Pediatric Minimally Invasive Open Cholecystectomy : A New Approach Involving 27 Cases

Aloise Sagna[1]*, Alagie Baldeh[2], Lissoune Cisse[2]

[1] Professor, Department of Pediatric Surgery, Albert Royer Children's National University Hospital, Cheikh Anta Diop University, Dakar, Senegal

[2] Pediatric Surgeon, Department of Pediatric Surgery, Cheikh Anta Diop University, Dakar, Senegal

***Address for Corresponder:** Dr Aloise Sagna, Professor, Department of Pediatric Surgery, Albert Royer Children's National University. (email: alosagna@hotmail.com)

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Abstract

Introduction: This study introduces a compelling alternative to traditional pediatric laparoscopic cholecystectomy.

Materials and methods: We conducted a three-year prospective study from 2020 to 2022 in two different centers. This preliminary descriptive and analytic study included a randomized trial and statistical analysis to determine whether Minimally Invasive Open Cholecystectomy (MIOC) is comparable to laparoscopic surgery, using the Pearson coefficient test with significance set at better than 1%. Children were randomly selected and the "open" cholecystectomy was performed by the same pediatric surgeon for all cases. We conducted tracking and tracing to identify the gallbladder's projection on the abdominal skin.

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Our surgical procedure involved tracking and tracing to identify the gallbladder's projection on the abdominal skin, followed by retrograde dissection towards gallbladder's neck, with cholecystectomy either anterograde or retrograde.

Results: Twenty-seven children aged from zero to fifteen were recorded (19 cases at ARCH and 8 cases at IPGH) among 1,965 treated in the two departments during the study, resulting in an incidence rate of 0.0137. The average age of the children was three years, with a range from eighteen months to eleven years. The most represented age group was six to eight years old. Our series included 15 boys and 12 girls, giving a sex ratio of 1.25. The most common reason for surgery was cholelithiasis, accounting for 74.1% of the cases. The mean operating time was 65 minutes (range 50-92 minutes), and celiotomy length varied from 20 to 28 mm. Anterograde cholecystectomy was performed in 92.6% of cases, with bile drainage needed in two patients (7%). The median follow-up period was 24 months, and all patients experienced good postoperative results. The minor complications were infection and jaundice. The average length of hospital stay was 3 days (range 2-6 days). There was a positive correlation between cosmetic and functional outcomes for open surgery (P=0.3).

Conclusion: The authors present an effective minimally invasive open cholecystectomy.

Keywords

- Minimally Invasive Surgery
- Pediatric Mini-Laparotomy
- Cholelithiasis
- Cholecystectomy

Introduction

Minimally invasive surgery (MIS) has experienced significant growth in pediatric care. The main benefits of this approach include less abdominal wall trauma, shorter hospital stays, reduced pain, and fewer postoperative bowel adhesions.[1] Currently, multiport laparoscopic cholecystectomy is the preferred technique for children. However, the evolution of MIS has led to the development of methods that result in fewer or even no visible scars, providing substantial advantages. Recent innovations in surgical techniques, combined with ongoing research aimed at preventing postoperative complications, have introduced new approaches, including robotic access to the abdominal cavity.[2]

Materials and Methods

This study was a three-year prospective analysis conducted at two centers : Albert ROYER Children's Hospital (ARCH) and Idrissa Pouye General Hospital (IPGH). It was a preliminary descriptive and analytical study that included randomized trials and statistical analyses to demonstrate that minimally invasive open cholecystectomy (MIOC) may be comparable to laparoscopic surgery. The significance was tested using the Pearson correlation coefficient, with a threshold set at better than 1%. Patients were randomly selected based on the presence of either obstructive biliary stones or complicated sickle cell disease. The age groups were categorized as follows : [0-1], [1-5], [6-8], [9-11], and [12-15] years. Data analysis results were presented as frequencies and percentages.

Technique

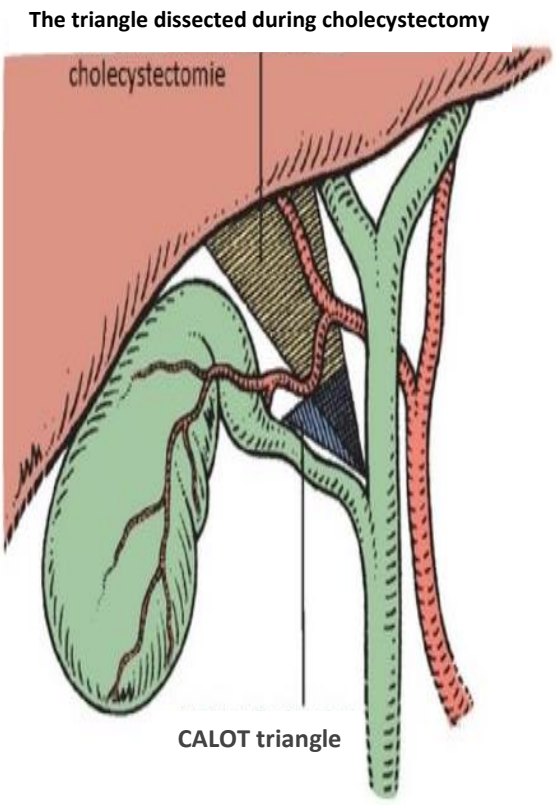
The open cholecystectomy was performed using a right supraumbilical transverse mini-laparotomy by the same pediatric surgeon in all cases. The patients were positioned supine with a pad placed under their back. We utilized tracking and tracing methods to locate the gallbladder's projection on the abdominal skin. Our surgical procedure involved the dissection of the mesocyst, "vesicula fundus detachment", followed by the release of the cystic neck and body, using either anterograde or retrograde cholecystectomy techniques, as illustrated by the following **Figures 1, 2, 3**.

(a) (b)

Figure 1:

a. Gallbladder's topographic identification

b. Celiotomy



(c) **(d) "Calot go home"**

Figure 2: Steps of dissection

c. mesocyst dissection - "cysticus fundus" traction - body and neck release.

Figure 3: Operative specimen

Result

Between January 1, 2020, and December 31, 2022, a total of 27 children aged 0 to 15 years who underwent open minimally invasive surgeries (MIS) were recorded. During the study period, both departments received a total of 1,965 patients, resulting in an incidence of 0.0137 for open MIS procedures in children. The mean age of the patients was 3 years, with ages ranging from 18 months to 11 years. The male-to-female ratio was 1.25, and the most represented age group was children aged 6 to 8 years. In ARCH, 19 children were included in the cohort, while 8 patients were recorded in IPGH. The clinical and paraclinical characteristics of these patients were primarily associated with billiary colic or cholelithiasis, which together accounted for 88.9% of the cases. All cases involved children with either Sickle Cell Disease (SCD) or Hemoglobin SC Disease (HbSC). A detailed overview of the various clinical presentations are provided in **Table 1.**

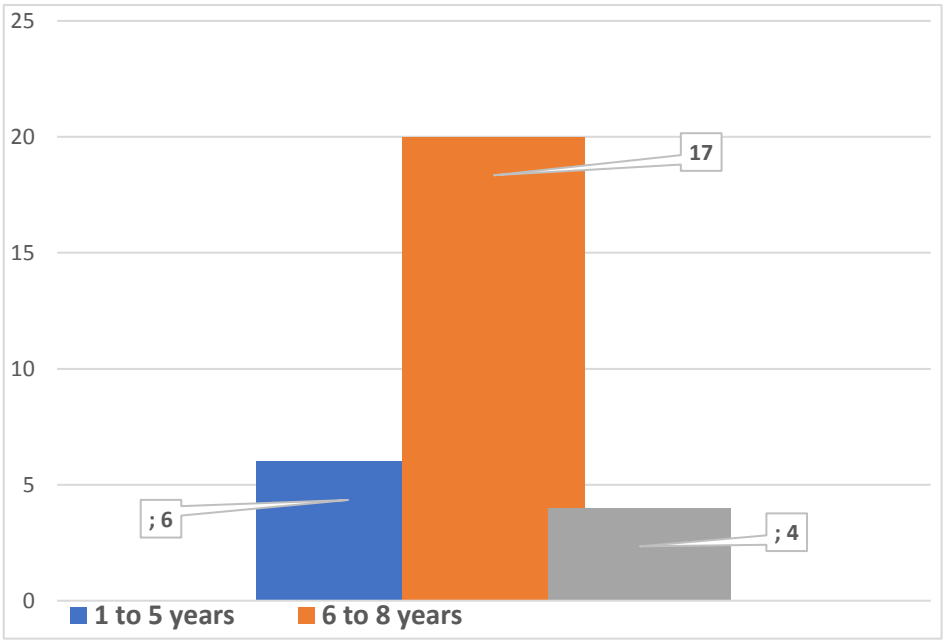


Figure 4: Distribution according to age group.

Medical History	SCD HbSC	**N = 23** **N = 04**
Clinical Diagnosis	Colic Cholelithiasis Angiocholitis	**N = 10** **N = 14** **N = 03**
Ultrasound Diagnosis	Micro-lithiasis Macro-lithiasiss Cholecystitis	**N = 05** **N = 16** **N = 06**
Surgery	**MIOC**	**N = 27**

Table1: Diagnostic characteristics (N: Number of cases; SCD: Sickle Cell Disease; HbSC: Hemoglobin SC disease; MIOC: Minimally Invasive Open Cholecystectomy)

The average operating time was 65 minutes, and the skin opening length varied between 20 and 28 millimeters. Anterograde cholecystectomy was performed en 92.6% of the cases (25 patients), while the retrograde procedure was used en 2 cases (7.4%). Two patients experienced biliary leakage during the operation, which was subsequently drained. Additionally, three patients encountered minor postoperative issues such as jaundice or infections, but these conditions improved well with antibiotic therapy. All patients showed favorable outcomes within a mean follow-up period of two years, and everyone reported excellent cosmetic results. The average length of hospitalization was 3 days, ranging from 2 to 6 days. A positive statistical correlation was found between having a minimal scar and rapid recovery related to open surgery (P = 0.3). Furthermore, there was no significant relationship between complications and the type of surgical procedures performed (P = 0.005).

Discussion

Epidemiological Aspects

Recent advancements in minimally invasive techniques for pediatric surgery have led to a less aggressive approach to treating gallbladder conditions, utilizing methods such as conventional laparoscopy and single-incision laparoscopy. Numerous studies in the literature demonstrate the safety and effectiveness of single-port cholecystectomy (SPLC)[3-4]. However, in many cases, the incision made is often larger than that of a conventional port to accommodate multiple working channels.[5] In 2023, Moreno Alfonso[1] from Spain published a study comparing single-port laparoscopic cholecystectomy (SPLC) with multiport laparoscopy. His research found no significant differences that favored one approach over the other. Earlier, en 2021, Adjerid[6] reported on pediatric multiport cholecystectomy in Algeria and suggested that the single-port approach might represent the future of minimally invasive cholecystectomy in children.[5]

The originality of our new technique appears to be a strong competitor to existing laparoscopic methods.

The mean age in Adjerid's cohort of ten patients over three years was 10 years (range : 7-13), with a male-to-female ratio of 0.66. In contrast, Alfonso's[1] series of 11 cases over six years reported a male-to-female ratio of 1.71 and a mean age of 10 years (range : 6-15). Montupet[7] reported on 131 patients operated in three centers over 15 years in France and Switzerland, with a median age at the time of surgery of 11.3 years (range : 3-18). In all these studies, the primary reason for the surgery was cholelithiasis.[4-7]

In our study of 27 patients over three years, we found that all cases involved cholelithiasis complicating sickle cell disease. Notably, the mean age at surgery in our cohort was 3 years, which is lower than reported in the current literature, and the male-to-female ratio favored boys. This two-center study also revealed that the most represented group of children in our context was between 6 to 8 years old.

Clinical Feature

The clinical features leading to the assessment and recommendation for laparoscopic cholecystectomy primarily include abdominal pain caused by gallstones. The migration of these stones can lead to acute conditions, often accompanied by jaundice or complications such as cholecystitis, angiocholitis, and even pancreatitis. In infants and children, cholelithiasis is frequently secondary to chronic hemolytic diseases, including hereditary spherocytosis, thalassemia, or sickle cell disease. Additionally, gallstones may be associated with autoimmune hemolytic anemias, cystic fibrosis, total parenteral nutrition (TPN), and cholestatic liver diseases. In adolescents, cholelithiasis typically has a cholesterol-based origin, with more than 50% of cases reported in the literature being idiopathic. Notably, the indication for cholecystectomy in cases of non-hemolytic conditions is the most commonly reported in studies from Algeria, France, Switzerland, and Spain.[1,6-7]

Our findings contrast with existing literature, revealing a high prevalence of Sickle Cell Disease (SCD) as the primary indication for cholecystectomy in our context.

The incidence of gallstone disease in children is influenced by both genetic and environmental factors, such as exposure to specific medications, such as Ceftriaxone. Additionally, the presence of certain predisposing conditions can contribute to the formation of gallstones. Despite

numerous studies on gallstone disease in children in recent years, there remains a significant lack of data regarding prophylactic measures and treatments that could help reduce the incidence of cholelithiasis in pediatric patients.[9-12]

When cholelithiasis is suspected, an ultrasound examination should be conducted. Children with sickle cell disease (SCD) are often asymptomatic at the time of their cholelithiasis diagnosis. A 13-year follow-up study involving 26 children with SCD cholelithiasis from Sudan found that only one patient developed symptoms three years later and required surgical treatment. The other 25 patients remained symptom-free. Cholelithiasis in children can lead to complications. Reported incidences of related issues include cholecystitis (27.7%), choledocholithiasis (10.6%), and acute pancreatitis (23.4%). In cases of abdominal pain, special attention should be given to cholelithiasis in even the youngest patients, particularly in premature infants, low-birth-weight infants, and very low-birth-weight infants. In cases of symptomatic cholelithiasis in children, 47.9% of patients were found to have complications such as cholecystitis upon pathological examination after laparoscopic cholecystectomy.[13]

In this study, no patient demonstrated any ultrasound-specific signs, organ adhesions, pericholecystic fluid, or peritoneal fluid.

Surgical Procedure Aspects and Outcomes

Laparoscopic cholecystectomy in children is widely accepted worldwide. Compared to open cholecystectomy, this procedure offers several advantages, including reduced postoperative pain, a shorter recovery period, a quicker return to unrestricted activities, and improved cosmetic results. Several predisposing factors, such as hemolytic disorders and obesity, may lead to conditions that necessitate surgery.[14] In our approach to pediatric minimally invasive surgery, we have chosen to perform a mini-laparotomy through an incision of less than 3 cm in diameter. This technique appears more cosmetic compared to the scars from multi-port procedures or the larger openings required for single-port surgeries.

We share the viewpoint of Montupet [7]that laparoscopic cholecystectomy (LC) in children is not a harmless procedure. The complication rate for this surgery is notably higher in children compared to adults,

particularly concerning biliary complications (3% in children versus 0.5% in adults). When performing LC, it is crucial to focus on the proper exposure of Calot's triangle (the hepato-cystic triangle). In children, this anatomical triangle is often narrow typically less than 2 cm on each side. Even minor bleeding can obscure this area, making precise hemostasis challenging. Additionally, the vascularization of the cystic artery shows significant anatomical variability. An early or atypical division of this artery can further increase the risk of injury.[15]

Our technique emphasizes the need for retrograde gallbladder's wall contact dissection with elective hemostasis. This approach does pay attention to the Calot's triangle design and the cystic variations of vascularization, as it stands far from those two principles of LC. Therefore, dissection is made simple by the use of bipolar hemostasis.

The mean operating time of 65 minutes (50 – 92mn) is comparable to that of most laparoscopic series. Frederico Seifarth[2], with his hybrid single-port LC in the USA found a median of 85 minutes. Most of the single port studies in the literature reported similar results but mentioned a learning curve that may require up to twenty procedures.[16-18] In those studies, the presence of multiple adhesions, as reported, could explain surgical time or complication rates. Whereas, in our cohort, no significant correlation was found between operating time and dissection conditions. In the two cases we performed postoperative suction drainage, bile leakage was suspected at the end of the procedure.

Overall, our study reports a short mean length of hospitalization of just 3 days, with all patients showing favorable outcomes. We found a statistically significant correlation between cosmetic results and rapid recovery associated with the mini-laparotomy technique (P = 0.3). However, we did not find a significant correlation between the surgical approach and complications (P = 0.005). Additionally, economic considerations influenced our treatment approach.

We acknowledge that there are limitations to this study, particularly due to the small sample size. Therefore, a larger cohort of patients is necessary to confirm these findings.

Conclusion

Pediatric laparoscopic cholecystectomy is considered the gold standard for minimally invasive surgery in children. This study introduces a new technique for performing open cholecystectomy through a single, very small skin incision. In terms of safety, no deaths were recorded, and there was a significant reduction in postoperative complication rates and the length of hospital stays. Thus, this new open approach for children appears to be comparable to pediatric laparoscopic cholecystectomy. Other techniques, such as endoscopic and robotic-assisted surgery, need to be assessed in large clinical trials to determine their effectiveness compared to both laparoscopic and open cholecystectomy. We believe that it remains unknown whether minimally invasive surgery leads to better surgical and patient-reported outcomes compared to open cholecystectomy, largely due to the limited evidence available to date.

Ethical Consideration

Approval was obtained from the Ethics Committee of Cheikh Anta Diop University of Dakar, Senegal.

Acknowledgment

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Conflict of interests

There is no conflict of interest

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