**: 653-658
 - 3 **Sugiyama M**, Haradome H, Atomi Y. Magnetic resonance imaging for diagnosing chronic pancreatitis. *J Gastroenterol* 2007; **42** Suppl 17: 108-112
 - 4 **Tennoe B**, Stiris MG, Dullerud R, Lunde OC, Aadland E. [Magnetic resonance tomography of biliary and pancreatic ducts] *Tidsskr Nor Laegeforen* 1999; **119**: 3252-3256
 - 5 **Seibold F**. Indications for preoperative ERCP. *Swiss Surg* 2000; **6**: 216-219
 - 6 **Pavone P**, Laghi A, Catalano C, Brogna L, Scipioni A, Di Girolamo M, Sarrantonio A, Passariello R. [Magnetic resonance cholangiopancreatography. A new method of noninvasive biliopancreatic diagnosis] *Radiol Med* 1995; **90**: 438-443
 - 7 **Reinbold C**, Bret PM, Guibaud L, Barkun AN, Genin G, Atri M. MR cholangiopancreatography: potential clinical applications. *Radiographics* 1996; **16**: 309-320
 - 8 **Chen WX**, Xie QG, Zhang WF, Zhang X, Hu TT, Xu P, Gu ZY. Multiple imaging techniques in the diagnosis of ampullary carcinoma. *Hepatobiliary Pancreat Dis Int* 2008; **7**: 649-653
 - 9 **Alkaade S**, Cem Balci N, Momtahan AJ, Burton F. Normal pancreatic exocrine function does not exclude MRI/MRCP chronic pancreatitis findings. *J Clin Gastroenterol* 2008; **42**: 950-955
 - 10 **Anupindi SA**, Victoria T. Magnetic resonance cholangiopancreatography: techniques and applications. *Magn Reson Imaging Clin N Am* 2008; **16**: 453-466, v
 - 11 **Hekimoglu K**, Ustundag Y, Dusak A, Erdem Z, Karademir B, Aydemir S, Gundogdu S. MRCP vs. ERCP in the evaluation of biliary pathologies: review of current literature. *J Dig Dis* 2008; **9**: 162-169
 - 12 **Behrns KE**, Ben-David K. Surgical therapy of pancreatic pseudocysts. *J Gastrointest Surg* 2008; **12**: 2231-2239
 - 13 **Han SL**, Chen J, Zhou HZ, Lan SH, Zhang PC, Zhu GB. Indications and surgical treatment of chronic pancreatitis. *Hepatobiliary Pancreat Dis Int* 2008; **7**: 638-642
 - 14 **Kavanagh DO**, O'Riain C, Ridgway PF, Neary P, Crotty TC, Geoghegan JG, Traynor O. Radical pancreaticoduodenectomy for benign disease. *ScientificWorldJournal* 2008; **8**: 1156-1167
 - 15 **Schlosser W**, Schwarz A, Beger HG. Surgical treatment of chronic pancreatitis with pancreatic main duct dilatation: Long term results after head resection and duct drainage. *HPB (Oxford)* 2005; **7**: 114-119
 - 16 **Abdel Aziz AM**, Lehman GA. Current treatment options for chronic pancreatitis. *Curr Treat Options Gastroenterol* 2007; **10**: 355-368
 - 17 **Schima W**, Ba-Ssalamah A, Plank C, Kulinna-Cosentini C, Puspok A. [Pancreas. Congenital changes, acute and chronic pancreatitis.] *Radiologe* 2007; **47**: S41-S56
 - 18 **Mayerle J**, Stier A, Lerch MM, Heidecke CD. [Chronic pancreatitis. Diagnosis and treatment] *Chirurg* 2004; **75**: 731-747; quiz 748
 - 19 **Hart AR**, Kennedy H, Harvey I. Pancreatic cancer: a review of the evidence on causation. *Clin Gastroenterol Hepatol* 2008; **6**: 275-282
 - 20 **Poelman SM**, Nguyen K. Pancreatic panniculitis associated with acinar cell pancreatic carcinoma. *J Cutan Med Surg* 2008; **12**: 38-42
 - 21 **Chen WX**, Zhang WF, Li B, Lin HJ, Zhang X, Chen HT, Gu ZY, Li YM. Clinical manifestations of patients with chronic pancreatitis. *Hepatobiliary Pancreat Dis Int* 2006; **5**: 133-137
 - 22 **Yan MX**, Li YQ. Gall stones and chronic pancreatitis: the black box in between. *Postgrad Med J* 2006; **82**: 254-258
 - 23 **Polednak AP**. Temporal trend in the U.S. black-white disparity in mortality rates from selected alcohol-related chronic diseases. *J Ethn Subst Abuse* 2008; **7**: 154-164
 - 24 **Bachmann K**, Mann O, Izbicki JR, Strate T. Chronic pancreatitis--a surgeons' view. *Med Sci Monit* 2008; **14**: RA198-RA205
 - 25 **Pezzilli R**, Lioce A, Frulloni L. Chronic pancreatitis: a changing etiology? *JOP* 2008; **9**: 588-592
 - 26 **Kinney TP**, Freeman ML. Approach to acute, recurrent, and chronic pancreatitis. *Minn Med* 2008; **91**: 29-33

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