Bingham and Sisters Murphy, McKee, and Devlin. Copies of the questionnaire can be obtained from ABS.

- 1 Waller JA. Chronic medical conditions and traffic safety: review of the California experience. *N Engl J Med* 1965;273:1413-20.
- 2 Crancer A, McMurray L. Accident and violation rates of Washington's medically restricted drivers. *JAMA* 1968;205:74-8.
- 3 Davis TG, Wehling EH, Carpenter RL. Oklahoma's medically restricted drivers. A study of selected medical conditions. *Oklahoma State Medical Association Journal* 1973;66:322-7.
- 4 Ysander L. The safety of drivers with chronic disease. *Br J Ind Med* 1966;23:28-36.
- 5 Eadington DW, Frier BM. Type I diabetes and driving experience: an eight year cohort study. *Diabetic Med* 1989;6:137-41.
- 6 Cochran WG. Some methods for strengthening the common Chi squared tests. *Biometrics* 1954;10:417-51.
- 7 Songer TJ, La Porte RE, Dorman JS, et al. Motor vehicle accidents and IDDM. *Diabetes Care* 1988;11:701-7.
- 8 Clarke B, Ward JD, Enoch BA. Hypoglycaemia in insulin-dependent diabetic drivers. *Br Med J* 1980;281:586.

- 9 Leyshon GE, Elliott RW, Lyons J, Francis HWS. Diabetics and motorway crashes. *Br Med J* 1972;iii:405.
- 10 Lasche EM. The diabetic driver. *Diabetes Care* 1985;8:189-91.
- 11 Haunz EA, Brosseau JD. Non-warning hypoglycemia in drivers with diabetes. *Am Fam Physician* 1984;30:189-97.
- 12 Steel JM. The controversy over insulin-treated diabetics holding a heavy goods vehicle licence. *Practical Diabetes* 1986;3:202.
- 13 Grattan E, Jeffcoat GO. Medical factors and road accidents. *Br Med J* 1968;ii:75-9.
- 14 Herner B, Smedby B, Ysander L. Sudden illness as a cause of motor vehicle accidents. *Br J Ind Med* 1966;23:37.
- 15 Ysander L. Diabetic motor-vehicle drivers without driving-licence restrictions. *Acta Chir Scand [Suppl]* 1970;409:45-53.
- 16 Frier BM, Steel JM, Matthews DM, Duncan LJP. Driving and insulin-dependent diabetes. *Lancet* 1980;i:1232-4.
- 17 Drasco M, Haggerty CM. A comparison of the British number plates and Snellen vision tests for car driving. Crowthorne: Transport and Road Research Laboratory, 1977. (Research report RF 676.)
- 18 Keen H. *Diabetes: Great Britain, London. Medical aspects of fitness to drive.* London: HMSO, 1985. (D.8893958/80 m/9/85.)
- 19 Day JL. *The diabetic handbook: insulin dependent diabetes.* London: British Diabetic Association, 1986:134-6.

(Accepted 3 July 1989)

Electrohydraulic lithotripsy with peroral choledochoscopy

Joseph W C Leung, Sydney S C Chung

Abstract

Objective—To determine the efficacy of peroral electrohydraulic lithotripsy performed with an extra large duodenoscope (outside diameter 14.8 mm) and a choledochoscope with a diameter of 4.1 mm (Olympus "mother and baby" endoscope system) in the removal of very large stones from the common bile duct.

Design—Prospective study of patients with giant stones in the common bile duct that were resistant to extraction by conventional means.

Setting—Endoscopy unit at a university hospital.

Patients—Four women and one man aged 48-82 (mean 66.4 years) with a total of nine stones in their common bile ducts ranging from 2.2 to 3.6 cm in diameter.

Interventions—Peroral electrohydraulic lithotripsy was performed after intravenous sedation and under antibiotic cover. Two endoscopists took part in each procedure, coordination being achieved by means of a video monitor. The procedures were performed with a Lithotron EL-23 lithotripter and a 3 French lithotripsy probe inserted through the choledochoscope under direct vision.

Main outcome measure—Complete clearance of the common bile duct confirmed by occlusion cholangiography.

Results—All nine stones (mean minimal diameter 2.6 cm; mean maximal diameter 3.1 cm) were successfully fragmented by electrohydraulic lithotripsy, allowing subsequent extraction with the aid of endoscopy and clearance of the common bile duct. A median of three (range two to five) sessions of endoscopic retrograde cholangiopancreatography were required to achieve complete clearance of the ducts. Patients stayed a median of eight days in hospital after lithotripsy (range eight to 14). There were no complications.

Conclusion—Peroral electrohydraulic lithotripsy offers a safe and effective alternative for the management of patients with large stones in the common bile duct.

Introduction

The role of endoscopic sphincterotomy in treating patients with stones in the common bile duct is now firmly established.^{1,2} Ninety per cent of patients with

these stones can successfully be treated in this way.^{3,4} Technical difficulty in extracting stones with the aid of endoscopy increases with their size. Stones more than 2 cm in diameter are difficult to remove endoscopically.⁵

Several methods have been used to fragment stones in the common duct to facilitate endoscopic removal.⁶ Electrohydraulic lithotripsy utilises the principle of high pressure shock waves generated by a high voltage discharge and has been used to fragment urinary stones.⁷ It has been used in the biliary tract through the choledochoscope via a percutaneous transhepatic route⁸⁻¹⁰ or a T tube tract.¹¹

We describe our experience with electrohydraulic lithotripsy of stones in the common duct under direct vision using peroral choledochoscopy with the "mother and baby" endoscope system (Olympus Optical, Tokyo).

Patients and methods

During December 1988 and January 1989 we saw five patients (four women) with giant stones in the common duct in whom stone extraction by conventional methods (including mechanical lithotripsy) had failed. Their mean age was 66.4 years (range 48-82). The reasons for failure were inability to engage a large stone with the basket (three cases) and inability to open the lithotripsy basket in a duct packed with large stones (two). A total of nine large stones were seen in these five patients. The largest diameters ranged from 2.4 to 3.6 cm (mean 3.1 cm) and the smallest diameters from 2.2 to 3.0 cm (mean 2.6 cm). The sizes of the stones were measured from the radiograph by comparison with the diameter of the endoscope in the same radiograph.

All five patients presented with acute cholangitis. One required emergency nasobiliary drainage in the acute attack. All five patients had their sepsis controlled with antibiotics before attempted stone extraction. Sphincterotomy was performed in four patients, the other patient having had a sphincteroplasty two years previously.

INSTRUMENT

The Olympus mother and baby endoscope consists of an extra large duodenoscope (mother endoscope, XTJF-5.5) with an external diameter of 14.8 mm. It has a 5.5 mm instrument channel which admits a 4.1

Combined Endoscopy Unit, Departments of Medicine and Surgery, Prince of Wales Hospital, Chinese University of Hong Kong, Shatin, NT, Hong Kong
Joseph W C Leung, MRCP, senior lecturer in medicine
Sydney S C Chung, FRCSed, senior lecturer in surgery

Correspondence to:
Dr J W C Leung,
Department of Medicine,
Prince of Wales Hospital,
Shatin, NT, Hong Kong.

Br med J 1989;299:595-8

mm diameter choledochoscope (baby endoscope). The baby endoscope has a working channel of 1.7 mm diameter and a two way (up-down) control for tip deflection.

The electrohydraulic lithotripter (Lithotron EL-23; Walz Electronic, West Germany) has probes of different sizes. We used the smallest (3 French). The tip of the probe contains a spark chamber with a bipolar coaxial electrode which generates a spark when the foot pedal is depressed. The spark produces a shock wave in a fluid medium (physiological saline) and fragments the stone. The instrument is calibrated to deliver an intermittent pulse with increasing frequency when activated (fig 1).

FIG 1—Mother and baby endoscope system with 3 French lithotripsy probe emerging from channel of baby endoscope

PROCEDURE

Insertion of the baby endoscope requires a prior sphincterotomy, which is best performed a few days before. A nasobiliary catheter is inserted with the tip above the stones. This allows the bile duct to be filled with contrast for checking the position of the stones or saline for lithotripsy. In addition, irrigation through the nasobiliary catheter helps to clear the view for the baby endoscope.

The procedure is performed with intravenous sedation and antibiotic cover. Two endoscopists are required to operate the mother and baby endoscopes. A video camera projects the image of the baby endoscope on the monitor to facilitate coordination between the two endoscopists. The position of the tip of the baby endoscope can also be checked by intermittent fluoroscopy.

Firstly, the mother endoscope is introduced into the duodenum. The baby endoscope is then passed through the instrument channel of the mother endoscope and manipulated into the common bile duct alongside the nasobiliary catheter. The movement of the baby endoscope depends to some extent on the rotational movement of the mother endoscope and also the insertion and withdrawal of the baby endoscope in the bile duct in addition to the up-down angulation of the tip. After examination of the interior of the common bile duct and the location of stones the ductal system is filled with diluted contrast and a cholangiogram taken. The system is then filled with physiological saline infused through the nasobiliary catheter using a pressure bag. The electrohydraulic lithotripsy probe is inserted through the channel of the baby endoscope. Lithotripsy is carried out under direct vision with the tip of the probe touching the stone (fig 2). Care is taken not to activate the probe when the tip is in contact with the bile duct wall. The probe is activated only when it is properly immersed in saline and touching the stone.

Because stone fragments and sludge generated during lithotripsy may obscure the endoscopic view of the baby endoscope, irrigation through the nasobiliary catheter and channel of the baby endoscope together with suction applied to the mother endoscope help to maintain a clear view of the stones. Stone fragmentation is monitored endoscopically and is also confirmed by fluoroscopy with contrast introduced through the nasobiliary catheter. Once the large stones are fragmented the baby endoscope is removed. The stone fragments within the duct are then extracted with Dormia baskets and balloon catheters passed through

FIG 2—(a) PERNASAL cholangiogram showing two large stones (arrowed) in dilated common bile duct. (b) Mother and baby endoscopes in position with lithotripsy probe (arrowed) in contact with distal large stone. (c) Distal large stone fragmented by electrohydraulic lithotripsy. (d) Clearance of common duct after two sessions of endoscopic retrograde cholangiopancreatography. Arrow indicates occlusion balloon catheter

the instrument channel of the mother endoscope. In patients with incomplete clearance of the duct the nasobiliary catheter is left in situ to ensure adequate drainage of the biliary system.

Check cholangiography or repeat endoscopic retrograde cholangiopancreatography is carried out at the next session and any residual stone fragments removed. Air refluxed into the bile duct after a sphincterotomy may mimic stones in the cholangiogram. In addition, contrast injected through the nasobiliary catheter may spill from the sphincterotomy. Using occlusion cholangiography with contrast injected under pressure through an occlusion balloon catheter ensures adequate filling of the ducts. The balloon catheter is also useful in differentiating air bubbles from stone fragments. When complete clearance of the duct is confirmed by an occlusion cholangiogram¹² the patient is discharged from hospital.

Results

Electrohydraulic lithotripsy was successful in fragmenting all the large stones in the five patients. Three patients required only one session of lithotripsy. One patient, who had two giant stones, required two sessions. In another patient a large stone impacted at the distal common duct prevented proper positioning of the baby endoscope and lithotripsy probe. The stone was pushed back into the common hepatic duct using a balloon catheter and successful lithotripsy carried out at a second session.

The time taken to fragment and remove the large stones ranged from 45 to 60 minutes. The total number of sessions of endoscopic retrograde cholangiopancreatography needed to achieve complete clearance of the duct ranged from two to five (median three). No complications occurred. The interval between the first session of lithotripsy and discharge of the patient from hospital ranged from eight to 14 days (median eight days).

Discussion

Success in removing large stones from the common bile duct depends on the size of the stones and the configuration of the distal duct. The size of the sphincterotomy that can safely be performed is also a factor. Removal of stones larger than 1 cm usually requires some form of lithotripsy before endoscopic extraction. Mechanical lithotripsy is effective only if the stones can be engaged in a basket.¹³ The use of a tunable dye laser to fragment stones in the common duct has recently been reported.¹⁴ This technique also requires the stone to be trapped in a basket before the laser can be applied unless the stone can be visualised directly.¹⁵ Large stones in the common duct are often soft and can easily be crushed, even with the ordinary stone retrieval baskets.¹⁶ Nevertheless, it is often difficult or impossible to engage these giant stones in the basket because of impaction or lack of space to open the basket in a duct packed with stones.

Electrohydraulic lithotripsy fragments the stone by shock waves generated at the tip of the probe by a high voltage electrical discharge in a fluid medium. This technique has been used extensively in the urinary tract. Because of the risk of damage to the wall of the bile duct¹⁷ direct visual control of the position of the probe is necessary during lithotripsy. This technique has been used in the biliary system through a percutaneous transhepatic route or a T tube tract under choledochoscopic guidance. It has also been applied via the endoscopic retrograde route under fluoroscopic control. This, however, is not widely practised because of the risk of damage to the bile duct. A special probe

has been designed for endoscopic retrograde electrohydraulic lithotripsy under fluoroscopic control.¹⁸ It has an inflatable balloon tip to keep the probe away from the bile duct wall. Direct contact of the tip of the probe with the stones, however, may be difficult to confirm on fluoroscopy and the risk of inadvertent damage to the duct wall remains.

Peroral choledochoscopy is now possible with the use of ultrathin endoscopes that can pass through the instrument channel of a standard duodenoscope¹⁹—hence the mother and baby endoscope system. Direct visualisation and access to the bile and pancreatic ducts widens our scope in the diagnosis and treatment of pancreaticobiliary problems. Peroral choledochoscopy with the mother and baby endoscopes allowed us to examine the stones in the common duct and to perform electrohydraulic lithotripsy under direct visual control. In this series of five patients in whom stone extraction by conventional methods failed electrohydraulic lithotripsy successfully fragmented the stones and permitted clearance of the duct. This technique is a useful alternative for patients with giant stones in the common duct, especially those who are unfit for surgery. Compared with the percutaneous transhepatic approach peroral choledochoscopy avoids the morbidity associated with liver puncture and does not require the creation of a percutaneous tract.

Several technical points deserve special mention. Though the tip of the baby endoscope has a 160 degree upward deflection and a 100 degree downward deflection, much of this is lost after insertion into the common duct owing to angulation. Movement of the baby endoscope depends to a large extent on manipulation and rotation of the mother endoscope. Likewise the positioning of the lithotripsy probe against the stone is controlled by the insertion and withdrawal of the baby endoscope and the lithotripsy probe. Close coordination between the two endoscopists is necessary, and this is facilitated by intermittent fluoroscopy and video projection of the endoscopic images, which allow both endoscopists to visualise the procedure. Electrohydraulic lithotripsy requires a fluid medium for the conduction of the shock waves. Debris and stone fragments generated at the stone surface during lithotripsy tend to obscure the endoscopic view. We use a nasobiliary catheter to fill the common duct with saline and wash away the debris. In our patients, all of whom had adequate sphincterotomies, irrigation of the common duct did not lead to bacteraemia or septicaemia. None the less, we think that it is prudent to give antibiotics prophylactically and to refrain from using this technique in patients with uncontrolled biliary sepsis.

The mother and baby endoscopes and the electrohydraulic lithotripter (Lithotron EL-23) were generously provided by Olympus Optical, Tokyo. We thank Dr E M Bondoc for his help.

- 1 Cotton PB. Endoscopic management of bile duct stones (apples and oranges). *Gut* 1984;25:587-97.
- 2 Ikeda S, Tanaka M, Matsumoto S, Yoshimoto H, Itoh H. Endoscopic sphincterotomy: long-term results of 408 patients with complete follow-up. *Endoscopy* 1988;20:13-7.
- 3 Cotton PB. Nonoperative removal of bile duct stones by duodenoscopic sphincterotomy. *Br J Surg* 1980;67:1.
- 4 Geenen JE, Vennes JA, Silvis SE. Resume of a seminar on endoscopic retrograde sphincterotomy (ERS). *Gastrointest Endosc* 1981;27:31-8.
- 5 Katon RM. The giant common duct stone: still a hard nut to crack. *Gastrointest Endosc* 1988;34:281-2.
- 6 Classen M, Hagemuller F, Knaym K, Frimberger E. Giant bile duct stones—non-surgical treatment. *Endoscopy* 1988;20:21-6.
- 7 Mitchell ME, Kess WS Jr. Experience with the electrohydraulic disintegrator. *J Urol* 1977;117:159-60.
- 8 Mo LR, Hwang MH, Yueh SK, Yang JC, Lin C. Percutaneous transhepatic choledochoscopic electrohydraulic lithotripsy (PCTS-EHL) of common bile duct stones. *Gastrointest Endosc* 1988;34:122-5.
- 9 Matsumoto S, Tanaka M, Yoshimoto H, Miyazaki K, Ikeda S, Nakayama F.

- Electrohydraulic lithotripsy of intrahepatic stones during choledochoscopy. *Surgery* 1987;102:852-6.
- 10 Liguory CL, Bonnel D, Canard JM, Cornud F, Dumont JL. Intracorporeal electrohydraulic shock wave lithotripsy of common bile duct stones: preliminary results in 7 cases. *Endoscopy* 1987;19:237-40.
 - 11 Ebbs RR, Beckley DE, Hammonds JC, Tensdale C. Percutaneous electrohydraulic lithotripsy of retained bile duct calculus. *Br Med J* 1986;292:94.
 - 12 Ikeda S, Yoshimoto H, Tanaka M, Matsumoto S, Itoh H. Cholangiography of intrahepatic bile ducts in hepatolithiasis by endoscopic placement of an indwelling balloon catheter. *Gastrointest Endosc* 1985;31:181-7.
 - 13 Schneider MU, Matek W, Bauer R, Domschke W. Mechanical lithotripsy of bile duct stones in 209 patients—effect of technical advances. *Endoscopy* 1988;20:248-53.
 - 14 Ell Ch, Lux G, Hochberger J, Muller D, Demling L. Laser lithotripsy of common bile duct stones. *Gut* 1988;29:746-51.
 - 15 Kozarek RA, Low DE, Ball TJ. Tunable dye laser lithotripsy: in vitro studies and in vivo treatment of choledocholithiasis. *Gastrointest Endosc* 1988;34:418-20.
 - 16 Leung JWC, Chung SCS, Mok SD, Li AKC. Endoscopic removal of large common bile duct stones in recurrent pyogenic cholangitis. *Gastrointest Endosc* 1988;34:238-41.
 - 17 Sievert CE, Silvis SE. Evaluation of electrohydraulic lithotripsy on human gall stones. *Am J Gastroenterol* 1985;80:854.
 - 18 Silvis SE, Siegel JE, Hughes R, Katon RM, Sievert CE, Sivak MV. Use of electrohydraulic lithotripsy to fracture common bile duct stones. *Gastrointest Endosc* 1986;32:155-6.
 - 19 Nakajima M, Akasaka Y, Yamaguchi K, Fujimoto S, Kawai K. Direct endoscopic visualisation of the bile and pancreatic duct system by peroral cholangiopancreatography (PCPS). *Gastrointest Endosc* 1978;24:141-4.

(Accepted 19 June 1989)

Non-admission or non-invitation? A case-control study of failed admissions

Stephen Frankel, Alexandra Farrow, Robert West

Abstract

Objective—To examine the causes of non-admission to hospital.

Design—Validation of published rates of non-admission by examination of medical records, followed by a case-control study of non-attenders (cases) and attenders (controls).

Setting—General hospital.

Subjects—246 Patients (cases in the case-control study) booked for admissions in four specialties (general surgery, gynaecology, otorhinolaryngology, and trauma and orthopaedics) during April, May, and June 1987 who were not admitted for reasons that seemed to be attributable to the patients. Controls comprised 167 patients admitted to the same specialty on the same day.

Results—The validation of administrative records indicated that it is unusual for patients to fail to present for admission without advising the hospital beforehand; this occurred in only 1.3% of all bookings. Information on the circumstances of non-admission and clinical and personal details were collected by means of a six page questionnaire completed by the patients. The case-control study showed that those not admitted were younger and had been on the waiting list longer. Otherwise only small differences were found in the social and clinical characteristics.

Conclusions—Despite a common tendency to blame patients for non-admission, factors due to patients are fairly unimportant.

Introduction

Considerable pressure exists on facilities for inpatients, and waiting lists are one expression of this.¹ When patients booked for admission fail to present themselves the task of reducing waiting lists is made more difficult. The perception is widespread that non-admission of this sort is a serious problem. One inquiry suggested that between 10% and 12% of booked inpatients fail to present themselves,² an estimate that led to a parliamentary question suggesting systematic reviews of waiting lists.³ The launch of a Scottish initiative to reduce waiting times in March 1988 included comments criticising "patients who failed to turn up for scheduled operations for adding to the problems."⁴ Resentment was expressed over "this waste of financial resources," and there followed an "appeal to patients to let hospitals know in advance if they cannot turn up."⁴ The study reported here arose when an apparent rate of non-admission of 28% was reported in one health authority.

The empty beds and unused theatre time that follow failed admissions clearly represent an inefficient use of resources. Accounts of non-admission tend to accept as self evident the view that resources are being wasted and that non-admission is essentially a problem of compliance. In an earlier paper we questioned similar assumptions about non-attendance of outpatients.⁵ In this paper we examine explanations for the reported number of failed admissions.

Subjects and methods

An important preliminary to the investigation was the validation of the summary of rates of non-admission derived from routine sources. We examined record sheets for admissions from 1 April to 30 June 1987 and obtained the total number of patients actually admitted in the four specialties of general surgery, otorhinolaryngology, gynaecology, and trauma and orthopaedics. These specialties were selected because of their throughput and the size of their waiting lists. When patients were identified on the record sheets as not having been admitted as planned one of several general explanations for non-admission was entered beside the name. These allowed a broad distinction to be drawn between factors due to the hospital and those due to the patients. Hospital factors comprised cancellation of the admission when no bed or theatre session was available. Patient factors were when patients cancelled because of other engagements or absence or because they were no longer seeking admission; for administrative purposes these were subdivided into whether sufficient notice was given to permit the booking of an alternative patient. Another group of non-admissions identified from the record sheets was those of patients who had already been admitted. The potential non-admission of such patients could reasonably have been known to the medical records department, and these cases were therefore classed under hospital factors.

After examining the routine records we undertook a questionnaire study incorporating a case-control design. The total final sample of patients was 413: 246 patients not admitted (cases) and 167 admitted (controls). We classed the non-admitted patients as all those identified on the record sheets from 1 April to 30 June 1987 whose failed admissions seemed to have been attributable to the patient rather than the hospital. Admissions were selected from the same specialty on the same booking sheet and when possible under the same consultant. We developed a six page self completion questionnaire to ask whether patients had presented on the day booked and, if they had not, what

Department of
Epidemiology and
Community Medicine,
University of Wales
College of Medicine,
Cardiff CF4 4XN
Stephen Frankel, DM, senior
lecturer
Alexandra Farrow, MSC,
research fellow
Robert West, PHD, reader

Correspondence to:
Dr Frankel, Health Care
Evolution Unit, Department
of Epidemiology and
Community Medicine,
Canyng Hall,
Bristol BS8 2PR.

Br Med J 1989;299:598-600