ORIGINAL ARTICLE

Needlescopic Versus Multi-Port Laparoscopic Cholecystectomy in Children, a randomized Controlled Study

Ali I. A. Ahmed *, Magid M. M. Ismail , Ibrahim A. I. Gamaan

Department of Pediatric Surgery, Faculty of Medicine for Boys, Al-Azhar University, Cairo, Egypt

Abstract

Background: ***Gallbladder surgery, specifically cholecystectomy, is a relatively uncommon procedure in pediatric populations. However, its incidence is on the rise due to increased recognition of gallbladder diseases such as cholelithiasis, often linked to conditions like obesity or hemolytic disorders.***

Objective: ***Our Study evaluates the comparative efficacy and outcomes of needle-scopic cholecystectomy (NC) versus multi-port laparoscopic cholecystectomy (LC) in pediatric patients.***

Patients and Methods: ***A randomized controlled trial was conducted involving 40 children with gallbladder diseases requiring surgical intervention, during the period from 2022-2024. Participants were assigned to either NC or LC groups, with primary outcomes including operative time, intraoperative complications, postoperative recovery, and cosmetic results.***

Results: ***NC demonstrated slightly longer operative times but offered significant advantages in postoperative recovery and cosmetic satisfaction, with minimal scarring and faster return to normal activities. Both techniques exhibited comparable safety profiles, confirming the feasibility of NC in pediatric surgery.***

Conclusion: ***These findings suggest that NC is a viable and advantageous alternative to LC, particularly for improving cosmetic outcomes. More researches in the future should investigate long-term outcomes and improve the technique for wider implementation.***

Keywords: Needlescopic cholecystectomy; multi-port laparoscopic cholecystectomy; pediatric surgery; minimally invasive surgery; cosmetic outcomes

1. Introduction

Gallbladder surgery, specifically cholecystectomy, is a relatively uncommon procedure in pediatric populations. However, its incidence is on the rise due to increased recognition of gallbladder diseases such as cholelithiasis, often linked to conditions like obesity or hemolytic disorders.[1,2]

Laparoscopic cholecystectomy (LC) has become the benchmark standard for gallbladder excision in children, offering decreased postoperative pain, reduced hospital stays, and improved cosmetic results if compared with open surgery .[3,4]

Generally, the goal has been to minimize the invasiveness of this procedure by reducing the number and, more commonly, the size of the operating ports and instruments. Efforts to further reduce the invasiveness of this approach have once again led to a new innovation, needle-scopic cholecystectomy.[5]

The advent of needle-scopic cholecystectomy (NC), employing tools with a diameter smaller than 3 mm, promises further advancements by reducing surgical trauma and enhancing aesthetic results .[5,6]

Needlescopic surgery in children has become increasingly favored due to its quick recovery and return to normal activity, shorter hospital stay, better cosmetic appearance, and less pain after surgery .[7]

Our Study is aiming for evaluation and comparison of the feasibility, safety, and outcomes of NSC versus traditional multi-port LC in children.

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* Corresponding author at: Pediatric Surgery, Faculty of Medicine for Boys, Al-Azhar University, Cairo, Egypt.
E-mail address: dr.aliibrahim2015@gmail.com (A. I. A. Ahmed).

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2. Patients and methods

The Study included 40 cases, underwent surgery at Al-Azhar University hospitals, Pediatric Surgery Department from 2022 to 2024 with NSC and Multiport LC.

Patients were divided into two groups: those receiving NSC and those undergoing multi-port LC.

We included all patients Aged between 2-18 years old. with confirmed gall bladder stones (acute cholecystitis), recurrent abdominal pain and gall bladder wall thickening as confirmed by ultrasonography (chronic cholecystitis), Presence of complication (gall stone pancreatitis, gall bladder mass or polyps, biliary dyskinesia).

We excluded all Patients aged below 2 years or aged older than 18 years old. Patients responding to medical treatment. Patients with previous abdominal surgery.

Evaluation was done with history taking stressing on disease duration, major complaints, physical examination, laboratory and radiological investigations.

Ethical consideration: The research protocol approval was obtained by the Institutional Review Board (IRB) of our medical school, and a well-informed consent was signed by patient's parent.

Procedures

Multi-Port LC: Standard laparoscopic techniques were employed, utilizing three to four ports, with a 5-mm telescope and various instruments for gallbladder dissection and removal. A through- or infraumbilical port is inserted using the open Hasson technique. In adolescents with a high body mass index, placing an optical trocar in an appropriate peri-umbilical location can help ensure safe access. CO2 insufflation for the creation of pneumoperitoneum was done. Once the port was inserted and the camera introduced, the surgeon determined the placement of the working ports. Two ports were positioned in the right subcostal area: the most lateral one for retracting the gallbladder over the liver to expose the operating field, and medial to that, the surgeon's left-hand operating port (Fig. 1A). An epigastric port was placed to the left of the falciform ligament for the right operating hand. Adhesions between the omentum, gallbladder, and liver were dissected. The anterior and posterior peritoneum overlying Calot's triangle were incised, usually with an L-shaped hook, creating windows between the cystic artery and duct (Fig. 2A). The cystic artery and duct were clipped after achieving a critical view of safety (Fig. 2B, C). Mass division or clipping of any large clump of tissue or duct structure was avoided. Care was taken to identify the looped right hepatic artery, which could be mistaken for the cystic artery. Electrocautery dissection was used to complete the cholecystectomy. Dissection began behind Hartmann's pouch (Fig. 2D). Gentle traction was applied to the gallbladder, moving it side to side to expose the loose areolar tissue (Fig. 2E). The gallbladder was extracted through the epigastric port (Fig. 2G). Fascial closure was only performed at the umbilical cannula site. During the extraction of the distended gallbladder, the epigastric port could be widened to facilitate its removal and avoid spillage of its contents. A drain was inserted into the operative bed, and the port introduction wounds were closed.

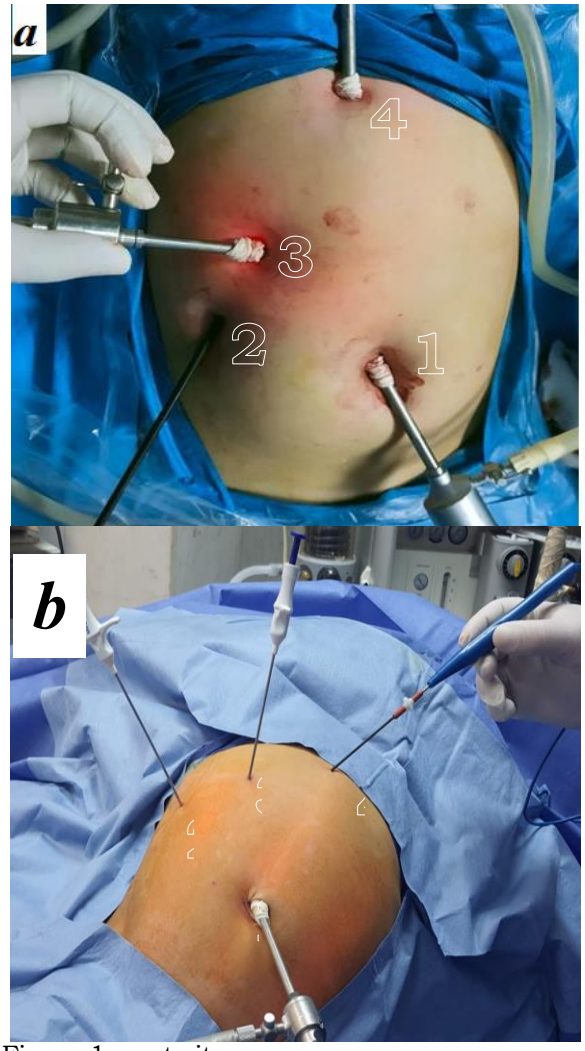

Figure 1. port sites

(A) Multiport laparoscopic cholecystectomy

1➔5-mm. umbilical camera port, 2,3➔two rt. subcostal working instruments the most lateral for fundus traction, Medial to that the surgeon's left operating hand, 4➔epigastric port, to the left of the falciform ligament for the right operating hand

(B) Needlescopic cholecystectomy

1➔5-mm. umbilical camera port, 2➔Mediflex suture device (MSD) for fundus traction, 3➔ another MSD for traction of Hartmann's pouch, 4➔• A third insulated (MSD) connected to diathermy.

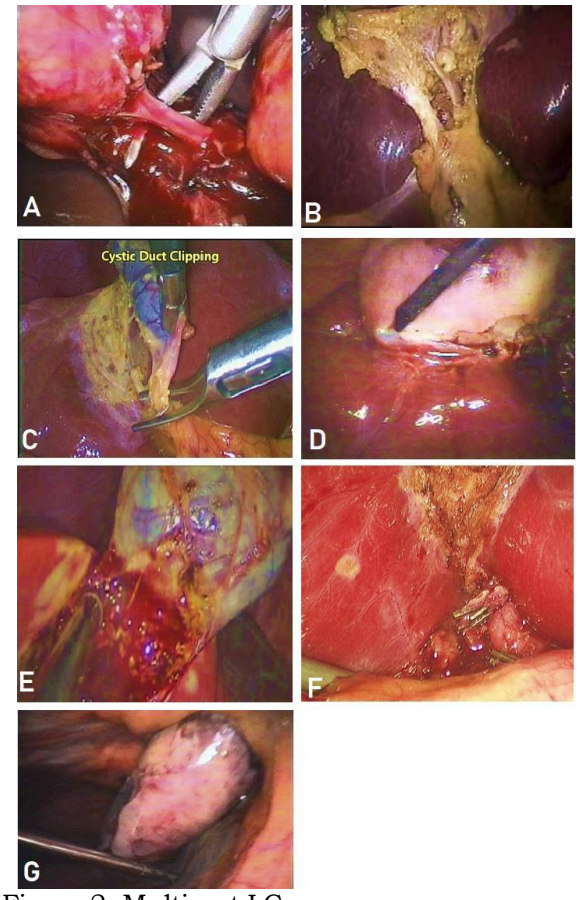

Figure 2. Multiport LC

A) Dissection of the cystic artery.B) Achievement of the critical view of safety. C) Clipping of the cystic duct. D) Use of hook electro-cautery to dissect the gallbladder from the liver bed. E) Removal of the gallbladder from its bed. F) Clean liver bed with clipped cystic duct and cystic artery. G) Extraction of the gallbladder.

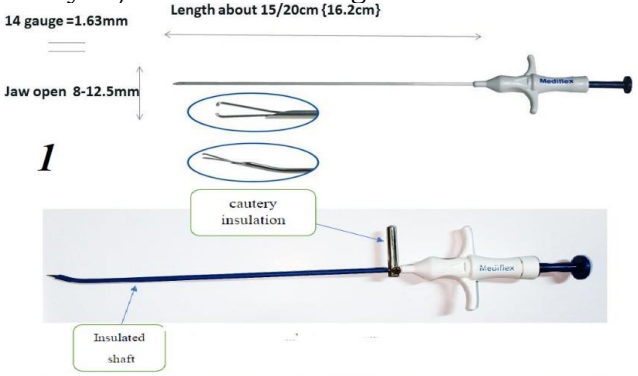

Figure 3. Mediflex suture device

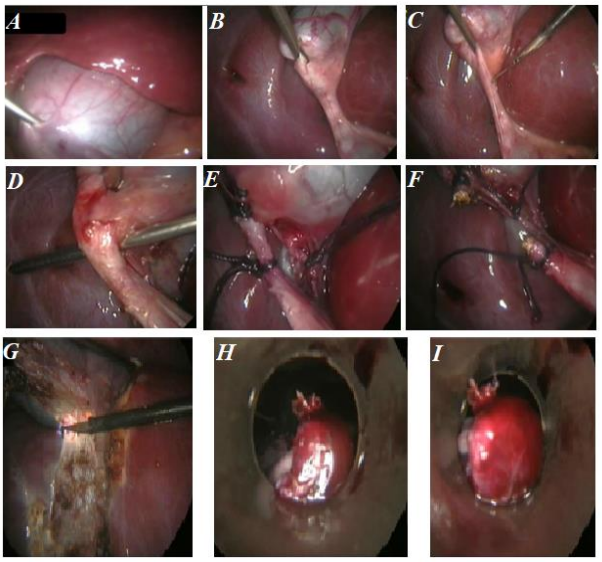

Figure 4. needlescopic cholecystectomy

The fundus of the gallbladder is grasped with the 1st MedN and pushed upward to the right upper quadrant. (B) The Hartman's pouch is grasped with the 2nd MedN. (C) The cystic duct is bluntly dissected using the 3rd MedN. (D) A window is created behind the cystic duct. (E) An Ismail Knot is tied proximally and distally along the cystic duct, and over the proximal end of the cystic artery, using a 2/0 vicryl suture. (F) The cystic duct is divided. (G) The gallbladder is dissected from the liver bed. (H, I) The gallbladder is extracted from the abdomen through the umbilical port.

Figure 5. Postoperative cosmetic results

3 months post operative cosmetic result A➔ laparoscopic cholecystectomy, B➔Needlescopic

cholecystectomy

Needlescopic Cholecystectomy: Two Mediflex suture devices (MSD) were inserted in the subcostal region, with the first one positioned at the anterior axillary line and the second at the midclavicular line. A third insulated MSD was inserted at the epigastric region, just to the right of the falciform ligament. The diathermy was connected to the third MSD. The fundus of the gallbladder was grasped using the first MedN and pushed upward toward the right shoulder. The Hartman's pouch was then grasped using the second MedN and manipulated upward and forward until Calot's triangle was clearly identified.

The cystic duct was bluntly dissected, and a window was created behind it using the third MedN. The cystic duct was ligated using a 2/0 Vicryl suture and divided with a 1.6 mm microscissor. The cystic artery was identified, ligated, and divided similarly. The gallbladder was then dissected from the liver bed, and its neck was grasped by the third MedN and extracted through the umbilical port.

The abdomen was inspected, and aspiration was performed using a Veress needle or a small suction tube, emphasizing precision due to the smaller instrument size. The umbilical port was then removed, and the incision was closed with a 2/0 Vicryl suture. The three MedNs were removed, and the needle sites were covered with Strips. All patients were discharged home on the same day of the surgery.

Outcome Measures

Primary outcomes included: Operative Metrics: Time, complications, and conversion rates. Postoperative Recovery: Pain levels, hospitalization period, and return to normal activities. Cosmetic Outcomes: Scar assessment and patient satisfaction scores.

3. Results

The study included 40 patients, evenly distributed between the NSC and LC groups. Key findings were:

When examining age distribution, our study demonstrated that NSC Grouphad a younger cohort (mean age 7.45 ± 3.38 years) compared to LC Group (mean age 10.25 ± 3.55 years), with a statistically significant p-value of 0.013.(Table 1)

Our study reported no instances of intraoperative complications in NSC Group, with zero occurrences of bleeding, bile duct injury, or gall bladder perforation. Similarly, LC Group also had no cases of bleeding or bile duct injury, but there was one instance of gall bladder perforation (5% of the group). There was a significant difference in operative times between both groups.

NSC Groupdemonstrated a shorteroperative time with a mean of 46.40 ± 9.82 minutes compared to NSC Groupwith a mean of 66.80 ± 9.85 minutes (Table 2).

NSC Group experienced no post-operative complications, indicating a highly favorable outcome for this minimally invasive approach. In contrast, LC Group reported a single case of Port site Infection (5%), yet overall complication rates were low.

Regarding time to attain normal bowel function, our study showed that patients who underwent needlescopic cholecystectomy had a mean time to attain normal bowel function of 5.5 ± 1.15 hours, compared to 6.30 ± 0.57 hours for those underwent laparoscopic cholecystectomy. The p-value of 0.001 indicates this difference is statistically significant (Table 3).

Also our results indicates that NSC Group is associated with significantly shorter hospital stays compared to LC Group . Patients in NSC Group had a mean hospital stay of 1.15 ± 0.31 days, which was significantly shorter than the 2.45 ± 0.51 days observed in LC Group, as indicated by a p-value of <0.001 (Table 4).

Our results showed a significant difference in family satisfaction with the cosmetic appearance through a self-designed questionnaire and which showed a highly statistical difference between the NSC Group and LC Group groups. An overwhelming 90% of families in NSC Group rated the cosmetic result as "Excellent," compared to none in LC Group, where 85% rated it as "Very good" and 15% as "Good." in LC Group. The statistical analysis showed a highly significant difference with a p-value of <0.001 (Table 5).

Table 1. Demographic data)

DEMOGRAPHIC DATA	NEEDLESCOPIC CHOLECYSTECTOMY (N = 20)		LAPAROSCOPIC CHOLECYSTECTOMY (N = 20)		TEST OF SIG.	P
	No.	%	No.	%		
SEX						
MALE	12	60.0	7	35.0	x^2= 2.506	
FEMALE	8	40.0	13	65.0		0.113
AGE (YEARS)						
MIN – MAX.	2.0 – 13.0		2.0 – 14.0			
MEAN ± SD.	7.45 ± 3.38		10.25 ± 3.55		U= 109.000*	0.013*
MEDIAN (IQR)	6.50 (5.0 – 11.0)		12.0 (8.50 – 13.0)			

Table 2. operative time.

OPERATIVE TIME	NEEDLESCOPIC CHOLECYSTECTOMY (N = 20)	LAPAROSCOPIC CHOLECYSTECTOMY (N = 20)	T	P
MIN – MAX.	32.0 – 70.0	51.0 – 80.0	6.51*	<0.001*
MEAN ± SD.	46.40 ± 9.82	66.80 ± 9.85		
MEDIAN (IQR)	44.50 (39.50 – 53.50)	66.50 (58.0 – 76.50)		

Table 3. time to attain normal bowel function

TIME TO ATTAIN NORMAL BOWEL FUNCTION (HOURS)	NEEDLESCOPIC CHOLECYSTECTOMY (N = 20)	LAPAROSCOPIC CHOLECYSTECTOMY (N = 20)	T	P
MIN – MAX.	4.0 – 7.0	6.0 – 8.0		
MEAN ± SD.	5.50 ± 1.15	6.30 ± 0.57		
MEDIAN (IQR)	5.50(4.50 – 6.50)	6.0(6.0 – 6.50)	2.792*	<0.001*

Table 4. Hospital stay

HOSPITAL STAY	NEEDLESCOPIC CHOLECYSTECTOMY (N = 20)	LAPAROSCOPIC CHOLECYSTECTOMY (N = 20)	T	P
MIN – MAX.	1.0 – 1.5	2.0 – 3.0		
MEAN ± SD.	1.15 ± 0.31	2.45 ± 0.51	9.208*	<0.001*
MEDIAN (IQR)	1.0(1.0 – 1.5)	2.0 (2.0 – 3.0)		

Table 5. Family satisfaction with cosmetic result

FAMILY SATISFACTION	NEEDLESCOPIC CHOLECYSTECTOMY (N = 20)		LAPAROSCOPIC CHOLECYSTECTOMY (N = 20)		FET	P
	No.	%	No.	%		
GOOD	0	0.0	3	15.0		
VERY GOOD	2	10.0	17	85.0	36.868*	<0.001*
EXCELLENT	18	90.0	0	0.0		

4. Discussion

Our demographic data analysis aligns with recent publications, no instances of intraoperative complications in Group (A), Similarly, LC Group showed only one instance of gall bladder perforation (5% of the group).

This was in line with Ismail et al.[7] noting particularly low incidences of bile duct injury and bleeding, which parallels our findings, With no intraoperative or postoperative complications, demonstrating safety of NSC and showing very low complication rates.

Shalaby et al.[8] found no other intraoperative complications apart from 2 cases (4.16%) of gall bladder perforation, which were managed by leaving a tube drain placed at the gall bladder bed.

The slight difference in the incidence of gall bladder perforation observed in Group B (5%) aligns with the low complication rates reported in the literature.

NSC Group demonstrated a shorter operative time compared to LC Group. These findings are in alignment with Zhao et al.[9] reported similar results, noting significantly shorter operative times for needlescopic procedures compared to traditional laparoscopic cholecystectomy.

Ismail et al.[7] also recorded a similar mean operative time of 43 minutes, with a range of 30 to 76 minutes. Highlight the efficiency of needle-scopic cholecystectomy.

Also, Our results were in line with Shalaby et al.[8] as he reported a average operative time of 47.69 ± 7.2 minutes, with a range from 35 to 75 minutes.

NSC Group experienced no post-operative complications, indicating a highly favorable outcome for this minimally invasive approach.

In contrast, LC Group reported a single case of Port site Infection (5%), yet overall complication rates were low.

These findings align with Ismail et al.[7] who demonstrated that minimally invasive techniques like needle-scopic cholecystectomy significantly reduce post-operative complication rates.

Similarly, Sajid et al.[10] found low post-operative complication rates in both needle-scopic and laparoscopic cholecystectomy, with a slightly higher incidence of complications in the laparoscopic group, particularly Port site Infections.

Patients undergoing needle-scopic cholecystectomy had a mean time to attain normal bowel function of 5.5 ± 1.15 hours, compared to 6.30 ± 0.57 hours for those undergoing laparoscopic cholecystectomy.

This aligns with recent publications, such as the Study by Ismail et al.[7] which highlighted the feasibility and safety of needle-scopic cholecystectomy in children, emphasizing its advantages in terms of cosmetic results and recovery.

Additionally, the narrative review by Nam et al.[11] further supports our findings by discussing the benefits of minimally invasive techniques, including needle-scopic cholecystectomy, in reducing invasiveness and improving recovery times.

NSC Group is associated with significantly shorter hospital stays compared to traditional laparoscopic cholecystectomy (Group B). Patients in NSC.

These findings are consistent with recent literature. Zani et al.[12] reported similar results, with patients undergoing needle-scopic cholecystectomy having a mean hospital stay of 1.6 days. This aligns closely with our observation and reinforces the advantage of needle-scopic techniques in reducing hospital stays.

Bourgeois et al.[13] also documented shorter hospital stays for needle-scopic cholecystectomy, with mean durations of 1.4 days for needle-scopic and 2.3 days for laparoscopic procedures.

Shalaby et al.[8] discharged most patients on the second postoperative day, while patients living farther from the hospital were discharged on the third postoperative day.

Conversely, Ismail et al.[7] achieved same-day discharge for all patients. While both studies indicate short hospital stays, Ismail's findings suggest an even greater potential for reduced hospital stays with the needlescopic technique.

These benefits not only enhance patient satisfaction but also reduce healthcare costs by decreasing the duration of hospital stays.

An overwhelming 90% of families in NSC Group rated the cosmetic result as "Excellent," compared to none in LC Group, where 85% rated it as "Very good" and 15% as "Good." strongly favoring the needlescopic approach.

These findings are consistent with recent literature. Bourgeois et al.[13] reported that cosmetic satisfaction was significantly higher among patients who underwent needle-scopic cholecystectomy, with most families rating the outcome as "Excellent."

Laparoscopic cholecystectomy. Shalaby et al.[8] similarly found high satisfaction levels, with excellent cosmetic results reported by parents in their questionnaire responses.

Ismail et al.[7] reported an even higher satisfaction rate of 97% "Excellent." This consistency in high satisfaction levels highlights the cosmetic benefits of needle-scopic surgery, significantly enhancing the overall patient and family experience.

The higher satisfaction with cosmetic outcomes in needle-scopic cholecystectomy can be attributed to the smaller incisions and reduced scarring, which are critical factors for patients and their families.

As marked by Bisgaard et al.,[14] it is noteworthy that using minilaparoscopic equipment proved feasible and that the costs associated with those instruments are comparable to the costs of the standard equipment for LC.

The findings demonstrate that NSC is a feasible and safe alternative to LC in pediatric populations. Although operative times were marginally longer, the benefits of reduced pain, quicker recovery, and enhanced cosmetic results outweigh this limitation. NSC represents a significant advancement in pediatric minimally invasive surgery, aligning with the goal of reducing surgical trauma while maintaining efficacy.

4. Conclusion

Needlescopic cholecystectomy offers distinct advantages over traditional multi-port laparoscopic cholecystectomy in children. It is associated with lower postoperative pain, faster recovery, and superior cosmetic outcomes, making it a promising technique in pediatric surgery. More studies in the future with larger sample sizes and extended follow-up periods are advised to validate these findings and further improve the procedure.

Disclosure

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Authorship

All authors have a substantial contribution to the article

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Conflicts of interest

There are no conflicts of interest.

References

1. Diez S, Müller H, Weiss C, Schellerer V, Besendörfer M. Cholelithiasis and cholecystitis in children and adolescents: Does this increasing diagnosis require a common guideline for pediatricians and pediatric surgeons? BMC Gastroenterol. 2021;21(1):186.
2. Todesco C, Molinaro F, Nascimben F, et al. Gallbladder Stones in Pediatric Age: An Emerging Problem: The Risk of Difficult Cholecystectomy and the Importance of a Preoperative Evaluation. Children. 2023;10(9):1544.
3. Destro F, Pierucci UM, Durante E, et al. Laparoscopic Cholecystectomy in Children: The Experience of Two Centers Focusing on Indications and Timing in the Era of “New Technologies.” Children. 2023;10(11):1771.
4. Sevik H, Karsidag T, Tatar C. A narrative review of technical developments for the laparoscopic cholecystectomy. Annals of Laparoscopic and Endoscopic Surgery. 2024;9(0).
5. Shinde PS, Gharde P, Shukla R, Sabnis J, Morey KH. Minimally Invasive Approaches for Cholecystectomy. Journal of Datta Meghe Institute of Medical Sciences University. 2023;18(4):821-826.
6. Brandão F, Chernov A. Evolving trends and future developments. In: BSAVA Manual of Canine and Feline Endoscopy and Endosurgery. BSAVA Library; 2020:297-315.
7. Ismail M, Elmorshedy HE, Maged M, et al. Needlescopic cholecystectomy using 14-gauge needles: a feasible and safe approach in children. J Ped Endosc Surg. 2022;4(4):161-165.

8. Shalaby R, Hamed A, Shams A, et al. Needlescopic cholecystectomy using 14-gauge assisting instruments: a technical modification for the pediatric age. J Ped Endosc Surg. 2022;4(2):75-81.
9. Zhao JJ, Syn NL, Chong C, et al. Comparative outcomes of needlescopic, single-incision laparoscopic, standard laparoscopic, mini-laparotomy, and open cholecystectomy: A systematic review and network meta-analysis of 96 randomized controlled trials with 11,083 patients. Surgery. 2021;170(4):994-1003.
10. Sajid MS, Khan MA, Ray K, Cheek E, Baig MK. Needlescopic versus laparoscopic cholecystectomy: a meta-analysis. ANZ Journal of Surgery. 2009;79(6):437-442.
11. Nam C, Lee JS, Kim JS, Lee TY, Yoon YC. Evolution of minimally invasive cholecystectomy: a narrative review. BMC Surg. 2024;24(1):378.
12. Zani A, Ade-Ajayi N. Laparoscopic Cholecystectomy. In: Color Atlas of Pediatric Anatomy, Laparoscopy, and Thoracoscopy. Springer, Berlin, Heidelberg; 2017:165-172.
13. Bourgeois C, Oyaert L, Van de Velde M, et al. Pain management after laparoscopic cholecystectomy: A systematic review and procedure-specific postoperative pain management (PROSPECT) recommendations. European Journal of Anaesthesiology| EJA. 2024;41(11):841-855.
14. Bisgaard T, Klarskov B, Trap R, Kehlet H, Rosenberg J. Microlaparoscopic vs conventional laparoscopiccholecystectomy. Surg Endosc. 2002; 16(3): 458-464.