

## FOCUSED CYSTIC DUCT EXAMINATION DURING HEPATOBIILIARY ULTRASONOGRAPHY: THE ADDITIONAL DIAGNOSTIC VALUE OF POSTEROLATERAL INTERCOSTAL APPROACH

### Original Article

## HEPATOBIİLİER ULTRASONOGRAFİ SIRASINDA SİSTİK KANAL ODAKLI İNCELEME: POSTEROLATERAL İTERKOSTAL YAKLAŞIMIN İLAVE TANISAL KATKISI

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### ABSTRACT

**Purpose:**Ultrasound is usually the first line of imaging in hepatobiliary disease for its widespread availability and due to advantages such as lack of radiation exposure and IV contrast administration. In this study we attempted to assess the success rate of US examination when the cystic duct is examined in a different position in addition to routine supine position.

**Materials and Method:**79 patients referred to our department between January 2009 and May 2009 (23 male, 56 female, with a mean age of 47) were included in this study. After routine assessment of upper abdominal US examination, evaluation was maintained on left lateral position. In this position, neck of the gallbladder and the continuity of the cystic duct was focused and evaluated through the lateral and/or posterolateral intercostal windows. Approximately 5 minutes additional time was needed just for sonographic evaluation of the cystic duct. Especially during sonography in left lateral position, repeated examinations were performed in deep expiration and following deep inspiration for the possibility of improved cystic duct visualization.

**Results:**In 7 cases, non-complicated biliary stones and sludge were noted. Except seven cases out of 79 cases (5 cases with duodenal gas superposition and 2 cases had excessive folding anatomy of duct), the cystic duct was adequately visualized implementing the posterior view in the remaining 72 patients.

**Conclusion:**The cystic duct must be examined in our new position during hepatobiliary ultrasonography. Especially in terms of increasing the likelihood diagnosing the pathologies such as micro-calculi, crystals and ductal wall-thickening, all the findings should be added to the conventional report accordingly.

**Keywords:** Cystic duct; Ultrasound; Pathology; Diagnosis.

## ÖZET

**Amaç:** Safra kesesi ve safra yollarının ultrasonografi (US) ile incelenmesi radyasyon kullanılmaması veya kontrast madde kullanımı söz konusu olmadığından, ayrıca da kolay ulaşılabilir olduğu için, bilier sistem için değerlendirmede genellikle ilk tercih edilen adımdır. Biz bu çalışma ile rutin bilier sistem US incelemenin aksine, daha farklı bir pozisyonda değerlendirmenin sistik kanalın gösterilmesinde daha başarılı olunabileceğini göstermeyi amaçladık.

**Materyal ve Metod:** Ocak 2009-Mayıs 2009 tarihleri arasında servisimize yönlendirilmiş 79 olgu çalışmaya dahil edildi. İncelemede rutin üst abdominal US değerlendirmeden sonra incelemeye sol yana yatar pozisyonunda devam edildi. Bu pozisyonda; lateral ve posterolateral interkostal pencerelerden kese boynu ve devamında da sistik kanal odaklanarak değerlendirildi. Sadece sistik kanalın sonografik değerlendirilmesi için ortalama 5 dakikalık ilave zaman ihtiyacı oldu. Özellikle sol lateral dekübitis pozisyonunda çalışma süresince sistik kanalın görünür olduğu pencereleri yakalayabilmek açısından derin ekspiryum ve derin inspiryum yaptırılarak işlem tekrarlandı.

**Bulgular:** Olguların 7'sinde, nonkomplike safra taşları ve eşlik eden safra çamuru saptandı. İki olguda ise büyük taş oluşumundan ziyade; kristal ekojeniteleri ve dependan az miktarda çamur söz konusu idi. Tüm 79 olgunun 7'si dışındaki (gaz süperpozisyonu veya katlantılı sistik kanal nedeniyle) 72 hastada sistik kanal başarılı olarak değerlendirilebildi.

**Sonuç:** Hepatobilier sistem US inceleme sırasında, sistik kanal bahsettiğimiz bu pozisyonda da incelenmeli; kalkül, kristal, duvar kalınlaşması gibi patolojilerin yakalanabilme ihtimalini arttırması bakımından bu yeni metod özellikle

kullanılmalı ve ilave bulgular rutin rapora eklenmelidir.

**Anahtar Kelimeler:** Sistik kanal;- Ultrasonografi; Patoloji; Tanı.

## INTRODUCTION

Biliary tract ultrasound (US) examination is usually the first imaging tool for biliary system evaluation since it does not require contrast administration nor it does expose the patients to ionized radiation. Despite recent developments in multidetector technology, computed tomography (CT) does not provide enough contrast resolution to diagnose or exclude the cystic duct pathologies (1). In general, there is a trend towards other modalities like magnetic resonance cholangiopancreatography (MRCP) or invasive techniques such as percutan trans-hepatic cholangiography (PTC) when there is a suspicion of the cystic duct pathology (1, 2). But all these additional investigations are more costly, limited, and more time-consuming. In this study, we attempted to investigate if it is possible to visualize and assess the cystic duct using different angles other than conventional positions on US.

## MATERIALS AND METHOD

79 cases prompt to our service for hepatobiliary system US between January 2009 and May 2009 (23 male, 56 female, mean age = 47) were included in the study. All 79 patients also had upper abdominal cross-sectional imaging findings with CT (n = 21) or (magnetic resonance imaging) MRI and MRCP (n = 58). In our study, reviews of two radiology specialists who only have information of symptomatology but unaware of the patients' cross-sectional imaging findings were taken into account. After routine assessment of upper abdominal US examination, recorded digital images and cine-images were evaluated by two different radiologists, evaluation was

performed in left lateral decubitus position by a third radiologist. In this position, neck of the gallbladder and its continuity with the cystic duct was assessed through the lateral, posterior and posterolateral intercostal windows. Approximately 5 minutes (3.5-8.5 min) additional time was required for focused sonographic evaluation of cystic duct.

During sonography in left lateral decubitus position, repeated examinations were performed in deep expiration and following deep inspiration for the possibility of improved cystic duct visualization. The best window that revealed the neck of gall bladder was determined, and the cystic duct was also visualized by rotating the transducer into different angles in this position. The data obtained from anterior aspect were recorded and reported within normal routine examination findings. Also, images obtained during assessment of the cystic canal were saved separately. All data were evaluated together by comparing the conventional and focused imaging findings which were recorded and reported separately.

## RESULTS

Between 79 patients, 12 patients had acute cholecystitis, 2 had acalculous cholecystitis associated with diabetes mellitus, 3 had idiopathic dilated common bile duct (physiologic senile dilatation, n=2, postcholecystectomy compensatory, n=1), 2 had distal common bile duct stone, and 1 patient had dilatation secondary to invasion of pancreatic head adenocarcinoma.

Biliary system data of all cases recorded by mentioned two radiologists were similar. There were not any different findings in both reported data. In 7 cases, non-complicated biliary stones and sludge were accompanying. In two cases, a small amount of the dependent sludge and crystal echogenicity without macro-calculi were imaged. All the cholecystitis cases have increased wall thickness and

distended gall-bladder. No data was reported separately about the cystic duct abnormality.

Except seven cases out of 79 cases (2 cases with duodenal gas superposition, 3 cases with obesity and 2 cases had excessive folding anatomy of the cystic duct); in the remaining 72 patients, the cystic duct was evaluated successfully with the posterior and posterolateral approach. With the focused posterior and posterolateral approach of total 20 cases with pathology, five cases had the cystic duct accompanying micro-echogenicity, crystal-sludge passage as filling defects within it. None of these five patients with nausea and right upper quadrant discomfort were reported by the two examiners during conventional US examination.

With retrospective re-evaluation by posterior and posterolateral approach, both of two examiners diagnosed the filling defects in all (n=5) of the patients who were evaluated as normal by conventional screening. Retrospectively, these changes determined by conventional anterior aspect in only two of five cases by both investigators.

As a result, in 72 of 79 cases (91%) the cystic duct was viewed visualized using posterior and posterolateral approaches. Out of 21 patients with biliary system wall thickening or gall-bladder filling defects (calculi and/or sludge), in 5 patients, the cystic duct abnormality could be identified with only posterior and posterolateral approach. When retrospectively evaluated, in thin section raw data of MRCP images, this microcalculi-sludge associated filling defects in the cystic duct were only barely visible with focused examination. Cross-sectional findings in other cases were in line with sonographic findings. Some demonstrative images are shown in **Figure 1.**

**Figure Legend**

*Representative images from some cases.*



**Figure 1.** Representative images of the some cases. a) Serial thin section contrast enhanced CT images of a case having variative biliary excretion of the nonionic contrast media shows some filling defects (arrows) in the bladder lumen and in last section en face image of the cystic duct is seen (encircled area). b) At the raw section of the MRCP, thin cystic duct is visualized with its proximal course obliquely (arrow). c) With scanning in routine position, the cystic duct is not visualized and gall-bladder neck is ending in blunt shape (arrow). d) In the same case, changing the scanning position to our method, the cystic duct is easily visualized (thorough the concave side of dashed line). In e) and f) magnified images show microcalculi and echogenic crystal formation in the cystic ducts of two different cases (arrow and encircled area), respectively.

**DISCUSSION**

Biliary tract US examination is usually performed for common complaints such as right upper quadrant pain, epigastric pain, and also in patients with nausea and jaundice. Several disadvantages of this technique exist such as decreased image quality in case of abdominal distention, intestinal gas superpositions in addition to being a highly operator-dependent technique. However, hepatobiliary US detects the diseases of the gallbladder (e.g. stones, inflammation, and

obstructions) with high sensitivity and specificity.

Cystic duct is a thin extension which carries the contents of the gallbladder to common hepatic duct, and its length is variable (1). During embryological development of the biliary system, the cystic and the hepatic duct takes their anatomical form in fifth week of gestation. The bile leaks through the cystic duct into the common bile duct and subsequently into the duodenum at the 13th week of gestation. Although, it has functional benefits, occasionally, a long cystic duct is known to cause predisposition for gallbladder torsion (2, 3).

The cystic duct is approximately 3-4 cm in length inside the porta hepatis (this length can vary between 0.5-8 cm regards to joining point), and 3 mm (3-13 mm) in diameter which joins the gallbladder neck with the hepatic duct, to create the common bile duct. In some forms, its course may be looking curved like a snake, especially in reconstructed sectional images. (4).

There are crescent shaped multiple (5-12 units) valves of Heister's continue from the neck of the gall-bladder thorough the cystic duct as plica spiralis ductus cystici. Besides, keeping open the canal intermittently for helping to retrograde filling of the gall-bladder with bile, these valves also serve as a cover blocks to the passage of stones into the common bile duct. (5).

The cystic duct often ends on the right corner of the common hepatic duct and joins the structure of the common bile duct. In some cases, it terminates on the back wall or lying in the back on left corner of the common hepatic duct. (6).

The cystic duct and common hepatic duct junction may be in angular, parallel or spiral shape. The most common type is angular-type junction and is observed in 70% of the cases. Two ducts extend together 1.5 to 6 cm in the parallel-type junction. It is very difficult to separate the

two channels on cross-sectional images which usually adhere to each other in these types of cases. The cystic duct extends from the front or back of the common hepatic duct and then combines in the spiral-type combination.(7)

Beside these variable anatomic courses, cystic duct also may be in vicinity of critical vasculature. After leaving the right hepatic artery, the cystic artery usually lies upon the cystic duct and enters into the gallbladder. However, sometimes it courses on the back and rarely (5%) beneath the duct. The right hepatic artery is usually located to the left of the cystic duct and courses behind the duct in %7-10 of the cases, and less frequently in front of it. Portal vein also extends on the left back side of the cystic duct (8).

Because of small caliper, the cystic duct has not been evaluated diagnostically on conventional cross-sectional images. One of the methods previously used in imaging of the gallbladder and bile ducts is oral cholecystography. In order to concentrate opaque substances sufficiently on oral cholecystography may take some time after ingestion (10-12 hours), and pouch mucosa must be sturdy. Another method is intravenous cholangio cholecystography. In this method, imaging method performed after administration of water-soluble iodine contrast agent by the intravenous route. It is mainly used to show the common bile duct. If the gallbladder is not filled adequately by oral cholecystography, examination usually continues in this way. Due to not filling of the gallbladder, factors related to absorption and concentration of substances disappears by this method, and achieving to view the common bile duct in all cases is the superiority of this method. However, examination lasts longer than two hours, biligraphy does not mix with bile in a good way and stratify similar to floating stones seen on standing radiographs, sometimes undue prolongation of the sac due to wrong diagnosis of dysfunctional gall-bladder, and more frequent and severe drug

reactions seen are all the drawbacks of the intravenous method. Due to these disadvantages, both oral and intravenous methods have been largely abandoned (9).

Imaging methods such as endoscopic retrograde cholangiopancreatography (ERCP) and intraoperative cholangiography can show the anatomy and variations correctly. However, these methods carry the risk of serious complications as being invasive and operator dependent techniques, and using ionizing radiation. So, these modalities are not being used as the first choice in diagnosis of biliary system diseases and replaced by magnetic resonance cholangiopancreatography (MRCP). MRCP is an MRI technique that uses heavily T2 sequence that allows noninvasive evaluation of pancreatobiliary system anatomy and pathologies. The anatomy of intra and extra-hepatic bile ducts can be evaluated fast and reliably without any complication, without use of any contrast material in this method. However, MRCP increases the cost and examination duration, and not able to show sludge or micro-calculi inside the cystic duct, clearly comparing to the US (10).

The evaluation of this small duct is possible now due to the developments in sequences like three-dimensional MRCP. With the addition of the hepatobiliary contrast agents (e.g. gadoxetic acid) to daily routine practice, the visualization of the cystic duct will enhance in near future (11). However, also these new methods have the same disadvantages that previously mentioned.

Based on the literature data, some techniques (e.g. ERCP, MRCP) which may provide enough information about cystic duct may also pose some disadvantages (e.g. cost, time, invasiveness) and could not be used as initial modality for examining the biliary tract. Because of its interesting anatomy and small caliper, though to being an important joining unit between the gallbladder and the common bile duct, it is hard to see the cystic duct



during conventional upper abdominal US examinations. In this study, we investigated to demonstrate the cystic duct adequately using posterior or posterolateral approaches with the transducer insonating through the intercostal spaces during different phases of respiration. The greatest advantage of the US is the possibility of real-time examination.

However, this focused US has several limitations. US examination window could be affected by the hepatic flexure or gas distension of anteroduodenal segment of the stomach. Folding of the gallbladder neck, collapsed channel (due to insufficient duration of fasting or structural), sound attenuation due to steatosis or very high anatomical location of the liver are all limitations to optimal cystic duct visualization.

In our study, despite to all these limitations, also considering the advantages of real-time examination, examiners success in demonstrating the cystic duct as high as %91 of cases.

The most important point we noticed in this study was to try to view the cystic duct both in full inspiration and forced expiration during examining in left lateral decubitus position. So, concerning the small volume of the duct, performing these respiratory manoeuvres will permit to catch the critical section which may include the information of the cystic duct. Another issue is, the necessity of examining all the cases with symptoms such as nausea and right upper quadrant to identify the pathologies including passage of crystal or sludge thorough the cystic duct. This procedure may even be applied to those symptomatic cases which have normal cross-sectional hepatobiliary imaging findings. When these established findings are reflected to the routine US reports, follow-up or treatment approach to these cases and consequently the whole algorithm may change. Also, according to the imaging result of the

cystic duct pathology, any planned intervention could be modified (12).

In conclusion, our study showed that, although not being included in the report format after routine upper abdominal US examination, the cystic duct could be viewed in 91% of the cases with posterior-posterolateral approach during focused US. In evaluation of the cystic duct abnormalities (e.g. canalicular calculi, crystal, wall thickening), this method must be used in addition to the conventional positions during hepatobiliary ultrasound, especially in symptomatic cases. We believe that this new method may be used as a supplementary study to conventional method for routine abdominal US in selected patients.

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