

Approach of suspected common bile duct stones : endoscopic ultrasonography

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Abstract

Recent studies have shown that endoscopic ultrasonography (EUS) is the most sensitive method for diagnosing choledocholithiasis. High sensitivities of more than 95% have been reported by several authors. Imaging the extrahepatic bile ducts and the gallbladder and searching for biliary stones are easy tasks for EUS. EUS has the advantages over ERCP to be less invasive (complication rate similar to diagnostic upper GI endoscopy) and to be able to detect small stones and sludge that can easily be masked by contrast medium during ERCP. In comparison with magnetic resonance imaging (MRI), EUS has the advantage to be close to the investigated areas and to allow the detection of very small stones or sludge, even in non dilated bile ducts.

Technical limitations of biliary imaging by EUS are few : upper GI stenosis, previous gastrectomy or Billroth II resection. Imaging can be obscured by the presence of air (previous sphincterotomy or surgical bypass), surgical clips calcifying pancreatitis or a duodenal diverticulum.

Main indications of EUS include the detection of choledocholithiasis in patients with a low and intermediate probability of presence of stones, in idiopathic acute pancreatitis, in mild and moderate pancreatitis after normal transabdominal ultrasonography, in pregnant women, in intensive care patients, in the diagnosis of gallbladder lithiasis or sludge, and also when MRI is contraindicated (claustrophobia and metallic implants) or fails to provide a diagnosis or is not available. Screening of choledocholithiasis with EUS has also been proposed in patients scheduled for laparoscopic cholecystectomy, but this is not common practice in Belgium. (*Acta gastroenterol. belg.*, 2000, 63, 295-298).

Key words : EUS, endoscopic ultrasonography, MRCP, magnetic resonance imaging, pancreatitis, choledocholithiasis, gallstones, sludge.

Introduction

The diagnosis of choledocholithiasis remains a challenge for most radiological techniques. Transcutaneous ultrasonography and tomodesitometry have a sensitivity of 75% according to the best studies (1-2). In clinical practice their diagnostic value is however much lower. Endoscopic retrograde cholangiography (ERCP) is considered as the gold standard in most studies. However its sensitivity depends on the endoscopist's experience (bile duct cannulation is not always possible), and whether a sphincterotomy (tiny stones can easily be masked by contrast medium during ERCP) or a microscopic examination of bile is performed (3-5). ERCP and endoscopic sphincterotomy are associated with a complication rate approaching 10% and should therefore be restricted to therapeutic rather than diagnostic indications (6-8).

Other imaging techniques are now available, including CT cholangiography (9), magnetic resonance cholangiopancreatography (MRCP) (10-17) and endoscopic ultrasonography (EUS) (18-32). CT cholangi-

graphy performed with the most recent technology has been reevaluated with rates of sensitivity and specificity approaching 88 and 97% respectively (33-34). Cholestasis and jaundice will however decrease its sensitivity and the technique implies intravenous injection of contrast media with a potential morbidity and mortality.

Magnetic resonance imaging with MRCP seems to be the most attractive non-invasive procedure with sensitivity rates of 81% to 95% in the diagnosis of choledocholithiasis. Its value in patients with non dilated ducts and suspicion of small stones, especially in acute pancreatitis, remains to be assessed in controlled studies. MRCP is an expensive procedure and it should not be performed in pregnant women and patients who are claustrophobic or have metallic implants. Its efficiency will decrease with small stones, sludge or the presence of air after surgical anastomosis or endoscopic sphincterotomy (35).

Recent studies have shown that EUS is the most sensitive imaging procedure to detect choledocholithiasis. A particularly interesting feature is its ability to detect small stones (1mm) and sludge (36). This high sensitivity has promoted its use in some countries immediately prior to laparoscopic cholecystectomy (21,22,27).

Feasibility

Two systems are currently widely available for EUS imaging : the "radial" mechanical Olympus echoendoscope with 360° sector scanning perpendicular to the axis of the endoscope and the "linear array" digital Pentax echoendoscope with a 100 degree sector scan that is parallel to the endoscope axis. Miniature probes are more recently available and can be introduced in the bile ducts to assess residual bile duct stones (37).

Both systems have been used in published reports with a similar accuracy (38). The learning curve of the linear array echoendoscope in the pancreaticobiliary area is somewhat longer but it provides a better view of the gallbladder than does the radial EUS system.

Stones in the biliary tree can be easily identified as a hyperechoic focus often associated with acoustic shadowing. The EUS appearance is well correlated with the structure of the stone and its hardness, thus

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providing interesting information before mechanical or external lithotripsy. In cases with aerobilia, the echogenicity and the position of the stones in the bile duct compared to air bubbles allow most of the time a correct differential diagnosis.

The technical limitations are few. Previous Billroth II procedures, total gastrectomy, hepaticojejunostomy should be considered contra-indications although visualisation of the common bile duct can be obtained in 50% of the patients with previous Billroth II surgery (personal experience). Upper GI stenosis, Zenker diverticulum, severe cervical arthrosis will complicate or preclude the endoscopic procedure. Chronic calcifying pancreatitis, duodenal diverticulum, previous sphincterotomy allowing for interposition of stones or air could lead to false positive examinations. In these cases EUS imaging of the biliary tree requires significant experience and practice.

Sensitivity and specificity of EUS

Multiple reports have shown a high accuracy of EUS in the detection of common bile duct stones (18-32). These are summarized in Table I. Average sensitivity, specificity and accuracy of EUS are 92%, 98% and 94%, respectively. These results are similar to those of ERCP followed by sphincterotomy for stone removal, without the associated risks.

The resolution rate of EUS reaches 0.1 mm compared to a 1.5 mm resolution rate of MRI. It can detect small stones and sludge in the main common bile duct, the cystic duct and the gallbladder (36,39). In the latter indication, several reports pointed out the efficiency of EUS to detect gallbladder stone despite normal transabdominal US. It is particularly recommended in patients with one of the following clinical situations : idiopathic acute or relapsing pancreatitis, obese patients with typical clinical presentation or any patient with a high suspicion of cholelithiasis and a negative work-up (39-41).

Comparative studies

Most studies on the efficiency of EUS in choledocholithiasis have compared the EUS results with those of ERCP (42). There are only two published reports comparing EUS with MRI and MRCP (29,32). The first one included 43 patients. Eleven patients were excluded because of unavailability of MRI (n = 5) or EUS (n = 6). Ten patients had choledocholithiasis. Sensitivity, specificity, positive and negative predictive values were 100, 95.4, 90.9, 100% and 100, 72.7, 62.5 and 100%, respectively for EUS and MRCP. Accuracy of EUS and MRCP were not significantly different (29). In the second study, 50 patients extrahepatic cholestasis were included, of whom 12 had choledocholithiasis. Sensitivity, specificity, positive and negative predictive values were 100, 93.7, 96.6, 100% and 93.5, 93.7, 88.2 and 93.6%, respectively for EUS and MRCP. Accuracy of EUS (97.8%) and MRCP (93.6%) was thus also not significantly different. EUS was however more sensitive in the detection of sludge in the common bile duct and was able to depict associated abnormalities suggestive of stone migration such as cholangitis (thickening of common bile duct walls) (32).

Concerning cost effectiveness, EUS followed by ERCP if necessary was shown more cost effective than MRI and ERCP. EUS and ERCP can be performed in the same anaesthetic or sedation procedure allowing further decrease of cost (28).

Complication rate

Complications with diagnostic EUS are remarkably uncommon : a Belgian survey on 21055 procedures performed in 12 centers by experienced endosonographers showed a complication rate of 0.06% comparable to the 0.008 to 0.24% rates reported for diagnostic upper GI endoscopy (43).

Table I. — Sensitivity and specificity of EUS for diagnosing choledocholithiasis

Author	Year	n	N with stones	EUS		CT		MRCP	
				Sens (%)	Spec (%)	Sens (%)	Spec (%)	Sens (%)	Spec (%)
Edmundowicz (18)	1992	40	8	88	97				
Amouyal (19)	1994	62	22	97	100				
Palazzo (20)	1995	422	185	95	98				
Shim (21)	1995	132	28	89	100				
Aubertin (22)	1996	50	12	100	97				
Prat (23)	1996	119	78	93	97				
Sugiyama (24)	1997	155	51	96	100	71	97		
Burtin (25)	1997	68	68	94	100				
Norton (26)	1997	50	50	88	96				
Montariol (27)	1998	240	37	85	93				
Canto (28)	1998	64	64	94	94				
De Lédinghen (29)	1999	43	10	100	95			100	72
Nandi (30)	1999	25	4	75	100			25	94
Chak (31)	1999	36	12	91	100				
Materne (32)	2000	50	12	97	88			91	94
Total/Average				92	98	81	97	73	86

Table II. — Indications for EUS in the diagnosis of cholelithiasis

INDICATIONS FOR EUS	
Good	<ul style="list-style-type: none"> – mild to moderate acute pancreatitis – low and intermediate probability of choledocolithiasis – diagnosis of gallbladder lithiasis or sludge – intensive care unit patients – prior to laparoscopic cholecystectomy – obstructive cholestasis and jaundice
Definite	<ul style="list-style-type: none"> – idiopathic acute or recurrent pancreatitis – pregnant women – contra-indication to perform MRI (claustrophobia and metallic implants) – failure of MRI – MRI not available or with a poor expertise
To compare with ERCP	<ul style="list-style-type: none"> – high probability of choledocolithiasis – acute cholangitis – severe pancreatitis
Contra-indications	<ul style="list-style-type: none"> – upper GI stenosis – previous surgical procedures such as Billroth II, total gastrectomy, hepaticojejunostomy,...

Conclusion

Transabdominal ultrasonography remains the diagnostic imaging modality of choice for the initial evaluation of suspected cholelithiasis. Its sensitivity is however low in clinical practice and further diagnostic testing should rely on EUS or MRCP.

The indications for EUS in the diagnosis of choledocolithiasis and related diseases are summarized in Table II. EUS can be considered as the gold standard non-invasive imaging method due to its high sensitivity especially in acute pancreatitis, normal sized ducts and small stones.

References

1. BARON R.L. Common bile duct stones : reassessment of criteria for CT diagnosis. *Radiology*, 1987, **162** : 419-424.
2. GROSS B.H., HARTER L.P., GORE R.M., CALLEN P.W., FILLY R.A., SHAPIRO H.A., GOLDBERG H.I. Ultrasonic evaluation of common bile duct stones : prospective comparison with endoscopic retrograde cholangiopancreatography. *Radiology*, 1983, **146** : 471-477.
3. BUSCAIL L., ESCOURROU J., DELVAUX M., GUIMBAUD R., NICOLET T., FREXINOS J., RIBET A. Microscopic examination of bile directly collected during endoscopic cannulation of the papilla : utility in patients with suspected microlithiasis. *Dig. Dis. Sci.*, 1992, **37** : 116-120.
4. FREY C.F., BURBIGE E.J., MEINKE W.B., PULLOS T.G., WONG H.N., HICKMAN D.M., BELBER J. Endoscopic retrograde cholangiopancreatography. *Am. J. Surg.*, 1982, **144** : 109-114.
5. LENRIOT J.P., LE NEEL J.C., HAY J.M., JAECK D., MILLAT B., FAGNIEZ P.L. Cholangio-pancreatographie rétrograde et sphinctérotomie endoscopique pour lithiase biliaire : évaluation prospective en milieu chirurgical. *Gastroenterol. Clin. Biol.*, 1993, **17** : 244-250.
6. COTTON P.B. Progress report : ERCP. *Gut*, 1977, **18** : 1316-321.
7. FREEMAN M.L., NELSON D.B., SHERMAN S., HABER G.B., HERMAN M.E., DORSHER P.J., MOORE J.P., FENNERTY M.B., RYAN M.E., SHAW M.J., LANDE J.D., PHELEY A.M. Complications of endoscopic biliary sphincterotomy. *N. Eng. J. Med.*, 1996, **335** : 909-918.
8. VAIRA D., AINLEY C., DOWSETT J., WILLIAMS S., BAILLIE J., CAIRNS S., CROKER J., SALMON P., COTTON P. Endoscopic sphincterotomy in 1000 consecutive patients. *Lancet*, 1989, **ii** : 431-434.
9. VAN BEERS B.E., LACROSSE M., TRIGAUX J.P., DE CANNIERE L., DE RONDE T., PRINGOT J. Noninvasive imaging of the biliary tree before or after laparoscopic cholecystectomy : use of three-dimensional spiral CT cholangiography. *Am. J. Roentgenol.*, 1994, **162** : 1331-5.
10. REGAN F., FRADIN J., KHAZAN R., BOHLMAN M., MAGNUSON T. Choledocolithiasis : evaluation with MR cholangiography. *AJR*, 1996, **167** : 1441-1445.
11. CHAN Y.L., CHAN A.C., LAM W.W., LEE D.W., CHUNG S.S., SUNG J.J., CHEUNG H.S., LI A.K., METREWELI C. Choledocolithiasis : comparison of MR cholangiography and endoscopic retrograde cholangiography. *Radiology*, 1996, **200** : 85-89.
12. PAVONE P., LAGHI A., LOMANTO D., FIOCCA F., PANEBIANCO V., CATALANO C., MAZZOCCHI P., PASSARIELLO R. MR cholangiography (MRC) in the evaluation of CBD stones before laparoscopic cholecystectomy. *Surg. Endosc.*, 1997, **11** : 982-985.
13. SUGIYAMA M., ATOMI Y., HACHIYA J. Magnetic resonance cholangiography using half-Fourier acquisition for diagnosing choledocolithiasis. *Am. J. Gastroenterol.*, 1998, **93** : 1886-1890.
14. DWERRYHOUSE S.J., BROWN E., VIPOND M.N. Prospective evaluation of magnetic resonance cholangiography to detect common bile duct stones before laparoscopic cholecystectomy. *Br. J. Surg.*, 1998, **85** : 1364-1366.
15. REINHOLD C., TAUREL P., BRET P.M., CORTAS G.A., MEHTA S.N., BARKUN A.N., WANG L., TAFAZOLI F. Choledocolithiasis : evaluation of MR cholangiography for diagnosis. *Radiology*, 1998, **209** : 435-442.
16. GUIBAUD L., BRET P.M., REINHOLD C., ATRI M., BARKUN A.N. Bile duct obstruction and choledocolithiasis diagnosis with MR cholangiography. *Radiology*, 1995, **197** : 109-115.
17. BECKER C.D., GROSSHOLZ M., BECKER M., MENTHA Y., DE PEYER R., TERRIER F. Choledocolithiasis and bile duct stenosis : diagnostic accuracy of MR cholangiopancreatography. *Radiology*, 1997, **205** : 523-530.
18. EDMUNDOWICZ S.A., ALIPERTI G., MIDDLETON W.D. Preliminary experience using endoscopic ultrasonography in the diagnosis of choledocolithiasis. *Endoscopy*, 1992, **24** : 774-778.
19. AMOUYAL P., AMOUYAL G., LEVY P., TUZET S., PALAZZO L., VILGRAIN V., GAYET B., BELGHITI J., FEKETE F., BERNADES P. Diagnosis of choledocolithiasis by endoscopic ultrasonography. *Gastroenterology*, 1994, **106** : 1062-1067.
20. PALAZZO L., GIROLLET P.P., SALMERON M., SILVAIN C., ROSEAU G., CANARD J.M., CHAUSSADE S., COUTURIER D., PAOLAGGI J.A. Value of endoscopic ultrasonography in the diagnosis of common bile duct stones : comparison with surgical exploration and ERCP. *Gastrointest. Endosc.*, 1995, **42** : 225-31.
21. SHIM C.S., JOO J.H., PARK C.W., KIM Y.S., LEE J.S., LEE M.S., HWANG S.G. Effectiveness of endoscopic ultrasonography in the diagnosis of choledocolithiasis prior to laparoscopic cholecystectomy. *Endoscopy*, 1995, **27** : 428-32.
22. AUBERTIN J.M., LEVOIR D., BOUILLOT J.L., BECHEUR H., BLOCH F., AOUAD K., ALEXANDRE J.H., PETITE J.P. Endoscopic ultrasonography immediately prior to laparoscopic cholecystectomy : a prospective evaluation. *Endoscopy*, 1996, **28** : 667-673.
23. PRAT F., AMOUYAL G., AMOUYAL P., PELLETIER G., FRITSCH J., CHOURY A.D., BUFFET C., ETIENNE J.P. Prospective controlled study of endoscopic retrograde cholangiography in patients with suspected common-bile duct lithiasis. *Lancet*, 1996, **347** : 75-79.

24. SUGIYAMA M., ATOMI Y. Endoscopic ultrasonography for diagnosing choledocholithiasis : a prospective comparative study with ultrasonography and computed tomography. *Gastrointest. Endosc.*, 1997, **45** : 143-6.
25. BURTIN P., PALAZZO L., CANARD J.M., PERSON B., OBERTI F., BOYER J. Diagnostic strategies for extrahepatic cholestasis of indefinite origin : endoscopic ultrasonography or retrograde cholangiography ? Results of a prospective study. *Endoscopy*, 1997, **29** : 349-55.
26. NORTON S.A., ALDERSON D. prospective comparison of endoscopic ultrasonography and endoscopic retrograde cholangiopancreatography in the detection of bile duct stones. *Br. J. Surg.*, 1997, **84** : 1366-1369.
27. MONTARIOL T., MISIKA S., CHARLIER A., REY C., BATAILLE N., HAY J.M., LACAINE F., FINGERHUT A. Diagnosis of asymptomatic common bile duct stones : preoperative endoscopic ultrasonography versus intraoperative cholangiography : a multicenter, prospective controlled study. French Association for Surgical Research. *Surgery*, 1998, **124** : 6-13.
28. CANTO MI, CHAK A, STELLATO T, SIVAK MV Jr. Endoscopic ultrasonography versus cholangiography for the diagnosis of choledocholithiasis. *Gastrointest. Endosc.*, 1998, **47** : 439-48.
29. DE LEDINGHEN V., LECESNE R., RAYMOND J.M., GENSE V., AMOURETTI M., DROUILLARD J., COUZIGOU P., SILVAIN C. Diagnosis of choledocholithiasis : EUS or magnetic resonance cholangiography ? A prospective controlled study. *Gastrointest. Endosc.*, 1999, **49** : 26-31.
30. NANDI P.S., BARNETT J.L., NOSTRANT T.T., CHEY W.D., FRANCIS R.I., PRINCE M.R., CARLOS R.C., SCHEIMANN J.M. A prospective blinded comparison of EUS and MRCP with ERCP in patients with suspected extrahepatic biliary disease. *Gastrointest. Endosc.*, 1999, **49** : AB95.
31. CHAK A., HAWES R.H., COOPER G.S., HOFFMAN B., CATALANO M.F., WONG R.C.K., HERBENER T.E., SIVAK M.V. Prospective assessment of the utility of EUS in the evaluation of gallstone pancreatitis. *Gastrointest. Endosc.*, 1999, **49** : 599-604.
32. MATERNE R., VAN BEERS B.E., GIGOT J.F., GEUBEL A., PRINGOT J., DEPREZ P.H. Extrahepatic cholestasis : prospective comparison of MRC and EUS. *Endoscopy* 2000, **32** : 3-9.
33. STOCKBERGER S.M., WASS J.L., SHERMAN S., LEHMAN G.A., KOPECKY K.K. Intravenous cholangiography with helical CT : comparison with endoscopic retrograde cholangiography. *Radiology*, 1994, **192** : 675-680.
34. NEITLICH J.D., TOPAZIAN M., SMITH R.C., GUPTA A., BURELL, ROSENFIELD A.T. Detection of choledocholithiasis : comparison of unenhanced helical CT and endoscopic retrograde cholangiopancreatography. *Radiology*, 1997, **203** : 753-757.
35. DAVID V., REINHOLD C., HOCHMAN M., CHUTTANI R., MCKEE J., WAXMAN I., WANG L., LI W., KAPLAN R., EDELMAN R.R. Pitfalls in the interpretation of MR cholangiopancreatography. *Am. J. Roentgenol.*, 1998, **170** : 1055-1059.
36. ROSEAU G. Millimetric choledochal calculi, diagnosis using echoendoscopy. *Presse Med.*, 1998, **27** : 593.
37. OHASHI A., UENO N., TAMADA K., TOMIYAMA T., WADA S., MIYADA T., Nishizono T., Tano S., Aizawa T., Ido K., Kimura K. Assessment of residual bile duct stones with use of intraductal US during endoscopic balloon sphincteroplasty : comparison with balloon cholangiography. *Gastrointest. Endosc.*, 1999, **49** : 328-333.
38. LACHTER J., RUBIN A., SHILLER M., LAVY A., YASIN K., SUISSA A., RESHEF R. Linear EUS for bile duct stones. *Gastrointest. Endosc.*, 2000, **51** : 51-54.
39. LIU C.L., LO, C.M., CHAN J.K.F., PON R.T.P., FAN S.T. EUS for detection of occult cholelithiasis in patients with idiopathic pancreatitis. *Gastrointest. Endosc.*, 2000, **51** : 28-32.
40. AMOUYAL G., AMOUYAL P. Endoscopic ultrasonography in gallbladder stones. *Gastrointest. Endosc. Clin. N. Am.*, 1995, **5** : 825-830.
41. DAHAN P., ANDANT C., LEVY P., AMOUYAL P., AMOUYAL G., DUMONT M., ERLINGER S., SAUVANET A., BELGHITI J., ZINS M., VILGRAIN V., BERNADES P. Prospective evaluation of endoscopic ultrasonography and microscopic examination of duodenal bile in the diagnosis of cholecystolithiasis in 45 patients with normal conventional ultrasonography. *Gut*, 1996, **38** : 277-81.
42. DEPREZ P. Comparison of EUS with the new medical imaging modalities. *Acta Endosc.*, 1999, **29** : 15-23.
43. DEPREZ P., DENIS P., DEVIERE J., DUNHAM F., GAST P., GILLARD C.H., HIELE M., LIENARD J.C., NYST J.F., PELCKMANS P., SMEKENS L., SCHAPIRA M., VAN OUTRYVE M., VOET D., WITTERWULGHE M., GILLARD V. Complication rate in the Belgian practice of endosonography. *Acta Gastroenterol. Belg.*, 1997, **60** : C20.