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Clinicopathologic Profile and Outcomes of Pediatric Patients Managed with Open and Laparoscopic Cholecystectomy: A Two-Center Experience

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Rationale/Objectives: This seven-year, two-center retrospective cross-sectional study aimed to describe the demographic, clinical characteristics and surgical indications of patients managed with open or laparoscopic cholecystectomy in the pediatric age group, and determine these variables' associations with patient outcomes.
Methods: Records of all patients less than 19 years old who underwent laparoscopic or open cholecystectomy at Jose R. Reyes Memorial Medical Center (JRRMMC) and National Children's Hospital (NCH) from January 2015 to December 2021 were reviewed. The gathered data were organized, described and analyzed using univariate and multivariate statistics.
Results: A total of 32 patients underwent open or laparoscopic cholecystectomy at the two institutions. Majority were female (78.1%). The diagnoses included chronic calculous cholecystitis (62.5%), acute calculous cholecystitis (21.9%), choledocholithiasis (12.5%). One (3.1%) patient had empyema of the gallbladder. The 15 – 18 year age group made up 78.1%, with the rest (21.9%) from the 10 – 14 year age group. By BMI percentile, 62.5% were normal, 15.6% were overweight, and 12.5% were obese. Most patients across all conditions (96.9%) had no known hemolytic disorder. Underweight patients (9.4% of the cohort) had statistically higher lengths of stay [$F(3,28) = 3.444$, $p = .030$]. No significant associations were found between the categorical outcomes (discharged well, morbidity, mortality) and patient variables (age group, sex, BMI percentile, presence of co-morbidities, symptoms, indication for surgery, operation done).
Conclusion: In pediatric patients undergoing laparoscopic or open cholecystectomy, BMI percentile is inversely related to the length of hospital stay.

Key words: Cholecystectomy, laparoscopic, pediatric, gall bladder disease, demography

Over the last several decades, the incidence of gallbladder disease in children has markedly increased. This has been attributed to an increase in diagnosed cholelithiasis and biliary dyskinesia.[1] Whether this was due to an actual rise in cases, or to an increase in their detection with the use of ultrasonography and cholescintigraphy[2], the documented prevalence of cholelithiasis in children younger than 16 years of age has risen from 0.15% in 1959, to an estimated prevalence of 1.9 to 4% over 20 years.[3]

Along with the increase in cases, the etiology of pediatric cholelithiasis also appears to be evolving. While the development of gallstones in this age group was traditionally attributed to hemolytic disease, cholelithiasis in the absence of hemolytic disease is now more frequently being diagnosed in this population.[2] Nonhemolytic cholelithiasis can be caused by factors altering the enterohepatic bile circulation and causing bile stasis, including total parenteral nutrition use, cystic fibrosis, sepsis, short bowel syndrome in infants; and oral contraceptive use, cystic fibrosis, pregnancy, and ileal resection in older children.[2] Other proposed predisposing factors include lithogenic interventions in the neonatal period, including long-standing parenteral nutrition, liberal use of ultrasonography, an idiopathic etiology, and a progressive increase in pediatric obesity.[4]

More prominently, the recent rise in nonhemolytic cholelithiasis cases is now being attributed mainly to the epidemic of childhood obesity.[1] While already well-recognized as a risk factor for adult gallbladder disease, the role of obesity is currently being investigated in the younger population as an emerging driver for pediatric cholelithiasis. In a retrospective study by

Mehta, et al., 39% of pediatric patients who underwent a cholecystectomy were classified as obese, with a median body mass index (BMI) percentile of 89% (classified as overweight).[3] Parallel to this, many countries have recently reported increases in the prevalence of obesity.[5] The National Health and Nutrition Examination Survey (NHANES) report on the prevalence of obesity among children and adolescents reports a four-fold increase from 1963-1965 (4.2%), to 2015-2016 (18.4%).[6]

Approximately 60% of children and adolescents with cholelithiasis present with symptoms. Younger children more often present with nausea and vomiting, whereas adolescents often present with the more classic symptom of right upper quadrant abdominal pain.[1] This supports findings of an adjacent rise in the prevalence of cholecystectomies, which are generally indicated for symptomatic gallbladder disease.[5] Mehta, et al. revealed that the number of cholecystectomies done at Texas Children's Hospital increased from 36 procedures done from 1960 to 1980, to 128 procedures over the next 17 years (1980 to 1997). Furthermore, the primary indications for cholecystectomy in pediatric patients, aged three years or older, were symptomatic cholelithiasis (53%), obstructive disease (28%) and biliary dyskinesia (16%).[3]

Laparoscopic cholecystectomy continues to be the gold standard for the surgical management of symptomatic gallstones.[7] In a retrospective study by Kim, et al (2015), most cholecystectomies were performed for gallstones (91.7%), on female patients (70.8%), and adolescents (66.6%), with a mean age of 13.2 years.[4] Compared to open cholecystectomy, laparoscopic chlecystectomy in the pediatric population is associated with shorter operative time, shorter length of hospital stay, rapid diet resumption, decreased pain medication use and improved cosmetic results.[8] However, laparoscopic cholecystectomy is not without its complications. Bile duct injuries represent a potentially devastating surgical complication often requiring re-operation and biliary reconstruction. Although rare, the true incidence of bile duct injuries during laparoscopic cholecystectomy in children has not been well-established.

With the steady increase in the incidence of cholecystitis in children and the emerging trend of minimally invasive surgical approaches for this condition, this study aims to review patient characteristics, surgical indications, and their relation to outcomes in pediatric patients managed with laparoscopic and open cholecystectomy.

Methods

This is a seven-year, two-center retrospective cross-sectional study for patients below 19 years of age, who underwent laparoscopic or open cholecystectomy in two government training institutions in Metro Manila accredited by the Philippine Society of Pediatric Surgeons (Jose R. Reyes Memorial Medical Center and National Children's Hospital). All patients below 19 years of age who underwent laparoscopic or open cholecystectomy at these centers from January 1, 2015 to December 31, 2021, were included in the study.

Pediatric patients with documented congenital heart disease, mental retardation, delayed milestones, coagulopathies with contraindications for general anesthesia, were excluded from the study. Patients who had a routine cholecystectomy as part of a different hepatobiliary operation (ie, excision of choledochal cyst, hepatoportoenterostomy), were also excluded from the study.

The patients' medical records were retrieved. Data for the independent variables (age group, sex, BMI percentile, presence of co-morbidities, symptoms, indication for surgery, operation done) were collected. Outcomes of interest were length of hospital stay (LOS), discharged well, 7-year morbidity (defined as any complications within a 7-year follow-up period, including in-hospital morbidity), and mortality (defined as disease-specific mortality within a 7-year period). These were encoded in a Google Sheet file. The data was then incorporated into the IBM Statistical Package for the Social Sciences (SPSS, version 25) for analysis. Statistical testing included $\chi 2$ independence tests for the categorical outcome variables (discharged well, 7-year morbidity, and mortality) and one-way ANOVA for the continuous outcome variable (LOS).

Approval from the Institutional Review Board (IRB) of both Jose R. Reyes Memorial Medical Center and National Children's Hospital was secured prior to gathering all data.

Results

Overall Patient Demographics

From January 1, 2015 to December 31, 2021, a total of 32 patients underwent open or laparoscopic cholecystectomy at Jose R. Reyes Memorial Medical Center and National Children's Hospital. There was a total of 7 males (21.9%), and 25 females (78.1%). The median age was 17 years, ranging from 10 to 18 years old. Majority came from the 15 to 18 year-old age group (Table 1). In terms of geographic location, 28 (87.5%) patients came from the National Capital Region (NCR), with 2 (6.3%) from Calabarzon and 2 (6.3%) from Central Luzon (Table 2).

Table 1. Age and sex distribution of 32 pediatric patients who underwent cholecystectomy at JRRMMC and NCH. (January 2015 – December 2021)

Characteristic		n = 32	%
		Frequency	Percent
Age (Years)	0-4	0	0
	5-9	0	0
	10-14	7	21.9
	15-18	25	78.1
Median Age (Range)		17 years (10 - 18 years)	
Sex	Male	7	21.9
	Female	25	78.1
	Total	**32**	**100.0**
	Ratio	**1: 3.6**	

Table 2. Location distribution of 32 pediatric patients who underwent cholecystectomy at JRRMMC and NCH (January 2015 – December 2021)

Characteristic		**n = 32**	**%**
		Frequency	**Percent**
Location	**NCR**	**28**	**87.5**
	Calabarzon	**2**	**6.3**
	Central Luzon	**2**	**6.3**
	Total	**32**	**100.0**

Overall, 20 (62.5%) patients were classified as healthy (5th to 85th percentile). A total of 3 (9.4%) patients were underweight (<5th percentile), 5 (15.6%) were overweight (85th to <95th percentile), and 4 (12.5%) were obese (>95th percentile) (Table 3).

Table 3. BMI percentile distribution of 32 pediatric patients who underwent cholecystectomy at JRRMMC and NCH (January 2015 – December 2021).

Characteristic		n = 32	%
		Frequency	Percent
Weight Classification	Underweight (<5th %ile)	3	9.4
	Healthy (5th – 85th %ile)	20	62.5
	Overweight (85th - <95th %ile)	5	15.6
	Obese (≥95th %ile)	4	12.5
	Total	**32**	**100.0**

Among all patients, only 1 (3.1%) reported an unrecalled bleeding disorder on anamnesis. A total of 4 (12.5%) patients each had non-hemolytic comorbidities, specifically 2 cases of asthma, 1 with polycystic ovarian syndrome, and 1 with mitral regurgitation. Only 1 (3.1%) patient reported having a family history of cholelithiasis.

A total of 18 (56.3%) were preoperatively diagnosed with chronic calculous cholecystitis, 7 (21.9%) with acute calculous cholecystitis, 6 (18.8%) with choledocholithiasis, and 1 (3.1%) with empyema of the gallbladder. Intraoperatively, 2 of the preoperatively diagnosed choledocholithiasis patients were found to have chronic calculous cholecystitis with no appreciable choledocholithiasis (Table 3). However, all patients were found to have at least cholecystolithiases intraoperatively. All patients were confirmed to have cholecystitis on histopathologic reports.

All patients underwent surgery for the first time on admission. A total of 16 (50%) patients underwent laparoscopic cholecystectomy alone. Four (12.5%) patients underwent open cholecystectomy, intraoperative cholangiogram. Three (9.4%) patients underwent open cholecystectomy alone. Three (9.4%) patients underwent laparoscopic cholecystectomy, intraoperative cholangiogram. Three (9.4%) patients went through open cholecystectomy, intraoperative cholangiogram, choledochotomy, common bile duct exploration. Two (6.3%) patients underwent conversions from laparoscopic to open cholecystectomy. One (3.1%) patient underwent laparoscopic cholecystectomy, intraoperative cholangiogram, with choledochoscopy (Table 4).

All thirty-two patients were discharged well with a mean length of stay of 4.75 days, ranging from 2 to 14 days (SD = 9.15). However upon reviewing each patient's status in 2022 (ranging from 1 to 7 years post-surgery), there was one (3.1%) reported morbidity that occurred 1 year postoperatively, described as a recurrent stone. There were no documented bile duct injuries or mortalities (Table 5).

Acute Calculous Cholecystitis

Age and Sex Distribution

Of the 32 patients, 7 (21.9%) were diagnosed with acute calculous cholecystitis. There was 1 (14.3%) from the 10-14 year age group, and 6 (85.7%) from the 15-18 year age group. There were 2 (28.6%) males and 5 (71.4%) females.

BMI Percentile

Majority of patients with this condition (6 of 7 patients) were classified as healthy (85.7%), while 1 (14.3%) patient was classified as underweight. There were no overweight or obese patients.

Table 4. Distribution of diagnosis and operations performed in 32 pediatric patients who underwent cholecystectomy at JRRMMC and NCH (January 2015 – December 2021).

Characteristic		**n = 32**	**%**
		Frequency	**Percent**
Operative Diagnosis	**Acute calculous cholecystitis**	**7**	**21.9**
	Chronic calculous cholecystitis	**20**	**62.5**
	Choledocholithiasis	**4**	**12.5**
	Empyema of the gallbladder	**1**	**3.1**
	Total	**32**	**100.0**
Operation Done	**Open cholecystectomy alone**	**3**	**9.4**
	Laparoscopic cholecystectomy alone	**16**	**50**
	Open cholecystectomy + IOC	**4**	**12.5**
	Laparoscopic cholecystectomy + IOC	**3**	**9.4**
	Open cholecystectomy + IOC + Choledochotomy, CBDE	**3**	**9.4**
	Laparoscopic cholecystectomy + IOC + Choledochoscopy	**1**	**3.1**
	Laparoscopic converted to open cholecystectomy	**2**	**6.3**
	Total	**32**	**100.0**

Table 5. Distribution of outcomes among 32 pediatric patients who underwent cholecystectomy at JRRMMC and NCH (January 2015 – December 2021)

Characteristic		n = 32	%
		Frequency	Percent
Outcomes	Discharged well, no morbidities	31	96.9
	Morbidity (7-year follow-up)	1	3.1
	Mortality (7-year follow-up)	0	0
	Total	**32**	**100.0**
Mean Length of Stay (Range)		4.75 days (2 to 14 days) *SD = 9.15*	

Co-morbidities
No patients were documented to have a hemolytic disorder. However, 1 (14.3%) had a previous diagnosis of mitral regurgitation.

Clinical Presentation
Among patients with acute calculous cholecystitis, 4 of 7 patients (57.1%) presented with abdominal pain alone. Two (28.6%) patients presented with abdominal pain and jaundice, 1 (14.3%) patient presented with abdominal pain and nausea/vomiting.

Preoperative Evaluation
All 7 patients underwent ultrasound alone for preoperative work-up (100%).

Surgical Procedures
Four (57.1%) of the 7 patients with acute calculous cholecystitis underwent laparoscopic cholecystectomy alone. Two (28.6%) patients underwent open cholecystectomy with intraoperative cholangiogram, and 1 (14.3%) underwent laparoscopic converted to open cholecystectomy.

Outcome
All 7 patients were discharged well, with no documented morbidity or mortality within the 7-year follow-up period. The average length of stay was 5 days (range of 2 to 8 days).

Chronic Calculous Cholecystitis

Age and Sex Distribution
There were 20 (62.5%) patients diagnosed with chronic calculous cholecystitis. Of these, 5 (25%) from the 10-14 year age group, and 15 (75%) from the 15-18 year age group. There were 4 (20%) males and 16 (80%) females.

BMI Percentile
Majority of patients,13 (65%), with chronic calculous cholecystitis were classified as healthy, while 2 (10%) patients were classified as underweight, 2 (10%) patients were classified as overweight, and 3 (15%) were obese.

Co-morbidities
Among 20 patients, 1 (5%) was documented to have a previously diagnosed hemolytic disorder; however the disorder was not specified. Three (15%) patients were diagnosed with other non-hemolytic co-morbidities prior to admission, specified as asthma (2 patients), and polycystic ovarian syndrome (1 patient). The patient with polycystic ovarian syndrome had a history of oral contraceptive use (Ethinyl Estradiol + Levonorgestrel + Ferrous Fumarate) for one year prior to her diagnosis.

Clinical Presentation
Majority (12 of 20 patients, 60%) presented with abdominal pain alone. Three (15%) patients presented with abdominal pain and nausea/vomiting; 3 (15%) patients presented with abdominal pain, fever, and nau-sea/vomiting; 1 (5%) patient presented with abdominal pain, jaundice, and fever; 1 (5%) patient presented with abdominal pain and jaundice.

Preoperative Evaluation
All 20 patients underwent ultrasound alone for preoperative work-up.

Surgical Procedures
Majority (12 of 20, 60%) of patients underwent laparoscopic cholecystectomy alone. Two (10%) patients underwent open cholecystectomy alone; 2 (10%) patients underwent open cholecystectomy with intraoperative cholangiogram; 2 (10%) patients underwent laparoscopic cholecystectomy with intraoperative cholangiogram; and 1 (5%) underwent laparoscopic cholecystectomy with intraoperative cholangiogram with choledochoscopy. There was 1 (5%) conversion from laparoscopic to open cholecystectomy.

Outcome
All 20 patients were discharged well, with no documented morbidity or mortality within the 7-year follow-up period. The average length of stay was 4.5 days (range of 2 to 14 days).

Choledocholithiasis

Age and Sex Distribution
Of the 32 patients, 4 (12.5%) were diagnosed with choledocholithiasis. They belonged to the 15 to 18 age group. All patients were female.

BMI Percentile
The majority of patients, 3 (75%), with choledocholithiasis were classified as overweight. One (25%) patient was classified as healthy. There were no underweight or obese patients.

Co-morbidities
There were no documented co-morbidities or disorders among patients with choledocholithiasis.

Clinical Presentation
Two (50%) patients presented with abdominal pain alone, while 2 (50%) presented with abdominal pain, jaundice, and nausea/vomiting.

Preoperative Evaluation
Two (50%) patients underwent ultrasound alone for preoperative imaging. One (25%) patient had an MRI alone, while 1 (25%) had both an ultrasound and an MRI scan done.

Surgical Procedures
Majority (3 of 4, 75%) of patients underwent open cholecystectomy, intraoperative cholangiogram, choledochotomy, common bile duct exploration. One (25%) underwent laparoscopic cholecystectomy with intraoperative cholangiogram.

Outcome
Three patients were discharged well with no subsequent morbidity or mortality. However, 1 (25%) incurred a morbidity 1 year post-operatively, described as a recurrent stone. The average length of stay was 5 days (range of 4 to 8 days).

Empyema of the Gallbladder

There was a single male patient (3.1%) with empyema of the gallbladder, and came from the 10 to 14 year age group. His BMI percentile fell in the obese category. He had no known comorbids.

Preoperatively, he presented with abdominal pain alone, and was evaluated with ultrasound alone. He underwent open cholecystectomy alone, and was subsequently discharged with no documented morbidity or mortality after 7 days.

Correlation Between Demographic Variables and Outcomes

In order to examine the relationship between categorical outcomes (discharged well, morbidity, or mortality), and categorical variables (age group, sex, BMI percentile, presence of co-morbidities, symptoms, indication for surgery, operation done), a Chi-square test was performed. A p-value less than 0.05 would indicate statistical significance. Table 6 summarizes these tests.

For the analysis of the input variables versus the continuous outcomes a one-way ANOVA was used. There were no statistically significant differences detected except for BMI percentile (Table 7).

Pairwise comparisons in the BMI percentile group, showed that the Underweight group had significantly higher lengths of stay (mean of 12.3 days, SD = 4.64) than the Healthy group (mean of 4.2 days, SD = 2.18). There was no statistically significant difference between the other groups (Table 8a and 8b, and Figure 1).

Table 6. Chi-square independence tests for categorical outcomes (discharged well, morbidity, mortality) and categorical variables (age group, sex, BMI percentile, presence of hemolytic comorbidity, presence of non-hemolytic comorbidity, symptomatology, operative diagnosis, type of operation)*

Variable	Outcome	Chi-Square (χ^2)	df	p-value	Phi/Cramer's V	Significant? ($p < 0.05$)
Age Group	**Discharged NoMorb**	0.289	1	0.591	0.095	No
Age Group	**Morbidity**	0.289	1	0.591	0.095	No
Sex	**Discharged NoMorb**	0.289	1	0.591	0.095	No
Sex	**Morbidity**	0.289	1	0.591	0.095	No
BMI Percentile	**Discharged NoMorb**	5.574	3	0.134	0.417	No
BMI Percentile	**Morbidity**	5.574	3	0.134	0.417	No
Other Hemolytic	**Discharged NoMorb**	0.033	1	0.855	0.032	No
Other Hemolytic	**Morbidity**	0.033	1	0.855	0.032	No
Other Nonhemolytic	**Discharged NoMorb**	0.147	1	0.701	0.068	No
Other Nonhemolytic	**Morbidity**	0.147	1	0.701	0.068	No
Symptoms	**Discharged NoMorb**	0.706	5	0.983	0.149	No
Symptoms	**Morbidity**	0.706	5	0.983	0.149	No
Diagnosis	**Discharged NoMorb**	4.473	3	0.215	0.374	No
Diagnosis	**Morbidity**	4.473	3	0.215	0.374	No
Operation	**Discharged NoMorb**	9.978	6	0.126	0.558	No
Operation	**Morbidity**	9.978	6	0.126	0.558	No

- Variables with OutcomeMortality were excluded from this table because **no chi-square statistics were computed** (OutcomeMortality was constant: no deaths).

Table 7. Analysis of variance (ANOVA) between age group, sex, BMI percentile, non-hemolytic comorbidities symptoms, surgical indication, operation done, and length of stay.

Analysis of Variance (ANOVA) between categorical variables and length of stay (LoS)						
		Sum of Squares	**df**	**Mean Square**	**F**	**Sig.**
Age Group & LoS	**Between Groups**	23.143	1	23.143	3.356	0.077
	Within Groups	206.857	30	6.895		
	Total	230	31			
Sex & LoS	**Between Groups**	0.56	1	0.56	0.073	0.789
	Within Groups	229.44	30	7.648		
	Total	230	31			
BMI %ile & LoS	**Between Groups**	62	3	20.667	3.444	0.03
	Within Groups	168	28	6		
	Total	230	31			

Non-hemolytic Comorbids & LoS	**Between Groups**	10.286	1	10.286	1.404	0.245
	Within Groups	219.714	30	7.324		
	Total	230	31			
Symptoms & LoS	**Between Groups**	17.544	5	3.509	0.429	0.824
	Within Groups	212.456	26	8.171		
	Total	230	31			
Surgical Indication & LoS	**Between Groups**	7	3	2.333	0.293	0.83
	Within Groups	223	28	7.964		
	Total	230	31			
Operation Done & LoS	**Between Groups**	38.313	6	6.385	0.833	0.556
	Within Groups	191.687	25	7.667		
	Total	230	31			

Table 8. Analysis of variance (ANOVA) between BMI percentile and length of stay: PostHoc tests.

Multiple Comparisons
Dependent Variable: OutcomeLOS
Tukey HSD

(I) BMI Percent_Num	(J) BMI Percent_Num	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	Upper Bound
Underweight (<5th %ile)	Healthy (5th-85th %ile)	4.800*	1.517	.018	.66	8.94
	Overweight (85th - <95th %ile)	4.800	1.789	.055	-.08	9.68
	Obese (=/>95th %ile)	4.000	1.871	.166	-1.11	9.11
Healthy (5th-85th %ile)	Underweight (<5th %ile)	-4.800*	1.517	.018	-8.94	-.66
	Overweight (85th - <95th %ile)	.000	1.225	1.000	-3.34	3.34
	Obese (=/>95th %ile)	-.800	1.342	.932	-4.46	2.86
Overweight (85th - <95th %ile)	Underweight (<5th %ile)	-4.800	1.789	.055	-9.68	.08
	Healthy (5th-85th %ile)	.000	1.225	1.000	-3.34	3.34
	Obese (=/>95th %ile)	-.800	1.643	.961	-5.29	3.69
Obese (=/>95th %ile)	Underweight (<5th %ile)	-4.000	1.871	.166	-9.11	1.11
	Healthy (5th-85th %ile)	.800	1.342	.932	-2.86	4.46
	Overweight (85th - <95th %ile)	.800	1.643	.961	-3.69	5.29

Tukey HSD[a,b]

8b: Homogenous Subsets

BMI Percent_Num	n	Subset for alpha = 0.05 1	2
Healthy (5th-85th %ile)	20	4.20	
Overweight (85th - <95th %ile)	5	4.20	
Obese (=/>95th %ile)	4	5.00	5.00
Underweight (<5th %ile)	3		9.00
Sig.		.957	.077

Discussion

The Demography of Pediatric Biliary Disease

There is a paucity of baseline local data regarding both the incidence and demographics of pediatric biliary disease warranting surgical intervention. Despite a limited sample size, the demographics of patients involved in this study is consistent with existing literature on the demographics of pediatric patients with biliary disease.

Majority of the patients in this study came from the older age group (particularly 15 to 18 years old), supporting studies by Mehta, et al., where older age was cited as an independent risk factor for non-hemolytic gallstone disease[3]; and by Pogorelic, et al., in which the median age of pediatric patients undergoing cholecystectomy was found to have increased from 11 to 15.5 years old.[13]

The patients from this study were also predominantly female (78.1%), supported by earlier theories that hormonal changes of puberty may promote gallstone formation by affecting gallbladder motility. This result is consistent with findings from Pogorelic, et al., who reported a consistently higher incidence of cholecystectomies among female patients[13]; and Koebnick, et al., who cited a fourfold increased risk of gallstones in girls versus boys[14]. In the current study, only one participant used oral contraceptives (for polycystic ovarian syndrome). This is consistent with findings that female oral contraceptive users were at higher odds of developing gallstones than their peers.[14]

A number of findings are consistent with current literature on the emergence of non-hemolytic risk factors for gallbladder disease. Only 1 patient (3% of the total number of patients) was documented to have an unspecified hemolytic disorder. The majority of patients with cholecystitis were at least healthy by WHO standards, while majority of patients with choledocholithiasis were overweight. These findings may support literature that gallstone disease in pediatric patients is increasingly becoming an acquired condition.

Furthermore, the results show a relatively similar trend in regard to the BMI percentile of the patients. While majority (62.5%) of patients were classified as healthy, more than a fourth (28.1%) were either overweight or obese. This was especially significant for patients with choledocholithiasis, among whom 75% were classified as overweight. Mehta, et al reported their experience that 39% of pediatric cholecystectomy patients were obese with a median BMI percentile of 89%.[3] Pogorelic, et al. reported that the median BMI of Croatian pediatric patients who underwent cholecystectomy had increased over the two decades (1998-2017), and that analyses of children's gallbladders revealed an increasing frequency of cholesterol stones.[13]

Another non-hemolytic factor of local interest is biliary ascariasis. While biliary ascariasis is a recognized factor causing biliary tract disease in tropical countries[15], and is anecdotally common in the Philippines, this was not found in any of the patients of the current study by imaging or intraoperatively. This may likely be influenced by the study's limited sample size, and possibly underreported cases in other areas within the country, given that majority of patients (87.5%) came from the National Capital Region (NCR). Additionally, many of these patients may have been treated adequately with anti-helminthic medications, and may have subsequently not warranted surgical intervention.

Consistent with findings from a study by Stoops and Slusher, majority of patients (57.1% of acute calculous cholecystitis, 60% of chronic calculous cholecystitis, 50% of choledocholithiasis, and 100% of empyema of the gallbladder) had abdominal pain alone as the most common presenting symptom, described mostly as right-upper quadrant pain.[16] This underscores the need for a high index of suspicion for biliary disease warranting surgery in any pediatric patient presenting with abdominal pain, even in the absence of other symptoms.

Most patients in the study were adequately diagnosed by ultrasonography alone as imaging, supplementing clinical findings. Ultrasound remains to be the first-line modality for most suspected pediatric hepatobiliary disease, being the most readily available, affordable, and accessible diagnostic imaging tool. It is often used more consistently as a first-line modality over hepatobiliary iminodiacetic acid (HIDA) scans, despite the latter having a relatively higher sensitivity and specificity for cholecystitis. Typically, any additional suspicion for biliary obstruction in the pediatric age group would be followed by a magnetic resonance cholangiopancreatography (MRCP). But due to its higher cost, there are times the alternative option for an intraoperative cholangiogram is taken. In contrast with findings from Ameh where a clinical diagnosis of cholecystitis was made in less than half (42.9%) of their patients, and was only confirmed with ultrasound findings[15], 100% of the 31 patients with an initial preoperative ultrasound had imaging consistent with intraoperative findings. Two patients were preoperatively diagnosed as choledocholithiasis due to a clinical history of jaundice, but had either equivocal or negative ultrasound findings for common bile duct stones (reported as "obscured common bile duct" and "nondilated biliary and pancreatic duct"). Intraoperatively, findings were more consistent with imaging reports, with cholecystitis but no stones in the common bile ducts. Neither patient reported a recurrence of jaundice postoperatively. Given these findings, it may be most practical in a low resource seyting to have at least a hepatobiliary ultrasound as an initial diagnostic in pediatric patients suspected of biliary disease.

Majority of the procedures done were laparoscopic procedures with a total of 2 conversions (6.3%) from laparoscopic to open cholecystectomies (a 9% conversion rate). Apart from the 2 conversions, a total of 10 (31.25%) open procedures were indicated and performed for 1 case of empyema of the gallbladder, 6 cases of suspected choledocholithiasis, and 3 cases of acute calculous cholecystitis. This may suggest a need to look more closely into specific factors and situations that would warrant a decision to perform open over laparoscopic surgery.

Factors Influencing Outcomes for Pediatric Biliary Disease

With scarce literature on the incidence of outcomes for pediatric biliary disease, especially bile duct injury, mortality rates, and length of hospital stay, this study sought to both establish a baseline demographic locally, and determine factors influencing these outcomes.

A chi-square analysis performed for categorical outcomes (mortality and morbidity) unfortunately showed no statistically significant correlation between outcome and age group, BMI percentile, co-morbidities, clinical presentation, operative diagnosis, and operation done. However, this is strongly limited by the small sample size, with only 1 reported morbidity (recurrent stone) and no recorded mortalities. The patient found to have a recurrent stone eventually underwent an endoscopic retrograde cholangiopancreatography (ERCP), sphincterotomy and stone extraction, one year after her first surgery (open transcystic cholangiography, cholecystectomy, choledochotomy, choledocholithotomy, tube choledochostomy, completion cholangiography) and has remained asymptomatic on recent follow-up.

A lower BMI percentile (underweight) had a statistically significant association with higher mean lengths of stay. Nutritionally deficient patients may be more prone to hospital-acquired infections perioperatively. These may have both caused a delay in preoperative clearances for surgery, delayed recovery from surgical stress, or delayed discharge due to postoperative pneumonia.

The low incidence of bile duct injuries in this study, compares with the relatively low reported injury rates among pediatric cholecystectomies. A single-center study on patients less than 20 years old by Raval, et al. reported a BDI rate of 0.44% and identified younger (>5 years old), non-white patients admitted in the elective setting as having a higher likelihood of bile duct injuries during laparoscopic cholecystectomy.[17] Another study by Kelley-Quon, et al. reported in a bile duct injury rate of 0.36% among children 4 to 18 years old who underwent cholecystectomy.[18] These rates are slightly lower than the reported incidence of bile duct injuries in the adult age group of 0.5% (for emergent laparoscopic cholecystectomy), and 1.4% (for delayed/elective laparoscopic cholecystectomy).[18] The relatively lower incidence of reported bile duct injuries in pediatric patients may possibly be related to the more frequent use of intraoperative cholangiogram to define the biliary tract anatomy (34.4% in this study; 30% for Kelley, et al).

As previously mentioned, these analyses are still strongly limited by the small sample size of patients across all diagnoses, and will need more evidence from further studies spanning either a longer period, or more local institutions. The study is limited by the availability of data from preserved medical records. Due to some inconsistencies in documentation, some of the perioperative complications, such as hospital-acquired pneumonia, may not have been properly documented in some of the patients' postoperative course.

With most patients in the current study presenting with abdominal pain alone, clinicians must have a high index of suspicion for biliary disease within the pediatric population. Since an underweight BMI percentile may result in longer lengths of stay at the hospital, adequate measures must be undertaken to optimize patients nutritionally, especially for non-emergent surgeries. Surgeons must take the necessary precautions in anticipation of possible hospital-acquired infections for such cases.

The authors suggest to either continue this study for a longer time period, or include more institutions for a more comprehensive and accurate analysis. The authors also recommend the following for future studies: 1) A comparative study on the BMI percentile of pediatric patients with and without biliary disease, to better establish statistical significance for this as a risk factor; 2) A study documenting the types of gallbladder stones retrieved intraoperatively, to further explore other risk factors for the growing incidence of cholelithiasis in the pediatric population; 3) A study looking into incidentally diagnosed, asymptomatic cases of pediatric biliary disease and their outcomes, to establish the possibility for conservative measures in cases with no clear indications for surgery; and 4) A longitudinal study on the outcomes of pediatric patients with recurrent stones.

Conclusions

For pediatric patients undergoing laparoscopic or open cholecystectomy, there are no statistically significant associations between age group, sex, BMI percentile, presence of co-morbidities, symptoms, indication for surgery, operation done and outcomes (discharged well, morbidity, mortality). The length of hospital stay is inversely related to BMI percentile.

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