

Peritoneal adhesions in pediatric abdominal surgery: incidence, severity, and predictors of adverse outcomes

Adherencias peritoneales en la cirugía abdominal pediátrica: incidencia, gravedad y predictores de resultados adversos

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SUMMARY

Background: Peritoneal adhesions are a frequent postoperative complication following abdominal surgery and may lead to significant morbidity. However, data on their incidence, severity, and clinical outcomes in pediatric populations remain limited. **Objectives:** This study aims to determine the incidence, severity, and clinical outcomes of peritoneal adhesions in pediatric abdominal surgery and to identify factors associated with adverse outcomes. **Methods:** A retrospective observational study was conducted from January 2023 to December 2025. All pediatric patients (<18 years) undergoing abdominal surgery were screened. Among 294 procedures, 43 patients with intraoperatively confirmed adhesions were included. Adhesion severity was categorized as severe (Grade 4) and non-severe (Grade ≤3). Outcomes included mortality, reoperation, and length of hospital stay (LOS). Associations were analyzed using Chi-square or Fisher's exact test and Mann-Whitney U test, with odds ratios (OR) and

95% confidence intervals (CI). Multivariable analysis was performed using logistic regression, with Firth correction applied for mortality. **Results:** The incidence of peritoneal adhesions was 14.6% (43/294; 95% CI: 10.6–19.3), with severe adhesions observed in 74.4% of cases. Reoperation occurred in 27.9% of patients, and in-hospital mortality was 16.3%. Severe adhesions were significantly associated with mortality (OR = 6.76; $p = 0.04$). Comorbidities were strongly associated with mortality, with all deaths occurring in patients with at least one comorbid condition ($p = 0.02$). Malnutrition was also significantly associated with mortality (OR = 13.6; $p = 0.01$). In multivariable analysis, severe adhesions (adjusted OR = 5.41; $p = 0.048$) and comorbidities (adjusted OR = 5.96; $p = 0.036$) were independent predictors of mortality, while malnutrition showed a strong trend (adjusted OR = 4.72; $p = 0.067$). Severe adhesions and malnutrition were also independently associated with prolonged LOS. **Conclusion:** Peritoneal adhesions in pediatric abdominal surgery are associated with considerable clinical burden. Adhesion severity and

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comorbidities independently predict mortality, while malnutrition contributes to adverse outcomes. These findings highlight the importance of comprehensive perioperative management addressing both surgical and systemic factors.

Keywords: Peritoneal adhesions, pediatric abdominal surgery, adhesion severity, clinical outcomes, postoperative complications, reoperation risk

RESUMEN

Antecedentes: Las adherencias peritoneales son una complicación posoperatoria frecuente tras la cirugía abdominal y pueden causar morbilidad significativa. Sin embargo, la información sobre su incidencia, gravedad y resultados clínicos en la población pediátrica es limitada. **Objetivos:** Este estudio tiene como objetivo determinar la incidencia, la gravedad y los resultados clínicos de las adherencias peritoneales en la cirugía abdominal pediátrica e identificar los factores asociados a resultados adversos. **Métodos:** Se realizó un estudio observacional retrospectivo de enero de 2023 a diciembre de 2025. Se seleccionaron todos los pacientes pediátricos (< 18 años) sometidos a cirugía abdominal. De 294 procedimientos, se incluyeron 43 pacientes con adherencias confirmadas intraoperatoriamente. La gravedad de las adherencias se clasificó en grave (grado 4) y no grave (grado ≤ 3). Los resultados incluyeron la mortalidad, la reintervención y la duración de la estancia hospitalaria. Las asociaciones se analizaron mediante la prueba de Chi-cuadrado o la prueba exacta de Fisher y la prueba U de Mann-Whitney, con odds ratios (OR) e intervalos de confianza del 95 % (IC). Se realizó un análisis multivariable mediante regresión logística, aplicando la corrección de Firth para la mortalidad. **Resultados:** La incidencia de adherencias peritoneales fue del 14,6 % (43/294; IC del 95 %: 10,6-19,3), y se observaron adherencias graves en el 74,4 % de los casos. Se requirió reintervención quirúrgica en el 27,9 % de los pacientes, y la mortalidad intrahospitalaria fue del 16,3 %. Las adherencias graves se asociaron de manera significativa con la mortalidad (OR = 6,76; p = 0,04). Las comorbilidades se asociaron de manera significativa con la mortalidad, y todos los fallecimientos ocurrieron en pacientes con al menos una comorbilidad (p = 0,02). La desnutrición también se asoció de manera significativa con la mortalidad (OR = 13,6; p = 0,01). En el análisis multivariado, las adherencias graves (OR ajustado = 5,41; p = 0,048) y las comorbilidades (OR ajustado = 5,96; p = 0,036) fueron predictores independientes de mortalidad, mientras que la desnutrición mostró una tendencia a un mayor riesgo de mortalidad (OR ajustado = 4,72; p = 0,067). Las adherencias graves y la desnutrición también se asociaron de forma independiente con una estancia

hospitalaria prolongada. **Conclusión:** Las adherencias peritoneales en la cirugía abdominal pediátrica se asocian con una carga clínica considerable. La gravedad de las adherencias y las comorbilidades predicen de forma independiente la mortalidad, mientras que la desnutrición contribuye a resultados adversos. Estos hallazgos resaltan la importancia de un manejo perioperatorio integral que aborde tanto los factores quirúrgicos como los sistémicos.

Palabras clave: Adherencias peritoneales, cirugía abdominal pediátrica, gravedad de las adherencias, resultados clínicos, complicaciones postoperatorias, riesgo de reintervención

INTRODUCTION

Peritoneal adhesions are fibrous bands of scar tissue that develop between abdominal organs or between these organs and the abdominal wall, typically resulting from surgical trauma, infection, or inflammatory processes. Peritoneal adhesions are a natural component of the healing response following peritoneal injury; however, when this process becomes dysregulated, it can result in abnormal fibrous connections between tissues and lead to significant clinical complications. Consequently, adhesion formation is recognized as one of the most frequent postoperative sequelae in abdominal surgery and continues to pose a persistent global challenge (1,2).

The incidence of peritoneal adhesions is remarkably high, with studies reporting occurrence rates of more than 90% following major abdominal surgery (1–3). Despite this high prevalence, not all adhesions become clinically significant. Many remain asymptomatic, while others can lead to serious conditions such as adhesive small bowel obstruction, chronic abdominal pain, infertility, and increased surgical difficulty during reoperation (4). Adhesion-related complications are also associated with increased healthcare utilization, including prolonged hospitalization and repeated surgical interventions, thereby contributing to substantial economic burden (4).

The pathophysiology of adhesion formation involves a complex cascade of biological events initiated by peritoneal injury. Tissue trauma induces an inflammatory response, activation of the coagulation pathway, and deposition of a fibrin matrix that serves as a scaffold for fibroblast proliferation and subsequent collagen synthesis (1,4). Under normal conditions, fibrinolytic activity dissolves this fibrin matrix; however, when fibrinolysis is impaired, persistent fibrin deposition leads to permanent fibrous adhesions (5). Factors such as infection, ischemia, foreign bodies, and repeated surgical interventions further exacerbate this imbalance, increasing the likelihood of dense and clinically significant adhesions (4,6).

Although the burden of adhesions has been extensively studied in adult populations, evidence in pediatric patients remains limited. This is particularly concerning given that children may experience long-term consequences due to their longer life expectancy and repeated exposure to surgical interventions (7). Previous studies have suggested that adhesion-related bowel obstruction occurs in a notable proportion of pediatric patients following abdominal surgery, underscoring its clinical relevance (7,8). However, variability in clinical presentation and the difficulty of non-invasive diagnosis often result in underreporting, especially in low- and middle-income countries (9).

Furthermore, the severity of adhesions plays a crucial role in determining clinical outcomes. While mild adhesions may remain asymptomatic, severe adhesions are more likely to cause organ dysfunction, increase operative complexity, and contribute to postoperative complications, including mortality (2,5). Importantly, most previous studies have concentrated primarily on the mere presence or absence of adhesions, with limited evaluation of their severity or their association with clinically relevant outcomes. Moreover, data on the incidence of clinically detected adhesions—and on the combined impact of surgical, clinical, and systemic factors on outcomes such as mortality, reoperation, and

length of hospital stay—remain scarce, particularly in resource limited settings (9).

Therefore, this study aims to evaluate the incidence, severity, and clinical outcomes of peritoneal adhesions in pediatric abdominal surgery. Furthermore, this study seeks to investigate the association between adhesion severity and key clinical outcomes, as well as to identify independent predictors of adverse outcomes, including mortality and prolonged hospitalization, by incorporating surgical factors (adhesion severity), clinical factors (previous surgery and comorbidities), and systemic factors (nutritional status). By providing a more comprehensive understanding of these relationships, this study is expected to contribute to improved risk stratification and inform preventive and management strategies in pediatric surgical care.

METHODS

Study Design, Setting, Population and Sample

This retrospective observational study was conducted at a tertiary referral hospital in Indonesia and included pediatric patients who underwent abdominal surgery between January 2023 and December 2025. The study aimed to evaluate the incidence, severity, and clinical outcomes of peritoneal adhesions and to identify factors associated with adverse outcomes.

All pediatric patients (<18 years) who underwent abdominal surgery between January 2023 and December 2025 were screened. During the study period, a total of 294 abdominal surgeries were performed. Among these, patients with intraoperatively confirmed peritoneal adhesions were identified, resulting in a final sample of 43 patients included in the analysis. Patients with incomplete medical records or without documented intraoperative findings were excluded. A total sampling approach was used for eligible cases with adhesions.

Variables and Definitions

Several exposure and outcome variables were defined based on clinical and intraoperative data. Adhesion severity was assessed intraoperatively by the operating surgeon and categorized into severe adhesions (Grade 4) and non-severe adhesions (Grade ≤ 3). Previous abdominal surgery was defined as any documented history of an abdominal operation (yes/no), and peritonitis was defined as the presence of intra-abdominal infection before surgery, based on clinical and operative findings. Comorbidities were defined as the presence of at least one underlying medical condition and categorized into no comorbidity (0) and the presence of one or more comorbidities (≥ 1). Nutritional status was classified from clinical records as malnourished or well-nourished.

The primary outcome of interest was in-hospital mortality. Secondary outcomes included reoperation (defined as any subsequent surgical intervention during the same admission), length of hospital stay (LOS), measured in days, and prolonged LOS, defined as a hospitalization duration exceeding the median LOS of the study population. In addition, the incidence of peritoneal adhesions was calculated as the proportion of patients with intraoperatively confirmed adhesions among all pediatric abdominal surgeries performed during the study period.

Data were extracted retrospectively from medical records using a standardized data collection form. The following variables were collected: demographic characteristics (age, sex, nutritional status, and comorbidities), clinical history (previous abdominal surgery and history of peritonitis), adhesion characteristics (intraoperative severity grading), and clinical outcomes (length of hospital stay, postoperative ileus, wound infection, reoperation, and in-hospital mortality). Categorical variables were summarized as frequencies and percentages, and 95% confidence intervals (CIs) were calculated to reflect the precision of the estimates.

Statistical Analysis

Descriptive statistics were used to summarize the study variables. Continuous data were presented as mean values, while categorical variables were expressed as frequencies and percentages with corresponding 95% confidence intervals (CI). The incidence of peritoneal adhesions was calculated as the proportion of patients with intraoperatively confirmed adhesions among all pediatric abdominal surgeries performed during the study period.

Bivariate analyses were conducted to assess the association between clinical factors and outcomes. The Chi-Square test or Fisher's exact test was applied for categorical variables, depending on expected cell counts. Continuous variables, including length of hospital stay (LOS), were analyzed using the Mann-Whitney U test because they were non-normally distributed. Odds ratios (ORs) with 95% CIs were calculated to estimate the strength of the associations. For contingency tables with zero cells, the Haldane-Anscombe correction was applied to enable stable estimation of the OR and CI.

Multivariable analysis was performed using logistic regression models to identify independent predictors of adverse outcomes. For in-hospital mortality, Firth penalized logistic regression was applied to address small-sample size and sparse-data bias arising from zero-cell counts. For reoperation and prolonged LOS, standard binary logistic regression models were used. Variables included in the multivariable models were selected based on clinical relevance and prior evidence, including adhesion severity, comorbidities, and nutritional status. A p-value of less than 0.05 was considered statistically significant; however, given the limited sample size, results were interpreted with consideration of both statistical significance and clinical relevance, including effect size and confidence intervals. All statistical analyses were performed using standard statistical software.

Ethical Considerations

This study was conducted following ethical clearance from the Research Ethics Committee of the General Hospital of West Nusa Tenggara, Indonesia, with No. 00.91.184a/KEP/2025. Due to the retrospective design, the requirement for informed consent was waived. All data were anonymized to ensure patient confidentiality.

RESULTS

Incidence and Baseline Characteristics

During the study period, a total of 294 pediatric abdominal surgeries were performed. Among these, 43 patients were identified with intraoperatively confirmed peritoneal adhesions, resulting in an incidence of 14.6% (95% CI: 10.6–19.3). The mean age of patients was 10.5 years, and the majority were male. More than half of the patients had a history of previous abdominal surgery and at least one comorbid condition, while a smaller proportion had a history of peritonitis. Malnutrition was observed in a considerable number of patients (Table 1).

Table 1. Characteristics of Pediatric Patients with Peritoneal Adhesions (n=43)

Variable	Value	95% CI
Total abdominal surgeries	294	—
Peritoneal adhesions (n, %)	43 (14.6)	10.6–19.3
Age, mean (years)	10.5	—
Age, median (years)	12	—
Male, n (%)	28 (65.1)	50.9–79.3
Female, n (%)	15 (34.9)	20.7–49.1
Previous abdominal surgery, n (%)	24 (55.8)	41.0–70.6
No previous surgery, n (%)	19 (44.2)	29.4–59.0
History of peritonitis, n (%)	6 (14.0)	3.6–24.4
No peritonitis, n (%)	37 (86.0)	75.6–96.4
Comorbidities ≥ 1 , n (%)	24 (55.8)	—
Malnutrition, n (%)	17 (39.5)	—

Adhesion Severity and Clinical Outcomes

Severe adhesions (Grade 4) were the predominant findings, accounting for most cases. The mean length of hospital stay was 16.6 days. Postoperative complications included ileus and wound infection, each occurring in a minority of patients. Reoperation was required in approximately one-quarter of cases, and in-hospital mortality was observed in a notable proportion of patients (Table 2).

Table 2. Adhesion Severity and Clinical Outcomes

Variable	Value	95% CI
Severe adhesions (Grade 4), n (%)	32 (74.4)	61.4–87.4
Non-severe adhesions, n (%)	10 (23.3)	10.7–35.9
Length of stay (mean days)	16.6	—
Postoperative ileus, n (%)	5 (11.6)	2.0–21.2
Wound infection, n (%)	5 (11.6)	2.0–21.2
Reoperation, n (%)	12 (27.9)	14.5–41.3
Mortality, n (%)	7 (16.3)	5.3–27.3

Factors Associated with Adhesion Severity

Patients with a history of abdominal surgery had a higher proportion of severe adhesions than those without prior surgery; however, this association did not reach statistical significance (OR = 2.92; $p = 0.12$). Similarly, peritonitis demonstrated a strong but non-significant association with severe adhesions (OR = 5.64; $p = 0.09$) (Table 3).

In contrast, neither comorbidities nor nutritional status were significantly associated with adhesion severity. Patients with at least one comorbid condition had comparable rates of severe adhesions to those without comorbidities (OR = 0.49; $p = 0.31$), and no significant difference was observed between malnourished and well-nourished patients (OR = 0.90; $p = 0.87$) (Table 3).

Association Between Clinical Factors and Outcomes

Severe adhesions were significantly associated with increased mortality (OR = 6.76; $p = 0.04$), although the association with reoperation did not reach statistical significance. The presence of comorbidities was strongly associated with mortality, with all deaths occurring in patients with at least one comorbid condition ($p = 0.02$). However, comorbidities were not significantly associated with reoperation (Table 4).

Malnutrition was also significantly associated with increased mortality (OR = 13.6; $p = 0.01$), indicating a substantial increase in risk among malnourished patients. Although malnourished patients showed a higher likelihood of reoperation, this association was not statistically significant (Table 4).

Multivariable Analysis

In multivariable analysis, severe adhesions and comorbidities were independently associated with increased mortality. Severe adhesions increased the risk of mortality more than fivefold (adjusted OR = 5.41; $p = 0.048$), while comorbidities were associated with a nearly sixfold increase in risk (adjusted OR = 5.96; $p = 0.036$). Malnutrition showed a strong trend toward increased mortality risk (adjusted OR = 4.72), although this did not reach statistical significance (Table 5).

For reoperation, no independent predictors were identified in the multivariable model. However, for a prolonged hospital stay, both severe adhesions and malnutrition were independently associated with an increased risk, whereas comorbidities showed a non-significant trend (Table 5).

DISCUSSION

This study identified an observed incidence of peritoneal adhesions of 14.6% among pediatric abdominal surgeries, with a predominance of severe adhesions. This incidence appears lower than the widely reported rates of up to 90% following abdominal surgery (1–3). However, this discrepancy is likely attributable to methodological differences: many studies report adhesions detected through systematic evaluation or second-look procedures, whereas the present study captured only clinically recognized and intraoperatively documented adhesions. Therefore, the reported incidence likely underestimates the true biological occurrence of adhesions, as many remain asymptomatic and undetected (10).

The high predominance of severe peritoneal adhesions among pediatric patients undergoing abdominal surgery in this study suggests that clinically detected cases may represent more advanced stages of disease (11). This finding aligns with existing literature suggesting that adhesions develop in up to 90% of patients

Table 3. Factors Associated with Severe Adhesions

Variable	Severe	Non-severe	OR (95% CI)	p-value
Previous surgery (Yes)	20	4	2.92 (0.70–12.09)	0.12
Peritonitis (Yes)	6	0	5.64 (0.29–109.3) *	0.09
Comorbidities ≥ 1	17	7	0.49 (0.10–2.20)	0.31
Malnutrition	12	4	0.90 (0.20–3.90)	0.87

*Haldane–Anscombe correction applied due to zero cell

Table 4. Association Between Clinical Factors and Outcomes

Variable	Outcome	OR (95% CI)	p-value
Severe adhesions	Reoperation	5.24 (0.59–46.30)	0.08
Severe adhesions	Mortality	6.76 (0.35–129.4) *	0.04
Comorbidities ≥1	Reoperation	1.08 (0.28–4.10)	0.90
Comorbidities ≥1	Mortality	∞	0.02
Malnutrition	Reoperation	1.82 (0.47–7.00)	0.47
Malnutrition	Mortality	13.6 (1.50–123.0)	0.01

*Haldane–Anscombe correction applied due to zero cell

Table 5. Multivariable Logistic Regression for Mortality and Clinical Outcomes

Variable	Mortality (Adj OR, 95% CI)	p-value	Reoperation (Adj OR, 95% CI)	p-value	LOS (Adj OR, 95% CI)	p-value
Severe adhesion	5.41 (1.01–38.7)	0.048	4.82 (0.52–44.6)	0.17	3.95 (1.10–15.8)	0.035
Comorbid ≥1	5.96 (1.12–49.8)	0.036	1.05 (0.25–4.40)	0.94	2.88 (0.80–10.3)	0.10
Malnutrition	4.72 (0.91–32.5)	0.067	1.70 (0.40–7.20)	0.48	3.72 (1.02–14.2)	0.046

following abdominal surgery, although only a subset progresses to clinically significant disease (7,8,12). Adhesion formation is driven by an imbalance between fibrin deposition and fibrinolysis following peritoneal injury, a process exacerbated by repeated surgical trauma and inflammation (13). This supports the notion that patients presenting in tertiary care settings are more likely to exhibit clinically significant adhesions, as milder cases may remain undiagnosed.

In the present study, prior abdominal surgery and peritonitis were associated with increased odds of severe adhesions, although these associations were not statistically significant. This finding is consistent with existing evidence identifying prior surgery and intra-abdominal infection as key contributors to adhesion formation through repeated tissue injury and inflammatory responses (7,13). However, the lack of statistical

significance in this study is likely due to a limited sample size rather than the absence of an association. Conversely, some recent evidence suggests that not all surgical factors independently predict clinically significant adhesion outcomes, highlighting variability across patient populations and surgical contexts (11,14).

Interestingly, this study found that comorbidities and nutritional status were not associated with adhesion severity. This suggests that adhesion formation is primarily driven by local peritoneal factors rather than systemic patient conditions. Previous literature supports this observation, indicating that the development of adhesion is largely influenced by localized inflammatory and tissue-repair mechanisms rather than by systemic health status (13). However, the absence of association in this study may also reflect limited statistical power.

Despite the lack of association with severity, comorbidities and malnutrition were strongly associated with adverse clinical outcomes, particularly mortality. All deaths in this study occurred in patients with at least one comorbid condition, and malnutrition was associated with a markedly increased risk of mortality. These findings highlight the importance of systemic patient factors in determining postoperative outcomes. Similar observations have been reported, where underlying health conditions and physiological reserve significantly influence postoperative morbidity and mortality in pediatric surgical patients (11). Malnutrition, in particular, is known to impair immune function, delay wound healing, and increase susceptibility to infection, thereby contributing to worse clinical outcomes.

Severe adhesions were also independently associated with increased mortality, consistent with the understanding that advanced adhesion disease can lead to life-threatening complications such as bowel obstruction, ischemia, and sepsis. Adhesion-related bowel obstruction is a major clinical consequence, often requiring emergency intervention and associated with substantial morbidity and mortality (11). Furthermore, surgical management of dense adhesions is technically challenging and carries a higher risk of intraoperative injury, which may further contribute to adverse outcomes.

In addition to mortality, this study demonstrated that both severe adhesions and malnutrition were independently associated with prolonged hospital stay. This finding aligns with previous studies showing that adhesion-related complications increase operative complexity and delay postoperative recovery, leading to longer hospitalization and greater healthcare burden (10). Prolonged length of stay may reflect not only surgical complexity but also the patient's overall physiological condition, further emphasizing the interplay between surgical and systemic factors. Notably, no independent predictors of reoperation were identified in this study. This may reflect the multifactorial nature of clinical decision-making regarding reoperation, influenced by patient condition, surgeon judgment, and institutional

practices. Additionally, the limited sample size may have reduced the statistical power to detect significant associations.

Overall, this study demonstrates that while adhesion severity is an important determinant of outcomes, systemic factors such as comorbidity and nutritional status play a critical and independent role in shaping clinical prognosis. These findings underscore the multifactorial nature of adhesion-related complications, where both local surgical factors and patient-related conditions must be considered. Importantly, the strong association between malnutrition and adverse outcomes suggests that nutritional optimization may represent a modifiable risk factor and should be integrated into perioperative management strategies.

This study has several limitations. The relatively small sample size resulted in wide confidence intervals and limited statistical power, particularly in multivariable analysis. The retrospective design may introduce information bias and limit causal inference. In addition, the incidence reported in this study reflects clinically detected adhesions and may underestimate the true prevalence of adhesion formation. Despite these limitations, this study provides valuable insights into the incidence, severity, and clinical impact of peritoneal adhesions in pediatric populations, particularly in a resource-limited setting where data remain scarce.

CONCLUSION

Peritoneal adhesions were observed in a notable proportion of pediatric abdominal surgeries, with severe adhesions predominating and significantly contributing to adverse clinical outcomes. Adhesion severity and the presence of comorbidities were identified as independent predictors of mortality, while malnutrition showed a clinically meaningful association with increased risk of death and prolonged hospitalization. Although surgical factors influence disease severity, systemic conditions

such as comorbidities and nutritional status play a critical role in determining patient outcomes. These findings highlight the multifactorial nature of adhesion-related complications and underscore the importance of comprehensive perioperative management, including early risk stratification and nutritional optimization, to improve outcomes in pediatric surgical patients.

REFERENCES

- Hassanabad AF, Zarzycki AN, Jeon K, Deniset JF, Fedak PWM. Post-operative adhesions: A comprehensive review of mechanisms. *Biomedicines*. 2021;9(8).
- Krielen P, Stommel MWJ, Pargmae P, Bouvy ND, Bakkum EA, Ellis H, et al. Adhesion-related readmissions after open and laparoscopic surgery: a retrospective cohort study (SCAR update). *The Lancet*. 2020;395(10217):33–41.
- ten Broek RPG, Issa Y, van Santbrink EJP, Bouvy ND, Kruitwagen RFPM, Jeekel J, et al. Burden of adhesions in abdominal and pelvic surgery: systematic review and meta-analysis. *BMJ*. 2013;347(7929).
- Hu Q, Xia X, Kang X, Song P, Liu Z, Wang M, et al. A review of physiological and cellular mechanisms underlying fibrotic postoperative adhesion. *Int J Biol Sci*. 2021;17(1):298.
- Liu ZY, Li RF, Qin HY, Ma PF. Postoperative adhesion formation: the role of peritoneal macrophages and targeting therapy. *Front Immunol*. 2025;16:1601642.
- Soltany S. Postoperative peritoneal adhesion: an update on physiopathology and novel traditional herbal and modern medical therapeutics. *Naunyn Schmiedeberg's Arch Pharmacol*. 2021;394(2):317–36.
- Ghimire P, Maharjan S. Adhesive Small Bowel Obstruction: A Review. *JNMA J Nepal Med Assoc*. 2023;61(260):390.
- Grant HW, Parker MC, Wilson MS, Menzies D, Sunderland G, Thompson JN, et al. Adhesions after abdominal surgery in children. *J Pediatr Surg*. 2008;43(1):152–7.
- Anderson SA, Beierle EA, Chen MK. Role of laparoscopy in the prevention and in the treatment of adhesions. *Semin Pediatr Surg*. 2014;23(6):353–6.
- Lakshminarayanan B, Hughes-Thomas AO, Grant HW. Epidemiology of adhesions in infants and children following open surgery. *Semin Pediatr Surg*. 2014;23(6):344–8.
- Liakakos T, Thomakos N, Fine PM, Dervenis C, Young RL. Peritoneal Adhesions: Etiology, Pathophysiology, and Clinical Significance. *Dig Surg*. 2001;18(4):260–73.
- Håkanson CA, Fredriksson F, Lilja HE. Paediatric Adhesive Small Bowel Obstruction is Associated with a Substantial Economic Burden and High Frequency of Postoperative Complications. *J Pediatr Surg*. 2023;58(11):2249–54.
- Deogracias JMC, Almonte JR. Postoperative adhesions after abdominal surgery in children: a pilot study in the Philippines. *World Journal of Pediatric Surgery*. 2019;2(2).
- Nguyen ATM, Holland AJA. Paediatric adhesive bowel obstruction: a systematic review. *Pediatr Surg Int*. 2021;37(6):755–63.
- Gudieav C. Method of Prevention of Postoperative Peritoneal Adhesions. *North Clin Istanb*. 2022;10(1):33–9.
- Hencke J, Nonnenmacher G, Loff S. The burden of adhesive bowel obstruction requiring surgery in children: a single-center retrospective review. *Pediatr Surg Int*. 2024;41(1):9.
- Davydova YD, Fedorov AA, Popov AA, Tyurina SS, Chechneva MA, Sopova YI. Peritoneal adhesions in modern surgery. *VFSnegirev Archives of Obstetrics and Gynecology*. 2024;11(1):17–24.
- Deng K, Li E, Li G, Ren Y, Shen T, Jiang Z, et al. Research landscape of abdominal adhesions from 2004 to 2023: A bibliometric analysis. *Heliyon*. 2024;10(9).
- Sturm M, Abazid A, Stope M. Tissue adhesion after surgical interventions (Review). *Exp Ther Med*. 2025;29(5):1–9.
- ten Broek RPG, Krielen P, Di Saverio S, Coccolini F, Biffl WL, Ansaloni L, et al. Bologna guidelines for diagnosis and management of adhesive small bowel obstruction (ASBO): 2017 update of the evidence-based guidelines from the World Society of Emergency Surgery ASBO Working Group. *World Journal of Emergency Surgery*. 2018;13(1):1–13.
- Tong JWV, Lingam P, Shelat VG. Adhesive small bowel obstruction – an update. *Acute Medicine & Surgery*. 2020;7(1):e587.
- Christensen RR, Wright KE, Ives JK, Minnick CE, Chen Q, Girgis MD, et al. A Developmental Roadmap Toward Abdominal Adhesions Prevention Technologies. *Annals of Surgery Open*. 2025;6(4):e637.
- Doshi N, Bandyopadhyay S, Green M, Richardson E, Komber A, Chen SE, et al. The Risk of Adhesive Bowel Obstruction in Children With Appendicitis: A Systematic Review. *J Pediatr Surg*. 2024;59(8):1477–85.