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Early Mobilization and Return to Physical Activity Following Common Pediatric Abdominal Surgery: A Narrative Review

2.1. Study population

The studies included in this review primarily involved pediatric patients younger than 18 years of age, including neonates undergoing abdominal surgical procedures. The analyzed literature encompassed patients undergoing appendectomy, inguinal hernia repair, colorectal surgery, neonatal intestinal surgery, and surgery for congenital duodenal obstruction. Both single-center and multicenter studies, together with evidence syntheses and clinical practice guidelines, were included to provide a comprehensive overview of postoperative recovery, early mobilization strategies, postoperative activity restrictions, and recommendations for return to physical activity following common pediatric abdominal surgery.

3. Research results

3.1. Why Early Mobilization Matters

Early mobilization has become one of the fundamental principles of modern perioperative care and an essential component of Enhanced Recovery After Surgery (ERAS) protocols. Rather

than focusing solely on early ambulation, it encompasses a multimodal strategy aimed at reducing the physiological stress response to surgery, promoting faster functional recovery, and facilitating an earlier return to normal daily activities. In pediatric patients, early mobilization is integrated with other ERAS interventions, including optimized perioperative nutrition, opioid-sparing analgesia, minimally invasive surgical techniques, and early removal of drains and urinary catheters, creating a comprehensive approach to postoperative recovery [4,5,6,7,9].

Prolonged postoperative immobilization contributes to delayed recovery through several mechanisms. Reduced physical activity may impair gastrointestinal motility, delay restoration of bowel function, increase muscle deconditioning, and prolong hospitalization. In contrast, early mobilization stimulates gastrointestinal recovery, promotes earlier oral feeding, and supports the return of normal physiological function. Together with optimized pain management and appropriate fluid therapy, it enables children to resume normal activities more rapidly while minimizing postoperative discomfort [4,5,7,9].

The available evidence consistently demonstrates that ERAS pathways incorporating early mobilization improve postoperative recovery without compromising patient safety. In a prospective cohort of children undergoing various gastrointestinal procedures, implementation of ERAS protocols reduced the time to first flatus and defecation, shortened postoperative intravenous nutrition and hospital stay, and lowered hospitalization costs without increasing postoperative complications [4]. Similarly, a systematic review and meta-analysis including 16 studies and 1723 pediatric patients found that ERAS protocols significantly reduced the time to initiation of enteral feeding, accelerated achievement of full enteral nutrition, decreased opioid requirements, and shortened hospital stay by an average of 2.5 days, while complication and readmission rates remained unchanged [7]. Comparable findings were reported in another meta-analysis, which demonstrated shorter length of stay, earlier oral intake, faster return of bowel function, and reductions in postoperative complications and 30-day readmission rates among children undergoing abdominal surgery [9].

Structured early mobility programmes have also been implemented after major pediatric procedures, including liver transplantation, and were associated with earlier independent ambulation and shorter hospital stay [10].

Overall, current evidence supports early mobilization as a safe and effective component of pediatric perioperative care. When incorporated into comprehensive ERAS pathways, it

contributes to faster functional recovery, earlier restoration of gastrointestinal function, shorter hospitalization, and improved postoperative outcomes without increasing the risk of complications [4,5,6,7,9].

3.2. Return to Physical Activity after Common Pediatric Abdominal Procedures

3.2.1. Appendectomy

Appendectomy is one of the most frequently performed emergency surgical procedures in children and is generally associated with rapid postoperative recovery, particularly in cases of uncomplicated appendicitis treated laparoscopically. Despite the widespread use of minimally invasive techniques, recommendations regarding the timing of return to unrestricted physical activity remain inconsistent and are often based on surgeon preference rather than high-quality evidence [3,11,12,13,14].

Recent prospective evidence suggests that postoperative activity restrictions may be more conservative than necessary. Harvey et al. compared physician-directed activity restrictions (PDAR), consisting of a routine recommendation to avoid full activity for two weeks, with self-directed activity restrictions (SDAR), in which children resumed activities whenever they and their caregivers felt comfortable. Although the difference did not reach statistical significance, patients in the SDAR group returned to unrestricted activity approximately two days earlier than those following physician-directed recommendations (9.5 vs. 11.9 days), without an increase in postoperative complications or a reduction in patient and caregiver satisfaction [3]. Importantly, nearly all caregivers (97.7%) reported feeling comfortable determining when their child could safely resume normal activities, supporting greater family involvement in postoperative decision-making [3].

Additional insight into postoperative recovery was provided by Reynolds et al., who evaluated recovery following several common pediatric surgical procedures. After uncomplicated laparoscopic appendectomy, children returned to baseline behaviour after a mean of 7.1 postoperative days, discontinued analgesics after approximately 2.9 days, and returned to school after an average of 7.6 days. These findings suggest that functional recovery generally occurs within the first postoperative week, although return to school may be delayed slightly beyond the resolution of symptoms [13]. The authors emphasized that evidence-based

counselling may better prepare families for postoperative recovery and help standardize recommendations regarding school attendance and daily activities [13].

The benefits of minimally invasive surgery are also reflected in the speed of functional recovery. In a prospective randomized trial, patients undergoing laparoscopic appendectomy resumed full activities significantly earlier than those treated with an open approach (14 versus 25 days) and required a shorter duration of postoperative analgesic use [11]. Consistent with these findings, Ionescu et al. reported that junior athletes treated laparoscopically for complicated appendicitis were able to resume sports participation within 10–12 days after surgery, suggesting that minimally invasive surgery may facilitate an early return to intensive physical activity even after more advanced disease [15].

More recently, improvements in perioperative care have further accelerated recovery after appendectomy. A systematic review and meta-analysis evaluating same-day discharge after laparoscopic appendectomy for uncomplicated appendicitis found no increase in readmissions, emergency department visits, reoperations, or overall complications compared with overnight hospitalization. Moreover, same-day discharge was associated with lower healthcare costs and a reduced risk of wound-related complications, suggesting that carefully selected children can safely recover at home immediately after surgery [12]. Similarly, the implementation of Enhanced Recovery Concepts (ERCs) in pediatric appendectomy resulted in significantly shorter hospital stays without increasing postoperative pain, readmissions, reoperations, emergency department visits, or hospital costs, highlighting the value of structured perioperative care pathways in promoting faster recovery [14].

Although precise timelines for unrestricted exercise and sport remain insufficiently defined, current evidence supports an individualized return based on functional recovery, symptom resolution, and the absence of postoperative complications rather than fixed time-based restrictions.

3.2.2. Inguinal Hernia Repair

Inguinal hernia repair is one of the most common elective surgical procedures in children and is usually followed by a short and uncomplicated recovery. Nevertheless, recommendations concerning return to unrestricted physical activity remain variable, and prolonged restrictions are often based more on traditional practice than on procedure-specific evidence [3,13,16].

Available data indicate that functional recovery after laparoscopic inguinal hernia repair is generally rapid. In a retrospective study of 40 children, Reynolds et al. reported that patients returned to baseline behaviour after a mean of 4.8 postoperative days, stopped analgesic medication after approximately 2.7 days, and returned to school after a mean of 5.8 days [13]. These findings suggest that most children regain normal daily functioning within the first postoperative week. The authors consequently recommended that children undergoing laparoscopic procedures should generally be expected to return to school within approximately five to seven days, provided that recovery is uncomplicated [13].

The necessity of fixed postoperative activity restrictions has also been questioned. In the prospective Let Them Play study, children undergoing routine laparoscopic appendectomy or inguinal hernia repair were managed either with physician-directed restrictions for two weeks or with a self-directed approach, allowing return to full activity when the child and family felt comfortable [3]. Across the combined study population, children in the self-directed group resumed full activity approximately two days earlier on average than those following physician-directed restrictions, although this difference was not statistically significant. No increase in postoperative complications, wound or fascial dehiscence, or short-term hernia recurrence was observed [3]. However, these results were not reported separately for inguinal hernia repair, and only 12 children undergoing this procedure completed the postoperative survey. Therefore, the findings support the potential safety of symptom-guided recovery but should not be interpreted as definitive hernia-specific evidence.

The choice between laparoscopic and open repair does not appear to substantially influence the speed of recovery. A meta-analysis of eight randomized controlled trials involving 733 pediatric patients found no significant differences between laparoscopic and open inguinal hernia repair in overall complication rates, recurrence, hospital stay, or time to full recovery [16]. Pooled analysis of four trials assessing return to full or normal daily activity showed comparable recovery times between the two approaches [16]. Thus, current evidence does not support selecting a surgical technique solely to accelerate return to physical activity.

Most children resume normal daily functioning within several days and return to school within approximately one week after uncomplicated repair. In the absence of robust sport-specific data, progression of activity may reasonably be guided by pain resolution, normal mobility, and uncomplicated wound healing.

3.2.3. Colorectal Surgery

Pediatric colorectal procedures, including operations performed for inflammatory bowel disease, Hirschsprung disease, anorectal malformations, and colonic dysmotility, are among the most extensive abdominal surgeries in children. Compared with routine procedures such as appendectomy or inguinal hernia repair, these operations are associated with greater surgical stress, prolonged postoperative ileus, delayed oral feeding, and longer hospitalization. Consequently, enhanced recovery after surgery (ERAS) protocols have been increasingly adopted to facilitate postoperative rehabilitation through multimodal perioperative care, with early mobilization representing one of their fundamental components [4,17,18].

Several studies have demonstrated that ERAS pathways improve postoperative recovery in pediatric colorectal surgery without increasing the overall risk of complications. In a retrospective cohort study including 194 pediatric colorectal surgery patients, implementation of an ERAS protocol resulted in significantly shorter Foley catheter duration (1.0 vs. 1.9 days), reduced postoperative opioid requirements, lower postoperative intravenous fluid administration, and a shorter postoperative length of stay (4.2 vs. 5.9 days) compared with conventional care [17]. Importantly, despite faster recovery and earlier discharge, ERAS implementation was not associated with higher rates of overall complications, emergency department visits, or hospital readmissions within 30 days. Although the adjusted analysis demonstrated an increased likelihood of reoperation within 30 days, the absolute number of reoperations remained very low, and the authors emphasized that the retrospective design, heterogeneous patient population, and limited event rate precluded establishing a causal relationship between ERAS implementation and this outcome [17].

Evidence supporting ERAS in pediatric colorectal surgery has been strengthened by a recent meta-analysis including 10 studies and 1,298 patients [18]. Compared with conventional perioperative care, ERAS protocols significantly accelerated several indicators of postoperative recovery, including earlier return of bowel function, shorter time to first enteral feeding, and earlier oral intake. Patients managed according to ERAS pathways also required less postoperative opioid analgesia and received lower volumes of intraoperative intravenous fluids. Furthermore, ERAS was associated with a reduction in hospital length of stay, lower healthcare costs, and a lower 30-day readmission rate. Notably, no significant increase in overall postoperative complications was observed. However, sensitivity analysis demonstrated that the apparent reduction in readmission rates was not robust after exclusion of one study,

while power analysis indicated insufficient statistical power for both readmission and complication outcomes. Consequently, these findings should be interpreted cautiously, highlighting the need for larger prospective studies [18].

Additional evidence comes from a prospective study evaluating ERAS implementation across pediatric gastrointestinal procedures, including transabdominal Soave procedures. Children treated within the ERAS pathway experienced significantly faster gastrointestinal recovery, with earlier first flatus, first bowel movement, initiation of oral feeding, removal of gastric tubes and urinary catheters, and shorter postoperative intravenous nutrition compared with conventional care [4]. These improvements translated into a substantially shorter postoperative hospital stay (4.8 vs. 7.7 days) and lower hospitalization costs without increasing postoperative complications [4]. These benefits were attributed to the combined effects of early feeding, optimized fluid therapy, reduced use of tubes and drains, opioid-sparing analgesia, and mobilization [4].

3.3. Role of ERAS in Early Mobilization and Postoperative Recovery

3.3.1. Principles and Mechanisms of Pediatric ERAS

Enhanced Recovery After Surgery (ERAS) is a multidisciplinary, evidence-based perioperative care pathway designed to optimize recovery through the coordinated implementation of multiple interventions across the preoperative, intraoperative, and postoperative periods [5,6,8]. Unlike traditional approaches focused primarily on the surgical procedure itself, ERAS emphasizes the standardization of perioperative care, integration of best available evidence into clinical practice, and active collaboration among surgeons, anesthesiologists, nurses, allied healthcare professionals, patients, and their families [5,8]. The underlying principle of ERAS is that combining several evidence-based interventions produces synergistic effects that are greater than those achieved by any single measure alone, thereby reducing the physiological stress response to surgery and promoting faster functional recovery [5]. Core components of pediatric ERAS pathways include preoperative education and family engagement, minimization of fasting, minimally invasive surgical techniques whenever feasible, multimodal opioid-sparing analgesia, optimized fluid management, avoidance or early removal of tubes and drains, early enteral nutrition, and early postoperative mobilization [5,6,8]. Although these principles were originally established in adult colorectal surgery, increasing efforts have focused on adapting ERAS pathways to pediatric populations. Such adaptation is necessary

because children, particularly neonates, differ substantially from adults with regard to physiology, nutritional requirements, developmental stage, communication abilities, and dependence on caregivers. Consequently, pediatric ERAS pathways incorporate child-specific and family-centered elements while maintaining the central objective of accelerating recovery through standardized, evidence-based perioperative care [5,6,8].

Effective multimodal analgesia minimizes postoperative pain while reducing opioid-related adverse effects, facilitating earlier mobilization and recovery. Optimized fluid therapy helps maintain physiological homeostasis without fluid overload, whereas early enteral nutrition supports gastrointestinal function, limits postoperative catabolism, and enables faster progression to a normal diet [4,5]. In addition, minimizing the use of nasogastric tubes, urinary catheters, and surgical drains reduces discomfort and removes barriers to early ambulation. Together, these interventions promote restoration of bowel function, prevent physical deconditioning associated with prolonged bed rest, and facilitate an earlier return to functional independence [4,5]. Evidence from pediatric intensive care settings further suggests that structured early mobility programmes can safely improve functional recovery, with children achieving independent ambulation sooner following major abdominal procedures such as liver transplantation [10].

3.3.2. Clinical Benefits of ERAS

Clinical evidence indicates that ERAS pathways improve several short-term postoperative outcomes in pediatric abdominal surgery. A systematic review and meta-analysis of 16 studies involving 1,723 children found that ERAS reduced the time to initiation of enteral feeding by approximately 21 hours, shortened the time to full enteral nutrition by 2.2 days, decreased postoperative opioid requirements, and reduced hospital stay by 2.54 days without increasing overall complication or readmission rates [7]. Similar benefits were reported in pediatric colorectal surgery, where ERAS was associated with earlier return of bowel function and oral intake, lower opioid and intravenous fluid use, shorter hospitalization, and reduced in-hospital costs [18]. In a broader meta-analysis of abdominal procedures, ERAS shortened hospital stay and accelerated oral intake and bowel recovery, while also being associated with lower postoperative complication and 30-day readmission rates [9]. However, these safety findings are not entirely uniform. In a single-center colorectal cohort, ERAS reduced opioid use, intravenous fluid administration, urinary catheter duration, and postoperative length of stay, but was associated with higher adjusted odds of reoperation within 30 days, although the

absolute number of reoperations was small and no differences were observed in overall complications, emergency department visits, or readmissions [17]. Overall, the available evidence supports ERAS as an effective strategy for accelerating early postoperative recovery while maintaining an acceptable safety profile. In addition to improving recovery parameters, ERAS implementation has also been associated with a reduction in postoperative surgical site infections in pediatric surgical patients [19]. Nevertheless, the heterogeneity and predominantly retrospective design of existing studies warrant cautious interpretation of less frequent safety outcomes [7,9,17,18].

3.3.3. ERAS Across Different Pediatric Procedures

ERAS principles have been applied across a broad spectrum of pediatric abdominal surgery, ranging from appendectomy in older children to complex neonatal intestinal procedures. In pediatric appendectomy, the use of enhanced recovery concepts, including early oral intake and mobilization, was associated with a shorter hospital stay without significant differences in readmissions, reoperations, or emergency department visits [14]. In neonates with congenital upper gastrointestinal obstruction, an adapted ERAS pathway incorporating parental involvement, thermal management, regional analgesia, and passive early activity promoted earlier feeding and bowel recovery and reduced the duration of parenteral nutrition and hospitalization [20]. The development of an internationally endorsed ERAS guideline for neonatal intestinal surgery further demonstrates that these principles can be adapted to the physiological and developmental needs of even the youngest surgical patients [8].

3.3.4. Limitations and Future Directions

Interpretation of the available evidence is limited by the predominance of retrospective designs, heterogeneous patient populations, and substantial variation in ERAS protocol composition. Because most studies assess entire care pathways, the independent contribution of early mobilization remains uncertain [5,7,8,9,18].

4. Discussion

The available evidence indicates that early mobilization should be considered within a broader, multimodal approach to postoperative recovery. Pediatric ERAS pathways appear feasible and promote faster recovery through coordinated measures such as early oral feeding, multimodal analgesia, and avoidance of unnecessary postoperative interventions, without a consistent increase in postoperative complications [4,5,6,7,9,14].

These findings also suggest that early mobilization should not be viewed solely as an inpatient intervention but rather as the first stage of a gradual return to normal physical activity. Although the reviewed studies rarely evaluated return to sport directly, improved postoperative recovery may facilitate an earlier return to age-appropriate daily activities when clinically appropriate.

As restoration of normal mobility is a fundamental component of functional recovery, postoperative recovery strategies should aim not only to reduce hospital stay but also to facilitate a safe return to everyday physical activity [4,6,14].

The available evidence has important implications for postoperative activity recommendations in pediatric surgery. Current practice remains highly variable, with activity restrictions often based on surgeon preference and clinical experience rather than robust evidence. Recent prospective data suggest that allowing children and their families to guide the timing of return to normal activities may be safe following routine procedures, without increasing postoperative complications, while also reducing the psychosocial burden associated with prolonged restrictions [3]. Furthermore, procedure-specific recovery data indicate that evidence-based preoperative counselling can provide more realistic expectations regarding return to school, pain management, and functional recovery, thereby supporting individualized postoperative recommendations and improving communication between healthcare providers and families [3,13].

Despite the encouraging results reported across the available studies, several important limitations remain. Most evidence focuses on short-term perioperative outcomes, such as hospital stay, gastrointestinal recovery, or early postoperative complications, whereas data on return to sport, long-term physical function, and quality of life remain limited [18]. Although long-term follow-up studies have identified persistent differences in motor function and health-related quality of life in selected pediatric surgical populations, the clinical significance of these findings remains uncertain and requires further investigation [21]. Future research should prioritize well-designed prospective, multicenter studies evaluating standardized postoperative activity recommendations and long-term functional outcomes to support the development of evidence-based guidelines for return to physical activity after pediatric abdominal surgery [8,18].

5. Conclusions

Early mobilization is an important component of postoperative recovery following common pediatric abdominal surgery, particularly when incorporated into comprehensive, multimodal ERAS pathways. Available evidence indicates that such pathways can accelerate gastrointestinal recovery, reduce opioid requirements, shorten hospital stay, and support an earlier return to normal daily functioning without a consistent increase in postoperative complications. However, early mobilization should not be considered an isolated intervention, as its benefits are closely linked to coordinated perioperative measures, including effective analgesia, early enteral nutrition, optimized fluid management, and timely removal of tubes and catheters.

Despite favourable short-term outcomes, evidence concerning the optimal timing of return to unrestricted physical activity and sport remains limited and procedure-specific recommendations are still lacking. Current data support an individualized, symptom-guided approach to postoperative activity after routine procedures, while ERAS protocols appear beneficial in promoting recovery after more complex operations [3,18]. Further prospective, multicentre studies are required to establish standardized recommendations for safe return to physical activity and to evaluate long-term functional outcomes in pediatric surgical patients.

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