RESEARCH PAPER

A Comparative Study Between Laparoscopic and Open Appendectomy in Children with Acute Appendicitis

Mahalakshmi Nagarajan[1], Prathiba Nanjundaiah[2], Saravana Balaji M[3*]

[1]Post Graduate, Department of General Surgery, E-mail- maha.kannagi@gmail.com, Orchid ID: 0009-0006-4725-0674
[2]Assistant Professor, Department of Pediatric Surgery,
E-mail- prathiba_n@hotmail.com, ORCID ID: 0009-0009-6743-1503
[3*]Assistant Professor, Department of Pediatric Surgery,
E-mail- drsaravanabalaji@gmail.com, ORCID ID: 0009-0007-0120-0783
[1,2,3]SRM Medical College Hospital & Research Centre, Faculty of Medicine & Health Sciences, SRM Institute of Science and Technology, Kattankulathur, Chengalpattu, Tamil Nadu 603 203, India

Corresponding author*

Saravana Balaji M
Assistant Professor, Department of Pediatric Surgery, SRM Medical College Hospital & Research Centre, Faculty of Medicine & Health Sciences, SRM Institute of Science and Technology, Kattankulathur, Chengalpattu, Tamil Nadu 603 203, India,
E-mail- drsaravanabalaji@gmail.com, ORCID ID: 0009-0007-0120-0783

ABSTRACT

Background- In children, acute appendicitis is the leading cause of emergency surgery performed on the abdomen. Prompt surgical treatment is the best way to prevent serious complications (perforation, peritonitis, and sepsis). The "traditional" surgical approach for removing the appendix was through an "open" incision. However, there has been an increase in the use of the laparoscopic technique (using very small incisions) in pediatric surgical practice. By using the laparoscopic technique, many potential advantages exist such as: decreased pain after surgery; shorter time in the hospital; quicker recovery after surgery; reduced number of complications related to the surgical wound; and improved cosmetic appearance of the surgical site. However, concerns about the time it takes to perform the operation, formation of abscesses in the abdomen, and whether or not it is cost-effective remain. Therefore, a systematic comparison of these two techniques in children is necessary for surgical decision-making based on the outcome of surgery performed using both methods.

Objectives- The purpose of this study was to compare laparoscopic appendicectomy to open appendicectomy regarding operative time, postoperative pain intensity, length of hospital stay, the length of time until resuming oral intake, postoperative complications (i.e., wound infections, intra-abdominal abscesses), and return to normal daily activities for children diagnosed with acute appendicitis.

Methods- In a tertiary care hospital, a prospective comparative study was conducted as part of a research project over a period of 18 months. The sample consisted of 120 pediatric patients with a diagnosis of acute appendicitis between the ages of 5 to 15 years. All patients were divided into two equal (60 each) treatment groups: Group L (laparoscopic group) and Group O (open group). All patients received standardized perioperative treatments as part of the study protocols. Data gathered during intraoperative procedures included the total time for the completed operation. The patients' pain level was determined by an age-appropriate visual analogue scale; other data recorded after completion of surgery included, (1) Time until patients ate something by mouth for the first time postoperatively, (2) Time until patients could move, (3) Length of time that patients were admitted to the hospital past the day of surgery and, (4) Postoperative complication occurrence. Patients were followed up for wound healing and return to normal activities.

Results- When comparing laparoscopic and open appendectomies, laparoscopic appendectomy showed evidence of reduced pain levels after surgery, earlier resumption of food intake, shorter hospital stays, and faster return to normal activities compared with open appendectomy. The operative time in laparoscopic cases was slightly increased; however, there was no increase in associated morbidity from an increase in operative time. The laparoscopic group had lower rates of wound infection compared with the open appendectomy group and the incidence of intra-abdominal abscesses was similar in both groups. Patients who underwent laparoscopic appendectomy had a quicker overall recovery and better cosmetic results following laparoscopic surgery compared with patients undergoing open appendectomy.

Conclusion- The laparoscopic approach to appendectomy represents a viable and safe option for the treatment of acute appendicitis in children versus the traditional open technique. The laparoscopic technique may require a slightly longer operating time, however it provides the child with several distinct advantages after surgical intervention including decreased pain postoperatively; shorter hospital stays; earlier return to life activities; and reduced rates of wound complications. Thus, the laparoscopic approach should be the preferred method of surgical treatment of acute appendicitis in children provided that expertise is present and the necessary facilities are available to perform such a procedure.

Keywords- Acute appendicitis; Pediatric appendectomy; Laparoscopic surgery; Open appendectomy; Postoperative recovery; Surgical outcomes; Pediatric emergency surgery

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INTRODUCTION

Acute appendicitis is a common cause of emergency surgery in children. Children and adolescents represent a large portion of hospital admissions related to acute abdominal pain due to appendicitis [1]. Appendicitis has an expected lifetime risk of approximately 10% and early diagnosis and timely surgical treatment are critical to prevent further complications, such as perforations, widespread peritonitis, abscess development, and sepsis. In children, diagnosing appendicitis is sometimes difficult because of atypical presentations, inability to clearly communicate symptoms and signs of abdominal pain, and overlapping presentations with other causes of abdominal pain [2].

Appendectomy is the only definitive treatment for appendicitis. Open appendectomy has been used for many years and is still the procedure of choice for most surgeons. The open appendectomy is well established and widely performed, is a straightforward, technically uncomplicated operation, and has reliable and predictable outcomes. However, the operation requires an incision in the right lower quadrant, which may lead to prolonged postoperative pain, higher incidence of wound infections, prolonged recovery periods, and cosmetic consequences from scarring [3].

With the advent of minimally invasive surgical techniques, laparoscopic appendectomies emerged as a new and viable alternative method of performing appendectomy. Laparoscopic appendectomies have rapidly gained acceptance by pediatric surgeons since first introduced [4]. Laparoscopic procedures offer some potential advantages to the surgeon and to the patient, including smaller incisions, improved visualisation of the abdominal cavity, less postoperative pain, shorter duration of postoperative hospitalisation, faster return to normal activities, and improved cosmetic appearance. Laparoscopic techniques allow for complete visualisation of the abdominal cavity and may be particularly useful in patients with uncertain diagnoses [5].

There are concerns regarding laparoscopic appendectomy in children, such as the longer operating times associated with the learning curve, the increased costs of laparoscopic equipment, and the controversial association between laparoscopic appendectomies for complicated appendicitis and the increased risk of postoperative intra-abdominal abscesses. Lastly, the availability of laparoscopic surgery facilities and trained personnel may determine the choice of surgical technique in many low-resource countries [6].

Several studies have compared the laparoscopic and open appendectomy techniques in children, addressing parameters including the times of the operative procedure, postoperative pain, time to discharge, length of hospitalisation, complication rates, and overall recovery. These studies have produced inconsistent results due to differences in experience, patient selection, and design of the studies conducted at various institutions. As a result, continuing to study the laparoscopic appendectomy technique for children through structured comparative studies will allow healthcare providers to develop evidence-based recommendations for treating children with acute appendicitis [7,8].

The purpose of this prospective comparative study was to evaluate and compare laparoscopic appendectomy and open appendectomy techniques in children with acute appendicitis over an 18-month period. The study will evaluate intraoperative parameters associated with each type of appendectomy procedure, postoperative recovery time, and overall complication rates associated with each surgical approach to determine their relative advantages and safety for children.

Materials and Methods

Study design and setting

This is a prospectively conducted comparative study over an 18-month period conducted by the Department of Pediatric Surgery within a Tertiary Care Teaching Hospital. The goal of the study was to compare the results from the laparoscopic method of removing the appendix (laparoscopic appendicetomy) with the traditional method of removing the appendix (open appendicetomy) that used on children that have been diagnosed with acute appendicitis.

Sample size and study population

During the study, 120 pediatric patients diagnosed with acute appendicitis were enrolled as the subjects of the research. For the purposes of this research project, a sample size was selected based on the projected number of cases that would be treated over the 18 months of data collection, and also to give sufficient statistical power for identifying clinically important differences between the postoperative outcomes of the two procedures being compared.

Patients were allocated into two groups of 60 each:

- Group L (n = 60): Laparoscopic appendectomy
- Group O (n = 60): Open appendectomy

Inclusion criteria

- Children aged 5–15 years
- Clinical and radiological diagnosis of acute appendicitis
- Patients undergoing emergency appendectomy
- Informed consent obtained from parents or guardians

Exclusion criteria

- Appendicular mass managed conservatively
- Generalized peritonitis requiring extensive laparotomy
- Previous abdominal surgery
- Known bleeding disorders
- Significant systemic illness contraindicating laparoscopy
- Refusal of consent

Preoperative assessment

Using a thorough history and physical examination, every patient was clinically assessed and had additional laboratory tests performed. Relevant laboratory tests included complete blood counts and imaging tests of the abdominal area performed via ultrasound. An individual was diagnosed with acute appendicitis based on the clinical signs that were confirmed by imaging studies.

Surgical technique

In this section, patients with appendicitis undergoing laparoscopic appendectomy will be referred to as L and those undergoing open appendectomy will be referred to as O.

Laparoscopic Appendectomy Group L: All operations were performed under general anesthesia. Three standard ports were placed to establish pneumoperitoneum. Appendix was located, the mesoappendix divided, and base of appendix secured using either endoloops or clips. The appendectomy specimen was removed through the port site using a technique to protect the incision. Peritoneal Lavage was performed when necessary, based on surgeon preference.

Open Appendectomy Group O: All surgeries were conducted under general anesthesia using a right lower quadrant incision (or "gridiron incision"). Appendix was located, mesoappendix was ligated, and appendectomy was performed in the standard fashion. Surgeon performed peritoneal Lavage if necessary, based on the surgeon's evaluation of contamination.

Outcome measures

Primary outcomes:

- Operative time (minutes)
- Postoperative pain score assessed using age-appropriate visual analog scale (VAS)
- Duration of hospital stay (days)

Secondary outcomes:

- Time to first oral intake (hours)
- Time to ambulation (hours)
- Wound infection rate
- Intra-abdominal abscess formation
- Postoperative ileus
- Time to return to normal daily activities (days)

Postoperative care and follow-up

Patients received standardized postoperative analgesic protocols and antibiotic protocols. Pain scores were recorded pre-specified intervals for the first 24 hours after surgery, and patients were discharged once clinically stable, able to tolerate oral intake, and afebrile. Follow-up assessments were made to evaluate wound healing and any late complications.

Statistical analysis

The continuous variables were stated in mean ± SD greater than 0.05 were statistically insignificant. The categorical variables were presented by number and percentage. For comparisons between groups, the appropriate statistics were used to compare the respective statistics between groups. A p-value <0.05 was regarded as statistically significant.

Results

Over the 18-month duration of this study, 120 pediatric patients who underwent an appendectomy for acute appendicitis were enrolled in the study. Patients were divided equally into two treatment groups: laparoscopic appendectomies (L) and open appendectomies (O). Both groups were similar in terms of patient demographics and preoperative clinical characteristics (age, gender, and clinical presentation). We found that while the span of time spent performing an appendectomy through the laparoscopic approach was greater than that required by an open approach, the pain experienced by the patients after the laparoscopic approach was significantly less over the first 24-hours post-operative period. Patients in the laparoscopic group were able to take an oral diet and begin ambulating earlier than the open group. Length of stay in the hospital was also shorter for those patients who had undergone laparoscopic surgery versus the open surgery group. Patients required treatment for wound infections in the open appendectomy group at a higher rate than those in the laparoscopic group, however the overall incidence of intra-abdominal abscesses was similar between the two groups. In addition, children who underwent laparoscopic appendectomies returned to normal daily activities earlier than children who had an open appendectomy. In summary, the laparoscopic technique produced superior recovery outcomes for the patients undergoing laparoscopic appendectomy and no increased incidence of complications compared to the open technique.

Table 1: Age distribution of patients

Table 1 shows comparable age distribution between both groups.

Age group (years)	Group L (n = 60)	Group O (n = 60)
5–8	18 (30%)	20 (33.3%)
9–12	24 (40%)	22 (36.7%)
13–15	18 (30%)	18 (30%)

Table 2: Gender distribution

Table 2 shows similar male predominance in both groups.

Gender	Group L (n = 60)	Group O (n = 60)
Male	36 (60%)	38 (63.3%)
Female	24 (40%)	22 (36.7%)

Table 3: Type of appendicitis (Intraoperative findings)

Table 3 shows comparable distribution of uncomplicated and complicated appendicitis.

Type	Group L (n = 60)	Group O (n = 60)
Uncomplicated	42 (70%)	40 (66.7%)
Complicated (perforated/gangrenous)	18 (30%)	20 (33.3%)

Table 4: Operative time (minutes)

Table 4 shows operative duration in both groups.

Parameter	Group L (mean ± SD)	Group O (mean ± SD)
Operative time	62 ± 12	48 ± 10

Table 5: Postoperative pain score (VAS) at 24 hours

Table 5 shows significantly lower pain scores in Group L.

Parameter	Group L (mean ± SD)	Group O (mean ± SD)
VAS score	3.2 ± 1.1	5.6 ± 1.4

Table 6: Time to first oral intake (hours)
Table 6 shows earlier resumption of oral intake in Group L.

Parameter	Group L (mean ± SD)	Group O (mean ± SD)
Time to oral intake	14 ± 4	22 ± 6

Table 7: Time to ambulation (hours)
Table 7 shows earlier ambulation in laparoscopic group.

Parameter	Group L (mean ± SD)	Group O (mean ± SD)
Time to ambulation	16 ± 5	28 ± 7

Table 8: Duration of hospital stay (days)
Table 8 shows shorter hospitalization in Group L.

Parameter	Group L (mean ± SD)	Group O (mean ± SD)
Hospital stay	3.1 ± 0.8	5.2 ± 1.1

Table 9: Postoperative complications
Table 9 shows complication profile in both groups.

Complication	Group L (n = 60)	Group O (n = 60)
Wound infection	3 (5%)	9 (15%)
Intra-abdominal abscess	2 (3.3%)	3 (5%)
Postoperative ileus	2 (3.3%)	5 (8.3%)

Table 10: Time to return to normal activities (days)
Table 10 shows faster return to daily routine in Group L.

Parameter	Group L (mean ± SD)	Group O (mean ± SD)
Return to normal activities	7.4 ± 1.6	12.8 ± 2.3

Table 1 shows that children aged 9–12 years constituted the largest proportion in both Group L (40%) and Group O (36.7%), with comparable distribution across all age categories, confirming demographic homogeneity. **Table 2** demonstrates male predominance in both groups (60% in Group L and 63.3% in Group O), indicating balanced gender representation. **Table 3** shows that uncomplicated appendicitis accounted for 70% in Group L and 66.7% in Group O, while complicated cases constituted 30% and 33.3% respectively, confirming similar disease severity distribution. **Table 4** indicates that the mean operative time was longer in Group L (62 ± 12 minutes) compared to Group O (48 ± 10 minutes), reflecting the technical demands of laparoscopy. **Table 5** shows significantly lower postoperative pain scores in Group L (3.2 ± 1.1) compared to Group O (5.6 ± 1.4), demonstrating better postoperative comfort in laparoscopic surgery. **Table 6** demonstrates earlier resumption of oral intake in Group L (14 ± 4 hours) compared to Group O (22 ± 6 hours), indicating faster gastrointestinal recovery. **Table 7** shows earlier ambulation in Group L (16 ± 5 hours) versus Group O (28 ± 7 hours), reflecting improved postoperative mobility. **Table 8** indicates a shorter hospital stay in Group L (3.1 ± 0.8 days) compared to Group O (5.2 ± 1.1 days), highlighting faster overall recovery. **Table 9** shows wound infection occurred in 5% of Group L compared to 15% in Group O, while intra-abdominal abscess rates were low and comparable (3.3% vs 5%), indicating similar safety profiles. **Table 10** demonstrates that children undergoing laparoscopic appendectomy returned to normal activities earlier (7.4 ± 1.6 days) compared to those undergoing open surgery (12.8 ± 2.3 days), reinforcing the functional advantage of laparoscopy.

Discussion

Laparoscopic vs Open Appendicectomy in Children. An 18-month, prospective, controlled study was conducted on 120 kids with acute appendicitis to compare laproscopic appendectomy to open appendectomy and results from this study show laproscopic appendectomy will lead to significantly less pain, shorter stay in hospital, quicker return to normal activities and a similar safety profile to open appendicectomy [9]. Age, gender ratio and severity of appendicitis were compared between both groups. One can conclude outcomes were primarily due to surgical technique rather than demographic and disease differences. Most patients in both groups had simple appendicitis and therefore, were able to compare postoperative outcomes [10]. The operative time for the laproscopic group was longer than the open group. This is consistent with the fact that laparoscopic procedures are technically more difficult than open techniques, especially in the case of pediatric patients where anatomical space is limited [11]. The longer operative time did not lead to an increased incidence of post-op morbidity or prolonged hospitalisation. Additionally, longer operative times for laproscopic procedures may be representative of the learning curve associated with this form of minimally invasive surgery [12]. Children undergoing laproscopic appendicectomy have significantly lower pain scores post-operatively than their counterparts treated with open appendicectomy. Less pain results from smaller incisions, less tissue handling, and decreased parietal trauma due to the laparoscopic method of surgery [13]. Lower pain levels aid in earlier mobility, which decreases the need for analgesics, and is a significant factor contributing to improved recovery.In children, the laparoscopic approach allowed for earlier oral intake and ambulation when compared to open surgery [14]. It has been suggested that the enhanced recovery of gastrointestinal function is a result of less bowel manipulation and inflammatory response with laparoscopic surgical methods. Early ambulation is also of significant importance for paediatric patients, as it alleviates discomfort, enhances respiratory status, and lowers the risk of developing post-operative complications like ileus [15].

Additionally, the laparoscopic group had a significantly shorter duration of hospital stay, which has clinical significance, since it reflects a quicker recovery, less burden on the healthcare system, and increased satisfaction among patients and their families. The shorter hospital stays also decrease the risk of nosocomial infections (hospital-acquired infections) and provide overall cost savings (including

indirect costs) [16].

In the open appendectomy sample group, more patients experienced surgical site infections. The greater amount of tissue exposure and larger incisions associated with open surgery likely contributed to the increased rate of surgical site infections [17]. However, with the laparoscopic approach, the smaller port-site incisions and the use of specimen retrieval techniques, wound contamination is decreased, and thus, there is less incidence of surgical site infections. There was no significant difference in the development of intra-abdominal abscesses between the two surgical techniques, indicating that laparoscopic appendectomy does not increase the incidence of deep intra-abdominal infections in children [18].

Children in the laparoscopic group returned to normal activities significantly quicker than the children in the open appendectomy group. This outcome is especially important for school-aged children, as it decreases the disruption of their education and overall lives. Furthermore, improved cosmetic outcomes associated with smaller scars may improve a child's psychological status and enhance parental satisfaction [19, 20].

The findings from this study are consistent with the growing movement in paediatric surgical practice towards laparoscopic appendectomy. The benefits of laparoscopy with regard to recovery parameters outweigh the relatively minor increase in operative time, especially when performed by skilled surgeons with appropriate facilities. When laparoscopic appendectomy is done by skilled surgeons with appropriate resources, it appears to provide a better short-term outcome without compromising safety.

While there are important clinical implications for laparoscopic appendectomy, there are some limitations of this study to note. This was a single-center study, so the findings may not be generalizable. Additionally, an analysis of costs was not formally performed, which may be of interest in resource-constrained settings. Long-term outcomes, such as adhesive bowel obstruction, were not studied, which may limit the data's ability to provide adequate follow-up evidence regarding postoperative outcomes for children. Multicenter studies with larger sample sizes and longer-term follow-up are necessary to provide further evidence of the long-term efficacy of laparoscopic appendectomy as a safe and effective alternative to open appendectomy for children with acute appendicitis.

Conclusion

Laparoscopic appendectomies are more beneficial than open appendectomies in terms of postoperative recovery time. Although the laparoscopic group had slightly longer operative times, there was significantly less pain, earlier time to resume eating/drinking, quicker ambulation and shorter hospital stays for the laparoscopic patients versus the open appendectomy patients. The laparoscopic group also had fewer cases of wound infection; the incidence of intraabdominal abscesses and other complications was similar in both groups. Therefore, it can be said that laparoscopic appendectomies are a safer, effective option compared to the open technique for pediatric patients and may be considered the first option in facilities that have laparoscopic surgical expertise available.

Ethical Approval

The study was conducted after obtaining approval from the Institutional Ethics Committee. All procedures were carried out in accordance with accepted ethical standards for research involving human participants.

Informed Consent

Written informed consent was obtained from the parents or legal guardians of all participating children prior to inclusion in the study.

Data Availability

The data generated and analyzed during the study are available from the corresponding author upon reasonable request.

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No external funding was received for this study.

Conflict of Interest

The authors declare that there is no conflict of interest related to this study.

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References

1. Liu Y, Cui Z, Zhang R. Laparoscopic Versus Open Appendectomy for Acute Appendicitis in Children. Indian Pediatr. 2017 Nov 15;54(11):938-941. doi: 10.1007/s13312-017-1186-z. Epub 2017 Aug 24. PMID: 28849763.
2. Štichhauer R, Koudelka J. Otevřená versus laparoskopická operace akutní apendicitidy u dětí [Open versus laparoscopic appendectomy for acute appendicitis in children]. Rozhl Chir. 2018 Spring;97(3):117-121. Czech. PMID: 29589454.
3. Fujishiro J, Watanabe E, Hirahara N, Terui K, Tomita H, Ishimaru T, Miyata H. Laparoscopic Versus Open Appendectomy for Acute Appendicitis in Children: a Nationwide Retrospective Study on Postoperative Outcomes. J Gastrointest Surg. 2021 Apr;25(4):1036-1044. doi: 10.1007/s11605-020-04544-3. Epub 2020 Mar 3. PMID: 32128682.
4. Jaschinski T, Mosch CG, Eikermann M, Neugebauer EA, Sauerland S. Laparoscopic versus open surgery for suspected appendicitis. Cochrane Database Syst Rev. 2018 Nov 28;11(11):CD001546. doi: 10.1002/14651858.CD001546.pub4. PMID: 30484855; PMCID: PMC6517145.
5. Duan C, Li Y, Ma J, Song Y, Zhou L. The Impact of Laparoscopic Appendectomy and Open Appendectomy on B7-H3-Mediated Intrinsic Immune Response in Children with Acute Suppurative Appendicitis. J Inflamm Res. 2024 Mar 11;17:1577-1587. doi: 10.2147/JIR.S446199. PMID: 38495342; PMCID: PMC10941988.
6. Neogi S, Banerjee A, Panda SS, Ratan SK, Narang

R. Laparoscopic versus open appendicectomy for complicated appendicitis in children: A systematic review and meta-analysis. J Pediatr Surg. 2022 Mar;57(3):394-405. doi: 10.1016/j.jpedsurg.2021.07.005. Epub 2021 Jul 13. PMID: 34332757.

7. Botchway E, Marcisz L, Schoeman H, Kofi Botchway PP, Mabitsela EM, Tshifularo N. Laparoscopic versus open appendectomy: A retrospective cohort study on the management of acute appendicitis (simple and complicated) in children under 13 years of age. Afr J Paediatr Surg. 2021 Oct-Dec;18(4):182-186. doi: 10.4103/ajps.AJPS_102_20. PMID: 34341299; PMCID: PMC8423168.
8. Ayengin K, Alp HH, Avci V, Huyut Z. The effect of laparoscopic and open surgery on oxidative DNA damage and IL-37 in children with acute appendicitis. Ir J Med Sci. 2021 Feb;190(1):281-289. doi: 10.1007/s11845-020-02317-0. Epub 2020 Jul 17. PMID: 32681270.
9. Zhang S, Du T, Jiang X, Song C. Laparoscopic Appendectomy in Children With Perforated Appendicitis: A Meta-Analysis. Surg Laparosc Endosc Percutan Tech. 2017 Aug;27(4):262-266. doi: 10.1097/SLE.0000000000000411. PMID: 28472016.
10. Low ZX, Bonney GK, So JBY, Loh DL, Ng JJ. Laparoscopic versus open appendectomy in pediatric patients with complicated appendicitis: a meta-analysis. Surg Endosc. 2019 Dec;33(12):4066-4077. doi: 10.1007/s00464-019-06709-x. Epub 2019 Feb 25. PMID: 30805783.
11. Fourie N, De Vos C, Sidler D. Outcomes for open and laparoscopic appendicectomy for complicated appendicitis in children. S Afr J Surg. 2022 Mar;60(1):10-15. PMID: 35451263.
12. Fadgyas B, Garai GI, Őri D, Monostori G, Vajda P. Appendectomia gyermekkorban: laparoszkópia vagy nyitott műtét? [Appendectomy in children: laparoscopic or open approach?]. Orv Hetil. 2024 May 12;165(19):742-746. Hungarian. doi: 10.1556/650.2024.33056. PMID: 38735030.
13. Fujii T, Tanaka A, Katami H, Shimono R. Intra-/Extracorporeal Single-Incision Versus Conventional Laparoscopic Appendectomy in Children: A Systematic Review and Meta-Analysis. J Laparoendosc Adv Surg Tech A. 2022 Jun;32(6):702-712. doi: 10.1089/lap.2021.0738. Epub 2022 Feb 11. PMID: 35443815.
14. Childers CP, Dworsky JQ, Massoumi RL, Shenoy R, Maggard-Gibbons M, Lee SL, Russell MM. The contemporary appendectomy for acute uncomplicated appendicitis in children. Surgery. 2019 May;165(5):1027-1034. doi: 10.1016/j.surg.2018.12.019. Epub 2019 Mar 21. PMID: 30905469.
15. Klein T, Diesbach D, Boemers TM, Vahdad RM. Transumbilical laparoscopic-assisted appendectomy in children and adolescents: what have we learnt in more than 1200 cases? Langenbecks Arch Surg. 2024 Aug 29;409(1):263. doi: 10.1007/s00423-024-03437-2. PMID: 39207589.
16. Aziz O, Athanasiou T, Tekkis PP, Purkayastha S, Haddow J, Malinovski V, Paraskeva P, Darzi A. Laparoscopic versus open appendectomy in children: a meta-analysis. Ann Surg. 2006 Jan;243(1):17-27. doi: 10.1097/01.sla.0000193602.74417.14. PMID: 16371732; PMCID: PMC1449958.
17. Markar SR, Blackburn S, Cobb R, Karthikesalingam A, Evans J, Kinross J, Faiz O. Laparoscopic versus open appendectomy for complicated and uncomplicated appendicitis in children. J Gastrointest Surg. 2012 Oct;16(10):1993-2004. doi: 10.1007/s11605-012-1962-y. Epub 2012 Jul 19. PMID: 22810297.
18. Pogorelic Z, Buljubasic M, Susnjar T, Jukic M, Pericic TP, Juric I. Comparison of Open and Laparoscopic Appendectomy in Children: A 5-year Single Center Experience. Indian Pediatr. 2019 Apr 15;56(4):299-303. PMID: 31064898.
19. Han J, Kim H, Han SH, Kang BM. Hybrid Appendectomy in Pediatric Appendicitis: A Comparative Analysis of Single-Port and Multiport Laparoscopic Appendectomy. J Laparoendosc Adv Surg Tech A. 2022 Mar;32(3):330-335. doi: 10.1089/lap.2021.0625. Epub 2021 Nov 9. PMID: 34748411.
20. Ali R, Anwar M, Akhtar J. Laparoscopic versus open appendectomy in children: a randomized controlled trial from a developing country. J Pediatr Surg. 2018 Feb;53(2):247-249. doi: 10.1016/j.jpedsurg.2017.11.022. Epub 2017 Nov 14. PMID: 29223666.