

Complicated Appendicitis-An Update : A Narrative Review

Abstract

Complicated Appendicitis defined as perforated appendicitis with abscess or mass formation. Its diagnosis and management have been controversial with no consensus on its definition and treatment algorithm. The treatment was initially conservative management, but the current trend is immediate appendectomy by the laparoscopic method. Other areas of controversy include the need for interval appendectomy and the role of percutaneous drainage of appendicular abscess. We have conducted this review article to investigate the definition, diagnosis, and treatment of complicated appendicitis.

Keywords-Complicated Appendicitis, Appendicular Mass, Appendicular Abscess, Appendectomy and Laparoscopic Appendectomy

Introduction

Acute appendicitis is a common abdominal emergency with a life-time risk of 8% and it is divided into uncomplicated and complicated appendicitis. Uncomplicated appendicitis usually means inflammation of the appendix and complicated appendicitis being associated with inflammation of the appendix with phlegmon, perforation with or without abscess formation. (1)

The European Association of Emergency Surgeons defined complicated appendicitis as a gangrenous inflamed appendix with or without perforation, intra-abdominal abscess, peri-appendicular contained phlegmon or purulent free fluid. (2)

The treatment of complicated can be divided into conservative treatment with intravenous antibiotics followed by an interval appendectomy in eight weeks' time, conservative treatment alone without interval appendectomy and immediate appendectomy. The trend in treatment of complicated appendicitis has been moving towards immediate appendectomy since the introduction of laparoscopic appendectomy. (3–6)

Patients with complicated appendicitis who present with an appendicular abscess can be management with intravenous antibiotics and percutaneous drainage of the abscess being performed for abscess that is more than 5cm in size. (7)

As there is no current consensus in the management of complicated appendicitis, we have conducted this review article looking into the definition, diagnosis, and management of

complicated appendicitis. We conducted a literature review using PUBMED, the Cochrane database of systemic reviews, Google scholar and semantic scholar looking for randomized control trials, non-randomized trials, observational and cohort studies, clinical reviews, systemic reviews, and meta-analysis from 1995 to 2023. The following keywords were used, “complicated appendicitis”, “appendicular mass”, “appendicular abscess”, “appendectomy” and “laparoscopic appendectomy”. All articles were in English, and all articles were assessed by manual cross referencing of the literature. Commentaries, case reports and editorials were excluded from this review. Adult and pediatric patients were included in this study and pregnant patients with acute appendicitis were excluded.

Discussion

Definition of complicated appendicitis

Complicated appendicitis is defined as perforation of the appendix, with abscess formation or mass formation. The mass is an inflammatory one consisting of the appendix, caecum, terminal ileum, and omentum.(8)

The Italian polispecialistic society of young surgeons defined complicated appendicitis as presence of any of the following intraoperative findings, visible perforation, abscess, diffuse fibrin purulent exudate or extraluminal fecalith.(9)

Mariage et al defined complicated appendicitis as perforated appendicitis, peri appendicular abscess or peritonitis, defined as acute inflammation of the peritoneum secondary to infection of the appendix. Moris et al defined complicated appendicitis as appendiceal rupture with subsequent abscess or phlegmon formation.(10–12)

Based on the studies there is still no consensus on the definition of complicated appendicitis, with perforation of the appendix, with mass formation, with or without abscess formation being the most common definition.

Diagnosis of complicated appendicitis

Laboratory investigations like total white cell count, C-reactive protein, serum bilirubin and neutrophil lymphocyte ratio can be used to aid in the diagnosis of complicated appendicitis, but it must be used with clinical examination due to its low sensitivity.(13)

Elevated white cell count, and C-reactive protein are important predictors for complicated appendicitis, but both these markers have low sensitivity and specificity. These serum markers can be used to differentiate uncomplicated from complicated appendicitis. (14,15)

The use of imaging modalities like ultrasound and computerized tomography have shown varied results, Bolmers et al in his prospective observational study showed that the use of ultrasound in diagnosing complicated appendicitis showed a sensitivity of 35% and a specificity of 93%, while computerized tomography showed a sensitivity of 45% and a specificity of 88%. This study showed that imaging modalities were poor in diagnosing complicated appendicitis. (16)

Gaskill et al retrospectively evaluated the use of computerized tomography in diagnosing complicated appendicitis and the sensitivity was 7% with a specificity of 89%. This study showed that the diagnostic accuracy of computerized tomography from differentiating complicated from uncomplicated appendicitis was poor. (17)

Computerized tomography was useful in detecting fat stranding and free fluid in the abdomen and these features are seen in complicated appendicitis. This highlights the importance of computerized tomography in diagnosing complicated appendicitis. (18)

Bom et al conducted a systemic review and meta-analysis to discriminate complicated appendicitis by ultrasound, computerized tomography, and magnetic resonance imaging. The results of this study showed that for computerized tomography the sensitivity was 78%, specificity 91%, positive predictive value 74% and negative predictive value 93%. There was lack of data for ultrasound and magnetic resonance imaging, and this meta-analysis showed that these imaging modalities had limitations in diagnosing complicated appendicitis (19)

The conclusion of these studies shows that the diagnosis of complicated appendicitis includes both clinical examination and imaging.

Conservative treatment of complicated appendicitis

The conservative treatment of complicated appendicitis includes starting the patient on intravenous antibiotics and analgesics, while monitoring the vital signs. This was traditionally followed by an interval appendectomy in 8 weeks' time. This was associated with reduced complications and reoperation rates. (20–25)

A meta-analysis by Simillis et al, concluded that conservative treatment of complicated appendicitis was associated with reduced wound infection rates, decreased intra-abdominal abscess, pelvic abscess, and bowel obstruction. This study concluded that conservative treatment was a safe option in the management of complicated appendicitis. (26)

A meta-analysis by Fugazola et al comparing conservative treatment and immediate surgery on complicated appendicitis in children concluded that conservative treatment was associated with better complication rates and readmission rates. This meta-analysis concluded that conservative

treatment was a viable and safe treatment option in the treatment of complicated appendicitis.(27)

Anderson et al also performed a meta-analysis on the management of complicated appendicitis and concluded that conservative management was associated with lower complication, but routine interval appendectomy need not be performed due to the low risk of recurrence.(28)

A meta-analysis by van Amstel et al on the management of complicated appendicitis in children showed that conservative treatment with intravenous antibiotics should be the first line of management with appendectomy reserved for patients who do not respond to conservative treatment.(29)

The conclusion from these studies show that conservative treatment is a viable treatment option for patients with complicated appendicitiswithappendectomy being reserved for recurrent attacks. It was associated with reduced complications and mortality.

study	Study type	N=numbers	Recurrence rate
Anderson et al (2007)	Meta-analysis	59,448	7.4%
Fugazola et al (2019)	Meta-analysis	1288	15.4%
Van Amstel et al(2020)	Meta-analysis	1355	34%

Table 1 the meta-analysis on recurrence rates after conservative treatment of complicated appendicitis

The role of interval appendectomy

Traditionally interval appendectomy was performed after conservative treatment, but its role was questioned due to the low recurrence rates. A systemic review of the literature by Darwazeh et al concluded that interval appendectomy can be omitted as it provides minimal benefit and is associated with increased cost and morbidity.(30)

Retrospective studies by Willemsen et al and Tekin et alalso concluded that interval appendectomy need not be routinely performed after completion of conservative treatment as patients who were at risk of malignancy can be followed up with computerized tomography or colonoscopy.(31,32)

A Reviewby Perez et al on the need of interval appendectomy after conservative treatment for complicated appendicitis concluded that interval appendectomy should be considered for patients who present with recurrent symptoms and those who have fecalith on imaging.

This was also supported by a review by Corfield who concluded that due to the low recurrence rate interval appendectomy need not be routinely performed.(33,34)

The conclusion from these studies show that routine interval appendectomy need not be routinely performed, and it is reserved for patients with recurrent attacks.

Percutaneous drainage of appendicular abscess

The use of conservative treatment followed by percutaneous drainage of appendicular abscess in patients with complicated appendicitis was studied by Lasson et al. 24 patients underwent percutaneous drainage of abscess and there was recurrence in 4 patients, and they concluded that percutaneous drainage of abscess was effective in large abscess and can be combined with intravenous antibiotics in the treatment of complicated appendicitis.(35)

Percutaneous drainage of appendicular abscess was found to be effective in the management of complicated appendicitis in pediatric patients. A study by Cheng Luo et al showed that percutaneous drainage in children with complicated appendicitis with appendicular abscess was associated with reduced incidence of recurrence and the need for interval appendectomy.(36)

A retrospective study by Roach et al on the use of intravenous antibiotics and percutaneous drainage of abscess in children who presented with complicated appendicitis was associated with reduced complications and readmissions due to recurrence.(37)

A prospective study by Zerem et al comparing percutaneous drainage with antibiotics with antibiotics alone in the treatment of complicated appendicitis showed a lower recurrence rate and reduced need for interval appendectomy. This study highlighted the effectiveness of percutaneous drainage of an appendicular abscess.(38)

Factors that affect percutaneous drainage include the onset, durations of symptoms and if the drainage is performed by ultrasound or computerized tomography.(39)

The conclusion from these studies show that percutaneous drainage is a viable treatment option, but the size of the abscess influences the outcome.

Immediate appendectomy in the management of complicated appendicitis

There has been a shift in the management of complicated appendicitis with immediate appendectomy being advocated as the primary treatment of choice to treat this condition and

prevent complications like recurrence.(40) A study by Deelder et al noted the high complication rates with conservative treatment and immediate appendectomy was able to provide a definitive diagnosis.(41)

Traditionally open appendectomy has been the treatment of choice, but the introduction of laparoscopic appendectomy has seen a trend towards this form of management. Laparoscopic appendectomy was associated with a shorter operative time, lower incidence of wound infection, reduced analgesia usage and reduced hospital stay.(42–45)

Laparoscopic appendectomy was compared with open appendectomy, and it was safe with reduced wound infection rates and intra-abdominal abscess formation that was comparable to conventional appendectomy and not influenced by the laparoscopic technique. Laparoscopic appendectomy has been shown to reduce the morbidity, mortality, length of hospital stays and cost.(46,47)

A systemic review and meta-analysis comparing laparoscopic versus open appendectomy in adults with complicated appendicitis concluded that laparoscopic appendectomy was associated with reduced risk of surgical site infection and with no additional risk of intra-abdominal abscess formation. These findings were also confirmed by Athanasiou et al in their systemic review and meta-analysis of laparoscopic versus open appendectomy in adults with complicated appendicitis.(48,49)

Randomized clinical trials were conducted to compare laparoscopic versus open appendectomy for complicated appendicitis and the results showed that laparoscopic appendectomy was associated with reduced wound infection rates, shorter hospital stays and reduced analgesia usage.(50,51)

The risk of intra-abdominal abscess formation following laparoscopic appendectomy for complicated appendicitis is the same as for open appendectomy. This was observed in the meta-analysis comparing laparoscopic versus open appendectomy in pediatric patients with complicated appendicitis.(52)

The current morbidity of intra-abdominal abscess formation following laparoscopic appendectomy for complicated appendicitis has seen a decreasing trend, which has seen a shift towards immediate appendectomy in the management of complicated appendicitis.(53,54)

The outcome from all these studies show that immediate laparoscopic appendectomy is the current first line treatment for complicated appendicitis.

Study	Study type	N=numbers	Wound infection rate-laparoscopic appendectomy	Wound infection rate-open appendectomy
K.You et al(2004)	Retrospective study	244	0.6%	10%
Taguchi et al (2005)	Randomized control trial	81	33.3%	25.6%
Athanasίου et al (2017)	Meta-analysis/systemic review	4439	6.7%	17.7%
Talha et al (1029)	Randomized control trial	126	8.3%	22.7%

Table 2: Summary of the studies that compared wound infection rates between laparoscopic and open appendectomy for complicated appendicitis.

Conclusion

The treatment of complicated appendicitis has seen a shift from conservative management towards immediate appendectomy. Laparoscopic appendectomy should be the surgery of choice if the expertise is available. Interval appendectomy should not be done as a routine and older patients should be followed up with imaging like computerized tomography and colonoscopy. For patients who present with intra-abdominal abscess there is a role for percutaneous drainage of the abscess.

Conflict of interest

There is no conflict of interest.

References

1. Becker P, Fichtner-Feigl S, Schilling D. Clinical management of appendicitis. *Visc Med.* 2018 Dec 1;34(6):453–8.
2. Gorter RR, Eker HH, Gorter-Stam MAW, Abis GSA, Acharya A, Ankersmit M, et al. Diagnosis and management of acute appendicitis. EAES consensus development conference 2015. *SurgEndosc.* 2016 Nov 1;30(11):4668–90.
3. Di Saverio S, Podda M, De Simone B, Ceresoli M, Augustin G, Gori A, et al. Diagnosis and treatment of acute appendicitis: 2020 update of the WSES Jerusalem guidelines. Vol. 15, *World Journal of Emergency Surgery.* BioMed Central Ltd.; 2020.
4. Garba ES, Ahmed A. Management of appendiceal mass. *Ann Afr Med.* 2008;7(4):200–4.
5. Forsyth J, Lasithiotakis K, Peter M. The evolving management of the appendix mass in the era of laparoscopy and interventional radiology. Vol. 15, *Surgeon.* Elsevier Ltd; 2017. p. 109–15.
6. Yamada T, Endo H, Hasegawa H, Kimura T, Kakeji Y, Koda K, et al. Risk of emergency surgery for complicated appendicitis: Japanese nationwide study. *Ann Gastroenterol Surg.* 2021 Mar 1;5(2):236–42.
7. Olsen J, Skovdal J, Qvist N, Bisgaard T. Treatment of appendiceal mass--a qualitative systematic review. *Dan Med J.* 2014;61(8):A4881.
8. Collard MK, Christou N, Lakkis Z, Mege D, Bridoux V, Millet I, et al. Adult appendicitis: Clinical practice guidelines from the French Society of Digestive Surgery and the Society of Abdominal and Digestive Imaging. *J Visc Surg.* 2021 Jun 1;158(3):242–52.
9. Guaitoli E, Gallo G, Cardone E, Conti L, Famularo S, Formisano G, et al. Consensus Statement of the Italian Polispecialistic Society of Young Surgeons (SPIGC): Diagnosis and Treatment of Acute Appendicitis. Vol. 34, *Journal of Investigative Surgery.* Taylor and Francis Ltd.; 2021. p. 1089–103.
10. Mariage M, Sabbagh C, Grelpois G, Prevot F, Darmon I, Regimbeau JM. Surgeon's Definition of Complicated Appendicitis: A Prospective Video Survey Study. *Euroasian J Hepatogastroenterol.* 2019 Jun 1;9(1):1–4.
11. Moris D, Paulson EK, Pappas TN. Diagnosis and Management of Acute Appendicitis in Adults: A Review. Vol. 326, *JAMA.* American Medical Association; 2021. p. 2299–311.
12. Skjold-Ødegaard B, Søreide K. The Diagnostic Differentiation Challenge in Acute Appendicitis: How to Distinguish between Uncomplicated and Complicated Appendicitis in Adults. *Diagnostics (Basel).* 2022;12(7):1724. Published 2022 Jul 15. doi:10.3390/diagnostics12071724
13. Patmano M, Çetin DA, Gümüş T. Laboratory markers used in the prediction of perforation in acute appendicitis. *Ulusal Travmave Acil Cerrahi Dergisi.* 2022 Jul 1;28(7):960–6.
14. Şahbaz NA, Bat O, Kaya B, Ulukent SC, İlkülÖz, Özgün MY, et al. Lökosit sayısının akut apandisit tanısında ve komplikasyonların belirlenmesindeki önemi. *Ulusal Travmave Acil Cerrahi Dergisi.* 2014;20(6):423–6.

15. Dinç T, Sapmaz A, Erkuş Y, Yavuz Z. Complicated or non-complicated appendicitis? That is the question. *Ulusal Travmatoloji ve Acil Cerrahi Dergisi*. 2022 Mar 1;28(3):390–4.
16. Bolmers MDM, Bom WJ, Scheijmans JCG, van Geloven AAW, Boermeester MA, Bemelman WA, et al. Accuracy of imaging in discriminating complicated from uncomplicated appendicitis in daily clinical practice. *Int J Colorectal Dis*. 2022 Jun 1;37(6):1385–91.
17. Gaskill CE, Simianu V V., Carnell J, Hippe DS, Bhargava P, Flum DR, et al. Use of Computed Tomography to Determine Perforation in Patients With Acute Appendicitis. *Curr Probl Diagn Radiol*. 2018 Jan 1;47(1):6–9.
18. Tsukada K, Miyazaki T, Katoh H, Masuda N, Ojima H, Fukuchi M, et al. CT is useful for identifying patients with complicated appendicitis. *Digestive and Liver Disease*. 2004 Mar;36(3):195–8.
19. Bom WJ, Bolmers MD, Gans SL, Van Rossem CC, Van Geloven AAW, Bossuyt PMM, et al. Discriminating complicated from uncomplicated appendicitis by ultrasound imaging, computed tomography or magnetic resonance imaging: Systematic review and meta-analysis of diagnostic accuracy. Vol. 5, *BJS Open*. Oxford University Press; 2021.
20. Coccolini F, Fugazzola P, Sartelli M, Cicuttin E, Sibilla MG, Leandro G, et al. Conservative treatment of acute appendicitis. Vol. 89, *Acta Biomedica*. Mattioli 1885; 2018. p. 119–34.
21. Nitecki S, Assalia A, Schein M. Contemporary management of the appendiceal mass. *Br J Surg*. 1993;80(1):18–20. doi:10.1002/bjs.1800800107
22. Oliak D, Yamini D, Udani VM, Lewis RJ, Vargas H, Arnell T, et al. Nonoperative Management of Perforated Appendicitis without Periappendiceal Mass. Vol. 179, *Am J Surg*. 2000.
23. Nimmagadda N, Matsushima K, Piccinini A, Park C, Strumwasser A, Lam L, et al. Complicated appendicitis: Immediate operation or trial of nonoperative management? *Am J Surg*. 2019 Apr 1;217(4):713–7.
24. Tingstedt B, Bexe-Lindskog E, Ekelund M, Andersson R. Management of appendiceal masses. *Eur J Surg*. 2002;168(11):579–582. doi:10.1080/11024150201680001
25. Tarar B, Batool S, Majeed S, Saleem A. Comparison Between Early Appendectomy vs. Conservative Management in Cases of Appendicular Mass. *Cureus*. 2023;15(4):e37986. Published 2023 Apr 22. doi:10.7759/cureus.37986
26. Simillis C, Symeonides P, Shorthouse AJ, Tekkis PP. A meta-analysis comparing conservative treatment versus acute appendectomy for complicated appendicitis (abscess or phlegmon). *Surgery*. 2010 Jun;147(6):818–29.
27. Fugazzola P, Coccolini F, Tomasoni M, Stella M, Ansaloni L. Early appendectomy vs. conservative management in complicated acute appendicitis in children: A meta-analysis. Vol. 54, *Journal of Pediatric Surgery*. W.B. Saunders; 2019. p. 2234–41.
28. Andersson RE, Petzold MG. Nonsurgical treatment of appendiceal abscess or phlegmon: A systematic review and meta-analysis. *Ann Surg*. 2007 Nov;246(5):741–8.

29. van Amstel P, Sluckin TC, van Amstel T, et al. Management of appendiceal mass and abscess in children; early appendectomy or initial non-operative treatment? A systematic review and meta-analysis. *SurgEndosc*. 2020;34(12):5234-5249. doi:10.1007/s00464-020-07822-y
30. Darwazeh G, Cunningham SC, Kowdley GC. A Systematic Review of Perforated Appendicitis and Phlegmon: Interval Appendectomy or Wait-and-See? *The American Surgeon*TM. 2016;82(1):11-15. doi:10.1177/000313481608200107
31. Willemsen PJ, Hoorntje LE, Eddes EH, Ploeg RJ. The need for interval appendectomy after resolution of an appendiceal mass questioned. *Dig Surg*. 2002;19(3):216-221. doi:10.1159/000064216
32. Tekin A, Kurtoğlu HC, Can I, Öztan S. Routine interval appendectomy is unnecessary after conservative treatment of appendiceal mass. *Colorectal Disease*. 2008 Jun;10(5):465–8.
33. Perez KS, Allen SR. Complicated appendicitis and considerations for interval appendectomy. *J Am Acad Physician Assist*. 2018 Sep 1;31(9):35–41.
34. Corfield L. Interval appendicectomy after appendiceal mass or abscess in adults: what is "best practice"? *Surg Today*. 2007;37(1):1-4. doi:10.1007/s00595-006-3334-2
35. Lasson A, Lundagårds J, Lorén I, Nilsson PE. Appendiceal abscesses: primary percutaneous drainage and selective interval appendicectomy. *Eur J Surg*. 2002;168(5):264-269. doi:10.1002/ejs.44
36. Luo CC, Cheng KF, Huang CS, Lo HC, Wu SM, Huang HC, et al. Therapeutic effectiveness of percutaneous drainage and factors for performing an interval appendectomy in pediatric appendiceal abscess. *BMC Surg*. 2016 Oct 18;16(1).
37. Roach JP, Partrick DA, Bruny JL, Allshouse MJ, Karrer FM, Ziegler MM. Complicated appendicitis in children: a clear role for drainage and delayed appendectomy. *Am J Surg*. 2007 Dec;194(6):769–73.
38. Zerem E, Salkic N, Imamovic G, Terzić I. Comparison of therapeutic effectiveness of percutaneous drainage with antibiotics versus antibiotics alone in the treatment of periappendiceal abscess: Is appendectomy always necessary after perforation of appendix? *Surgical Endoscopy and Other Interventional Techniques*. 2007 Mar;21(3):461–6.
39. Fagenholz PJ, Peev MP, Thabet A, Michailidou M, Chang Y, Mueller PR, et al. Abscess due to perforated appendicitis: factors associated with successful percutaneous drainage. *Am J Surg*. 2016 Oct 1;212(4):794–8.
40. Helling TS, Soltys DF, Seals S. Operative versus non-operative management in the care of patients with complicated appendicitis. *Am J Surg*. 2017 Dec 1;214(6):1195–200.
41. Deelder JD, Richir MC, Schoorl T, Schreurs WH. How to Treat an Appendiceal Inflammatory Mass: Operatively or Nonoperatively? *Journal of Gastrointestinal Surgery*. 2014;18(4):641–5.
42. Yau KK, Siu WT, Tang CN, Yang GPC, Li MKW. Laparoscopic Versus Open Appendectomy for Complicated Appendicitis. *J Am Coll Surg*. 2007 Jul;205(1):60–5.

43. So JBY, Chiong EC, Chiong E, Cheah WK, Lomanto D, Goh P, et al. Laparoscopic appendectomy for perforated appendicitis. *World J Surg.* 2002;26(12):1485–8.
44. Quezada F, Quezada N, Mejia R, Brañes A, Padilla O, Jarufe N, et al. Laparoscopic versus open approach in the management of appendicitis complicated exclusively with peritonitis: A single center experience. *International Journal of Surgery.* 2015 Jan 1;13:80–3.
45. Ball CG, Kortbeek JB, Kirkpatrick AW, Mitchell P. Laparoscopic appendectomy for complicated appendicitis: An evaluation of postoperative factors. *Surgical Endoscopy and Other Interventional Techniques.* 2004 Jun;18(6):969–73.
46. Wullstein C, Barkhausen S, Gross E. Results of laparoscopic vs. conventional appendectomy in complicated appendicitis. *Dis Colon Rectum.* 2001;44(11):1700-1705. doi:10.1007/BF02234393
47. Tiwari MM, Reynoso JF, Tsang AW, Oleynikov D. Comparison of outcomes of laparoscopic and open appendectomy in management of uncomplicated and complicated appendicitis. *Ann Surg.* 2011 Dec;254(6):927–32.
48. Markides G, Subar D, Riyad K. Laparoscopic versus open appendectomy in adults with complicated appendicitis: Systematic review and meta-analysis. *World J Surg.* 2010;34(9):2026–40.
49. Athanasiou C, Lockwood S, Markides GA. Systematic Review and Meta-Analysis of Laparoscopic Versus Open Appendectomy in Adults with Complicated Appendicitis: an Update of the Literature. *World J Surg.* 2017 Dec 1;41(12):3083–99.
50. Talha A, El-Haddad H, Ghazal AE, Shehata G. Laparoscopic versus open appendectomy for perforated appendicitis in adults: randomized clinical trial. *SurgEndosc.* 2020 Feb 1;34(2):907–14.
51. Taguchi Y, Komatsu S, Sakamoto E, Norimizu S, Shingu Y, Hasegawa H. Laparoscopic versus open surgery for complicated appendicitis in adults: a randomized controlled trial. *SurgEndosc.* 2016 May 1;30(5):1705–12.
52. Low ZX, Bonney GK, So JBY, Loh DL, Ng JJ. Laparoscopic versus open appendectomy in pediatric patients with complicated appendicitis: a meta-analysis. *SurgEndosc.* 2019 Dec 1;33(12):4066–77.
53. Cueto J, D’Allemagne B, Vázquez-Frias JA, Gomez S, Delgado F, Trullenque L, et al. Morbidity of laparoscopic surgery for complicated appendicitis: An international study. *Surgical Endoscopy and Other Interventional Techniques.* 2006 May;20(5):717–20.
54. Zamaray B, de Boer MFJ, Popal Z, Rijbroek A, Bloemers FW, Oosterling SJ. AbcApp: incidence of intra-abdominal Abscesses following laparoscopic vs. open Appendectomy in complicated appendicitis. *SurgEndosc.* 2023 Mar 1;37(3):1694–9.