ORIGINAL ARTICLE

Urgent Ultrasonography in Diagnosis of Choledocholithiasis–Analysis on Factors Influencing Stone Detection

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PURPOSE: We observed the sensitivity of ultrasonography to detect choledocholithiasis under emergency basis and evaluated factors influencing the ultrasonic stone detection rate other than inadequate patient preparation.

MATERIAL AND METHOD: 92 patients receiving urgent ultrasound examination and subsequently proved choledocholithiasis by endoscopic retrograde cholangiography were classified into 3 groups; Group I: with ultrasound findings of ductal dilatation and intraductal stone, Group II: ductal dilatation without visible stone by ultrasound, and Group III: neither ductal dilatation nor intraductal stone visible. Common duct dimension and stone size were measured and compared in these 3 groups of patients as well.

RESULT: The overall ultrasonic intraductal stone detection rate was 57.6% (53/92). The mean common duct dimension in Group I was 16.8±6.1mm, in Group II was 13.6±3.5mm, and in Group III was 6.5±1.0mm (F test, $p<0.005$). The mean ductal stone dimension was 23.1±12.2mm in Group I, 13.0±5.3mm in Group II and 9.0±4.5mm in Group III respectively (F test, $p<0.0005$). The stone detection rate was 86.4% (32/37) in patients with common duct stone size of ≥20mm in diameter, 44.1%(15/34) in stone size between 10 to 19mm, and 19.0%(4/21) in stone size of <10mm in diameter.

CONCLUSION: The urgent ultrasound had an overall sensitivity of 57.6%in detecting choledocholithiasis. Factors influencing ultrasonic detection rate of common duct stone other than inadequate patient preparation include common duct size and intraductal stone size.

Key words: **choledocholithiasis, ultrasonography**

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The diagnostic sensitivity of choledocholithiasis by ultrasonography had a wide range of 13 to 75% [1-6]. Improvement of hardware from static to real-time scanner was considered to be the most important factor for the improvement in diagnosis, although other factors such as improvement of operation technique and adequate patient preparation could also play a role [4-5]. Ultrasonographers had concentrated on methods of patient preparation as filling the stomach and duodenum with drinking water, scanning after a fatty meal and/or changing the patient's position to facilitate visualization of the common duct; yet, most of the patients need to fast overnight in order that the sonographer can get a clear common duct image. In 1987, Dong et al reported that 80% of the common bile duct stones can be detected by ultrasonography under well preparations [6]. However, for a patient having a past history of cholelithiasis, with an acute abdominal colic, an accurate and prompt diagnosis followed by appropriate treatment is mandatory. We therefore conduct this study to evaluate the sensitivity of ultrasonography in the diagnosis of choledocholithiasis for emergent patients, and to analyze the factors that could influence ultrasound examination in the diagnosis of choledocholithiasis.

MATERIAL AND METHOD

From January 1997 to December 2002, a total of 105 patients who had received an endoscopic retrograde cholangiopancreatographic examination (ERCP) and were proved to have common duct stone(s) sequentially entered this study. Among them, 13 had stone impacted in Ampulla Vater and were excluded. For the remaining 92, 34 (36.9%) were male and 58 (63.1%) were female, ranging from 28 to 87 years of age with an average of 59.7 years.

Abdominal ultrasonography was done for all the patients at emergency by using a commercially available real-time linear or sector scanner with a 3.5 or 3.75MHz transducer (Toshiba SSA-250/SSA-260, Tokyo, Japan), in spite of overnight fasting or not, prior to the performance of ERCP.

The whole biliary tree was checked carefully to the distal end of the common bile duct by using the method previously described [7]. Changing the patient's position to facilitate the detection of stone(s) was done if the distal common duct cannot be well visualized. But, filling the stomach and duodenum with drinking water or scanning after a fatty meal was avoided. The common duct was defined as the extrahepatic portion of bile duct demonstrated by ultrasonography and interpreted as abnormally dilated if its maximal inner dimension exceeded 7mm [8]. The diagnosis of common duct stone were made if there were intraductal strong echogenic substances with or without acoustic shadow. Patients in this study were divided into 3 groups according to the ultrasound findings, including Group I: clearly showing common duct stone(s), Group II: showing common bile duct dilatation without clearly visible stone, and Group III: neither common duct dilatation nor stone detected.

The ERCP were performed with the videoduodenoscope (Olympus CV-1, Tokyo, Japan) within 24 hours after the ultrasound examination. The common bile duct stone(s) visible on the x-ray films were measured and calculated through the following formula:

$$\text{true CBD stone size} = \frac{\text{CBD stone(s) measured on x-ray film} \times \text{diameter of duodenoscope}}{\text{diameter of duodenoscope measured on x-ray film}}$$

Where, the maximal diameter of the stone(s) was noted; if there were 2 or more stones in the duct, the maximal diameter of the biggest one was noted. In order to evaluate whether the stone size influence the detection of choledocholithiasis by ultrasonography, the above 92 patients were also divided into those with stone diameter >=20mm

(Group A), those <20mm but >=10mm (Group B) and those <10mm (Group C).

F-test was used to observe the difference of common duct dimension and common duct stone size between group I and II patients. ANOVA was used to analyze the difference of common duct diameter between patients with single, two or multiple stones. Chi-square test was used to test ultrasound stone detection rate of groups with different stone sizes. The result is significant, if $p<0.05$.

RESULT

There were 53, 35 and 4 patients in group I,II and III by ultrasonography, respectively. (Table 1) As a whole, ultrasonography detected stone(s) in 53 with a sensitivity of 57.6%(53/92). However, it demonstrated abnormal signs in 88 (95.6%).

Totally, the common duct dimensions of the 92 patients were 15.6±5.5mm, with a range of 6 to 34mm. The dimensions were 16.8±6.1, 13.6±3.5, and 6.5±1.0mm in groups I, II and III, respectively. And, the ranges were 9 to 34, 9 to 24, and 6 to 7mm, respectively. There was a significant difference of ductal dimension between these 3 groups (F-test, $p<0.005$). (Table 2)

The mean size of the stones measured by ERCP was 23.1±12.2mm(ranging from 5 to 60mm), 13.0±5.3mm(ranging from 5 to 25mm) and 9±4.5mm(ranging from 5 to 16mm) in group I, II and III, respectively. The difference of the stones size between these 3 groups was significant (F-test, $p<0.0005$). (Table 3)

As to the effects of stone size on the sonographic detection of choledocholithiasis, there were 86.4% (32/37) of detection rate in group A, 44.%

Table 1. Classification of the 92 patients with choledocholithiasis according to ultrasonography at emergency

	Ultrasound Findings		No. of Patients(%)
	Common Duct Dilatation	Common Duct Stones	
Group I	+	+	53(57.6%)
Group II	+	−	35(38.0%)
Group III	−	−	4(4.3%)
Total			92(100%)

Table 2. The common duct size by ultrasonography in the 92 patients with choledocholithiasis at emergency

Classification (No.)	Common duct dimension (mm)* (range)
Group I (53)	16.8±6.1 (9-34)
Group II (35)	13.6±3.5 (9-24)
Group III (4)	6.5±0.1 (6-7)
Total (92)	15.6±5.5 (6-34)

*mean ± SD ; $p<0.005$, F-test.

Table 3. The stone size by ERCP in 92 patients with choledocholithiasis at emergency

Ultrasound	Common Duct Stone Size (mm)* (range)
Group I (53)	23.1±12.2 (5-60)
Group II (35)	13.0±5.3 (5-25)
Group III (4)	9.0±4.5 (5-16)

* mean ± SD; $p<0.0005$, F-test

Table 4. The common duct dimension by ultrasonography in cases with various number of ductal stone(s)

No. of Common Duct stone(s)	Common Duct Diameter (mm) *
Single (53)	15.3 ± 5.9
Two (20)	13.8 ± 3.7
Multiple (19)	16.0 ± 6.7

* mean ± SD ; p>0.05, F-test

(15/34) in group B, and 19.0% (4/21) in groups C, respectively. (x^2 test, p<0.0005; Fig.1) The diagnosis of choledocholithiasis by ultrasonography, hence, is undoubtedly dependent on the intraductal stone size. However, we found that the stone number detected by ERCP was not an influencing factor on the ductal size, as the ductal dimensions were 15.3 ±5.9mm in the 53 patients with single stone, 13.8 ±3.7mm in the 20 patients with 2 stones, and 16.0 ±6.7mm in the other 19 patients with more stones respectively. (Table 4) The number of common duct stone(s) did not play a role in the detection rate of choledocholithiasis by ultrasonography. The detection rates, indeed, were 56.6%, 55.0% and 63.1% respectively (x^2 test, p>0.05).

DISCUSSION

Abdominal ultrasonography remains the most convenient and efficient method in the diagnosis of biliary tract disease. The sensitivity of ultrasonic diagnosis of common bile duct stones by static scanning technique has been low [1-3]. Yet, the diagnostic efficacy was markedly improved after the introduction of the real-time scanner. [4-5] Since in most cases the stone was located in the distal part of the common duct, they were frequently interfered with by gastric or duodenal gas on ultrasonography. One could raise the detectability of common bile duct stone up to 75% [6-7], only by using a high-resolution real-time scanner with varying procedures to facilitate visibility of the distal common duct. As patients with choledocholithiasis, encountered in the emergency room with biliary colic or septic cholangitis, usually need a rapid and correct diagnosis, real-time ultrasonography often acts as the initial diagnostic test. Such an urgent ultrasonography could detect the stone(s) with a rate not so high as in routine examinations [4,6]. Indeed, in this study we obtained a detection rate of choledocholithiasis of around 58% through urgent ultrasonography without suitable preparation.

However, 95.6% of our patients with common duct stone(s) show common duct dilatation, that was higher than those reported by Cronan et al (64 to 67%) [1,5]. The possible reason might be that most of our patients were examined in the acute and severe obstruction phase with a more dilated common duct. O'connor et al have demonstrated a higher stone detection rate in a dilated common duct, and supposed that the bile filling the duct could create acoustic contrast to facilitate the stone detection [9]. Dong et al supported this point, but they found a higher stone detection rate in those with an increased common hepatic ductal size, especially those with a dilated duct after having a fatty meal [6]. Our study also revealed a higher

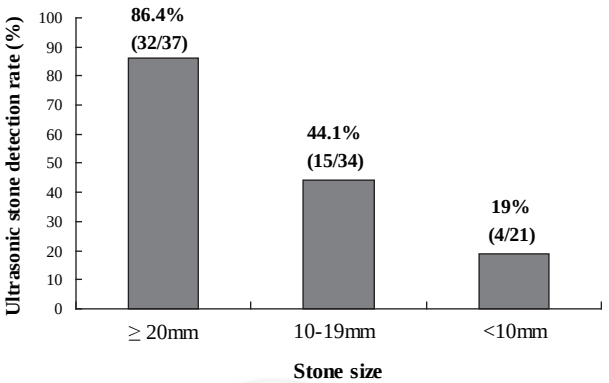

Fig. 1 Ultrasonic detection rate of common duct stone in different stone size. (No=92; x^2 test, p<0.0001)

detection rate in those with a larger caliber of common duct. (Table 1 & Fig 1) Moreover, we noted there were no stones visible by ultrasonography in those without a dilated common duct (Group III).

As to the evaluation of the effect of common duct stone size on the detection rate of choledocholithiasis by ultrasonography, our study revealed that the bigger the common duct stone the higher the ultrasonic detection rate. Swobodnik et al have reported that ultrasound can detect all common duct stones with the stone size larger than 1.5cm in dimension, but if the stone size was smaller than 1.0cm the detection rate fell to 50% [10]. The present study showed that detection rate was 86.4%, if the stone was not smaller than 2.0cm. Besides, if the stone size was between 1.0-1.9cm in dimension, the detection rate fell into 44.1%, and if smaller than 1.0cm the detection rate further fell into 19.0%. Choledocholithiasis with a stone dimension larger than 1.5 to 2.0cm is more difficult to remove with endoscopic procedure. Therefore, it is important to detect the ductal stone size correctly at any emergent conditions, and ultrasonography undoubtedly plays a major role in the determination. Choledocholithiasis with a single ductal stone could be presented as acute cholangitis with right upper abdominal colic pain, while it could be manifested simulating a malignant ductal obstruction if there were multiple stone(s) [11]. Although, less stones in the common duct, rather than crowded stones, usually had a higher ultrasonic detection rate [11]. In our study, there was no correlation between stone number in the common duct and the caliber of the common duct. In addition, the stone number did not play an important role in the detection rate by ultrasonography, as there were detection rates of 63.1%, 55.0% and 53.8% for cases with multiple stones, 2 stones and a single stone, respectively ($p>0.05$). Recently, the development of several newer imaging modalities, such as endoscopic ultrasound, higher resolution spiral computed tomography and MRI, proved to be superior to transabdominal ultrasonography. The latter remains the major performances at urgency, due to its convenience, rapidity, simplicity, and less expense [12-15]. As a conclusion, the results shown in our study revealed that trans-abdominal ultrasonography still plays an important role in the diagnosis of choledocholithiasis at emergency with a detection rate of about 60%. And, the more dilatation of the common duct and the larger size of the stone, the higher the detection rate by routine ultrasonography. Besides, in contrast to the previous studies by others, we found the stone number in the common duct did not affect the detection rate very much.

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總膽管結石之緊急超音波診斷—影響結石檢出率因素之研究

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目的：本研究在分析緊急超音波檢查對總膽管結石的檢出率，以及影響檢出率的因素。

材料與方法：總共92個經由內視鏡膽胰攝影術證實的總膽管結石病人，他們在來院時就安排緊急超音波檢查。我們把檢查結果分為3組；第一組：超音波發現總膽管擴張及總膽管結石，第二組：超音波發現總膽管擴張但無法看到結石，第三組：超音波發現總膽管無擴張且無法看到結石。本研究就各組之間的總膽管大小、結石大小、與結石數目作比較分析。

結果：緊急超音波檢查對總膽管結石的檢出率為57.6% (53/92)。第一組病人的平均總膽管直徑為16.8±6.1公釐，第二組為13.6±3.5公釐，第三組為6.5±1.0公釐 ($p<0.005$)。總膽管結石的大小第一組為23.1±12.2公釐，第二組為13.0±5.3公釐，第三組為9.0±4.5公釐。($p<0.0005$)

此外，若總膽管結石大於或等於20公釐，則結石檢出率為86.4% (32/37)；若結石大小界於10到19公釐之間，結石檢出率為44.1% (15/34)；若結石小於10公釐，則結石檢出率為19.0% (4/21)。($p<0.0005$)

結論：緊急超音波檢查可以檢出57.6%的總膽管結石。影響總膽管結石檢出之因素包括總膽管徑的大小，以及總膽管結石的大小。

關鍵詞：總膽管結石、超音波