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Brief Report

Point-of-care ultrasound diagnosis of pediatric cholecystitis in the ED

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Abstract

Objective: The diagnosis of cholecystitis or biliary tract disease in children and adolescents is an uncommon occurrence in the emergency department and other acute care settings. Misdiagnosis and delays in diagnosing children with cholecystitis or biliary tract disease of up to months and years have been reported in the literature. We discuss the technique and potential utility of point-of-care ultrasound evaluation in a series of pediatric patients with suspected cholecystitis or biliary tract disease.

Methods: We present a nonconsecutive case series of pediatric and adolescent patients with abdominal pain diagnosed with cholecystitis or biliary tract disease using point-of-care ultrasound. The published sonographic criteria is 3 mm or less for the upper limits of normal gallbladder wall thickness and is 3 mm or less for normal common bile duct diameter (measured from inner wall to inner wall) in children. Measurements above these limits were considered abnormal, in addition to the sonographic presence of gallstones, pericholecystic fluid, and a sonographic Murphy's sign.

Results: Point-of care ultrasound screening detected 13 female pediatric patients with cholecystitis or biliary tract disease when the authors were on duty over a 5-year period. Diagnoses were confirmed by radiology imaging or at surgery and surgical pathology.

Conclusions: Point-of-care ultrasound to detect pediatric cholecystitis or biliary tract disease may help avoid misdiagnosis or delays in diagnosis in children with abdominal pain.

1. Introduction

Although an uncommon occurrence in the emergency department (ED), the diagnosis of cholecystitis or biliary tract disease in children and adolescents has been reported to be increasing since the 1970s [1]. This may be due to several

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factors: rates of obesity have tripled in school-aged children aged 6 to 19 from 5% to 6.5% in the 1976-1980 National Health And Nutrition Examination Survey (NHANES) to 17.4% to 18.8% in the 2003-2004 NHANES [2]; more available diagnostic capability with the introduction of ultrasound in the 1970s; and the more recent expanding use of point-of-care ultrasound by clinicians around the world.

Health care providers may not be aware of the features of pediatric cholecystitis and its atypical presentation because it is infrequently encountered in the pediatric population and primarily considered an adult disease entity. In fact, many may not include cholecystitis or biliary tract disease on a differential diagnosis list when evaluating a pediatric patient with abdominal pain. The medical literature consists of case series with patients younger than 20 years, making 1.2% [3] to 4.3% [4] of all patients with gallbladder or biliary tract disease. No recent prospective population-based data of pediatric cholecystitis or biliary tract disease are available. Reports of delays in diagnosing younger children with cholecystitis or biliary tract disease of up to months and years are not infrequent in the medical literature [1,3-7]. In addition, misdiagnosis of cholecystitis in children can occur, with one series reporting up to 15% of pediatric cholecystitis patients with typical symptoms having a preoperative diagnosis of acute appendicitis [5]. The age of presentation can range from as early as the neonatal period to adolescence where features of gallbladder disease become similar to adult cholecystitis.

Data to support sonographic criteria for the diagnosis of cholecystitis or biliary tract disease in children are limited. The gallbladder wall thickness and common bile duct diameter measurements have been extrapolated from adult criteria and may pose a problem in certain cases. The purpose of this report is to present a series of pediatric and adolescent patients with cholecystitis or biliary tract disease diagnosed using point-of-care ultrasound. We discuss the technique and sonographic criteria for point-of-care ultrasound evaluation of children and adolescents with suspected cholecystitis or biliary tract disease.

2. Methods

We report the demographic, clinical, and sonographic indicators of 13 nonconsecutive pediatric patients with cholecystitis or biliary tract disease collected from 4 different EDs. These patients presented when the authors were on duty over a 5-year period and when clinical suspicion (upper abdominal pain) prompted the performance of a point-of-care ultrasound examination. We used the published sonographic criteria for the upper limits of 3 mm or less for normal for gallbladder wall thickness [8] in children up to 16 years old and 3 mm or less for normal common bile duct diameter [9] (measured from inner wall to inner wall) in children up to age 13 years old. Measurements above these limits were considered abnormal, in addition to the sonographic presence of gallstones, pericholecystic fluid, and a sonographic Murphy sign. We defined obesity as >95th percentile of body mass index according to CDC guidelines [10]. This brief report in case series format was determined to be exempt from review by the authors' institutional review boards.

3. Ultrasound technique

All patients were scanned with curvilinear or phased array transducers from 3.5 to 5 MHz in multiple transverse and longitudinal planes to evaluate the gallbladder, main lobar fissure, and portal triad in detail. When necessary, scanning in oblique planes or scans in the left lateral decubitis position were obtained.

4. Results

Point-of-care ultrasound screening detected 13 female pediatric patients with cholecystitis or biliary tract disease when the authors were on duty from 2004 to 2008. Table 1 describes the demographic and clinical information of the 13 cases. All cases were confirmed by subsequent radiology department imaging (ultrasound, hepatobiliary iminodiacetic acid [HIDA] scan, or magnetic resonance imaging) or at surgery.

5. Discussion

One of the primary difficulties in diagnosing cholecystitis or biliary tract disease in the pediatric population is the high threshold for suspecting the disease. Risk factors for cholecystitis or cholelithiasis in the pediatric population have been identified as menarche in females, obesity, a history of receiving total parental nutrition with and without ileal resection or dysfunction (eg, from necrotizing enterocolitis) in infants, biliary dyskinesia, and hemoglobinopathies such as sickle cell disease and hereditary spherocytosis. These risk factors are reviewed in detail elsewhere [1,4,11].

On clinical presentation, none of the pediatric patients in our series had the classic constellation of fever, elevated leukocyte count, and an acute abdomen on physical examination. In contrast to adults studied with nongangrenous acute cholecystitis, approximately 25% of adult patients lacked fever and elevated leukocyte count [12]. Thus, physical examination and laboratory testing can be of limited value in diagnosing pediatric biliary tract disease. Abdominal x-rays may only detect radiopaque pigmented gallstones in less than half of symptomatic children with hemolytic disorders [11]. Patients in our series were often referred by

Table 1 Demographic, clinical, and sonographic data of pediatric cholecystitis and biliary tract disease cases

Age/ sex/race	Prior MD Visit	Time of symptom onset to diagnosis	Presentation/referring diagnosis	BMI	Temp. (°F)	WBC (10^3/mm)	PoC US findings (GBWT in mm)	Final diagnosis
11/F/B	PMD/ED discharge	17 d	RLQ pain/r/o appendicitis	NL	98.6	5.5	Large gallstone (4.4)/+SMS	Cholecystitis
7/F/B	PMD	4 d	Midepigastric pain/ gastritis	OW	96.2	5.9	CBD 10.1 mm/ normal GB	Choledochal cyst
14/F/W[a]	None	1 d	Epigastric pain	OW	97.8	15.4	Gallstone (2.6)/+SMS	Acute cholecystitis
12/F/W	PMD	5 d	Epigastric pain radiating to back/N/V	NL	96.9	8.0	Gallstone in neck (4.0)/+PCF	Acute cholecystitis
8/F/B	ED discharge (3 mo prior)	5 y	Intermittent. bilious vomiting and RUQ pain	NL	98.2	8.6	Impacted gallstone (<3.0)/+SMS	Biliary colic
15/F/W[a]	PMD/ED discharge	60 d	Gastritis/ulcer/ psychiatric Evaluation	OW	97.0	9.2	Gallstone (5.0)/+SMS	Cholecystitis
13/F/W[a]	PMD/clinic/ED discharge	35 d	r/o appendicitis/ UTI	OW	99.2	8.7	Large gallstone (5.3), min PCF/+SMS	Cholecystitis
15/F/W[a]	PMD/ED discharge	60+ d	Gastritis/malingering	OW	100.1	7.4	Multiple small gallstones (4.4)+SMS	Cholecystitis
14/F/W	PMD	21 d	Dysmenorrhea/r/o appendicitis	OW	96.0	8.3	Gallstone (4.5)	Cholecystitis
12/F/W	PMD/ED discharge	45 d	Anxiety/gastritis	OW	97.9	10.0	Gallstone (4.5)	Cholecystitis
15/F/W[a]	Clinic/urgent care	14 d	Asthma/gastritis/ulcer	OW	99.1	8.9	Gallstone (5.0), CBD 8 mm/+SMS	Cholecystitis
13/F/W[a]	PMD/ED discharge	60+ d	Gastritis/ dysmenorrhea/ malingering	OW	98.9	4.5	Gallstone (4.0), PCF/+SMS	Cholecystitis
18 mo/F/W	PMD	1 d	Half-hour crying episode/r/o intussusception (ex-32 week twin gestation; hx/o TPN)	NL	97.0	12.0	Sludge (4.5)	Cholecystitis

F indicates female; W, white; B, black; mo, months old; PMD, primary care physician; r/o, rule out; N, nausea; V, vomiting; RUQ, right upper quadrant; UTI, urinary tract infection; hx/o, history of; TPN, total parental nutrition; BMI, body mass index; NL, normal (5 to <85% BMI); OW, overweight (>95% BMI) [10]; WBC, white blood cell count; SMS, sonographic Murphy's sign; PoC US, point-of-care ultrasound; GBWT, gallbladder wall thickness (in millimeters); CBD, common bile duct; PCF, pericholecystic fluid.

[a] Family history of gallstones.

primary care physicians with other diagnoses such as gastritis or for psychiatric evaluation, and in some cases, were returning after a prior ED visit. Thus, it is infrequent for physicians caring for pediatric patients to readily consider cholecystitis or biliary tract disease in the differential diagnosis of upper abdominal pain. Furthermore, this frequently led to considerable delays in diagnosis. Several patients in our series experienced delays in diagnosis ranging from greater than 60 days to 5 years.

Management of these pediatric patients can be complicated by their lack of symptoms or otherwise well appearance when symptoms are intermittent. Disagreement with discharge disposition can arise when a child becomes completely asymptomatic during ED evaluation despite an abnormal point-of-care gallbladder ultrasound evaluation, as occurred in patient 1 (Fig. 1A). The patient was discharged home and returned to pediatric surgery clinic a week later with intermittent abdominal pain. She was sent for radiology department ultrasound that was read as equivocal with an anterior gallbladder wall thickness measurement of 2.8 mm. On further radiology imaging, the patient had a positive HIDA scan and was admitted for intravenous antibiotics for a week and underwent elective cholecystectomy 2 weeks later. In addition, point-of-care ultrasound can be useful when

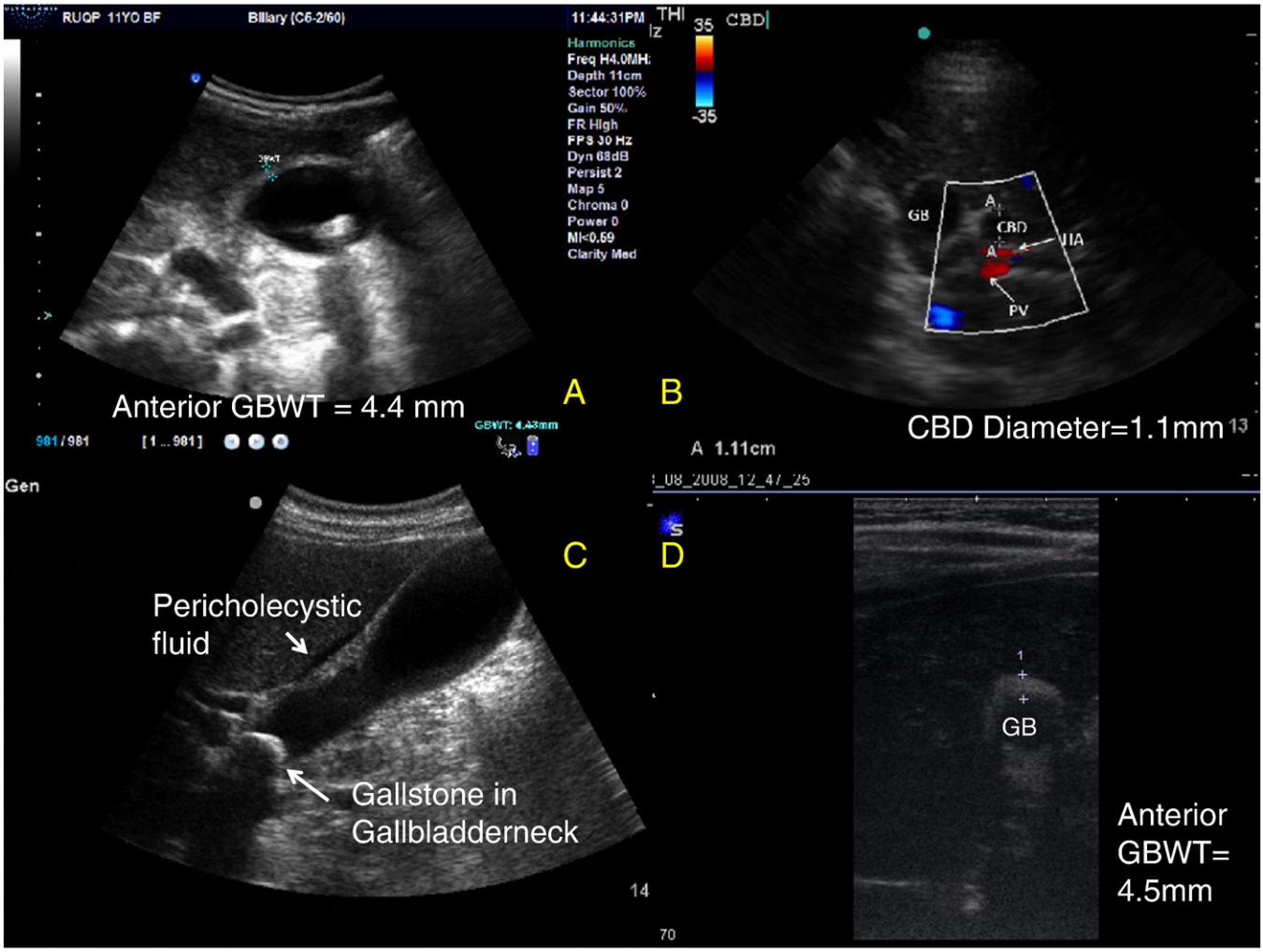

Fig. 1 A, Patient 1 with gallbladder wall thickness (GBWT) measuring 4.4 mm with gallstone in gallbladder. B, Patient 2 with choledochal cyst; image showing dilated common bile duct (CBD) measuring 11.1 mm. Flow (in red) visualized in the hepatic artery (HA) and portal vein (PV). C, Patient 7 with pericholecystic fluid and gallstone in gallbladder neck. D, Patient 13, an 18-month-old ex-32 weeks' gestation premature infant, had received total parental nutrition during neonatal course, with thickened anterior GBWT measuring 4.5 mm.

pathology other than cholecystitis or cholelithiasis may be detected: in patient 2, referred for midepigastric pain and a tentative diagnosis of gastritis by her pediatrician, point-of-care ultrasound examination demonstrated a normal gallbladder but revealed a dilated common bile duct measuring 1.1 cm (Fig. 1B), and a type 4 choledochal cyst was confirmed on subsequent magnetic resonance imaging.

In the past, physicians considering these uncommon diagnoses in children would be required to obtain radiology department imaging services. However, in the last decade, emergency ultrasound has expanded greatly [13]. It is now more likely that emergency physicians will themselves perform a focused point-of-care ultrasound of the right upper quadrant. Previous research on emergency gallbladder ultrasound in adults has shown that emergency physicians accurately perform and interpret the examination [14]. In addition, point-of-care gallbladder ultrasound performance tends to decrease throughput time and allow for faster disposition [15,16]. As emergency physicians in general and pediatric EDs increase point-of-care ultrasound utilization, they will be more likely to diagnose pediatric patients with cholecystitis or biliary tract disease. An increased awareness and a lower index of suspicion will be critical.

5.1. Limitations

This report is a limited nonconsecutive case series. Thus, we were unable to determine test performance characteristics for point-of-care gallbladder ultrasound to diagnose pediatric cholecystitis or make systematic observations regarding risk factors for cholecystitis or biliary tract disease in pediatric patients. Furthermore, no data exist that describe test performance characteristics of sonographic indicators such as the anterior gallbladder wall thickness measurement, common bile duct diameter, presence of pericholecystic fluid (Fig. 1C), or the sonographic Murphy's sign in children. In

our limited experience, the anterior gallbladder wall cutoff measurement of 3 mm to define the limits of normal [8] was occasionally problematic. Patient 4, with an anterior gallbladder wall thickness measurement of 2.6 mm, was diagnosed with cholecystitis confirmed by positive HIDA scan. These measurements will need to be confirmed by prospective investigation.

History regarding duration of chronic abdominal pain was obtained from parental recall and in the child with symptoms for 5 years, it was possible that there were other causes for chronic abdominal pain other than gallbladder disease. Contrary to the published literature, it is also notable that the gender predilection in our series was entirely female. In our collective experience, we know of only one male child (12 years old) who presented clinically with biliary colic symptoms with gallstones diagnosed by point-of-care ultrasound but was not included in this case series because of lack of a definitive diagnosis. We would caution readers that the lack of male patients in our series compared to the literature [1,4,7] may reflect underdiagnosis of male children on our part or the very limited number of patients in this series. In addition, being in EDs of general hospitals (as opposed to tertiary care children's hospitals), we did not encounter any children with hemoglobinopathies in our series, which is another well-documented risk factor for gallstones and biliary tract disease.

6. Conclusions

Point-of-care ultrasound to detect pediatric cholecystitis or biliary tract disease may help avoid misdiagnosis or delays in diagnosis in children with abdominal pain, especially in the context of intermittent symptoms or multiple visits to health care providers. Further research is necessary to determine the accuracy of point-of-care ultrasound in the diagnosis of pediatric cholecystitis or biliary tract disease. Further prospective population-based investigation is warranted to better describe the epidemiology of cholecystitis or biliary tract disease in the pediatric population.

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