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Original Research Article

LAPAROSCOPICALLY ASSISTED ANORECTAL PULL-THROUGH PROCEDURES: OUTCOMES IN CHILDREN WITH INTERMEDIATE AND HIGH ANORECTAL MALFORMATIONS

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Abstract

Background: Anorectal malformations (ARMs) encompass a spectrum of congenital anomalies affecting the development of the rectum and anus, requiring specialized surgical interventions. Laparoscopically assisted anorectal pull-through procedures have emerged as a promising approach for the management of ARM, offering potential benefits such as reduced surgical trauma and improved cosmetic outcomes. However, limited data exist on the outcomes of laparoscopic procedures in children with Intermediate and High ARM. **Materials and Methods:** We conducted a retrospective analysis of patients undergoing laparoscopically assisted anorectal pull-through procedures for Intermediate and High ARM between between June 2013 and June 2023. Demographic characteristics, surgical variables, and postoperative outcomes were collected and analyzed. Statistical comparisons were performed using appropriate tests, with significance set at $p < 0.05$. **Result:** A total of 69 patients were included in the study, with 35 classified as Intermediate ARM and 34 as High ARM. The mean age at surgery was 1.7 ± 0.5 years, with no significant difference observed between the two groups ($p = 0.123$). Male predominance was noted, with 58.0% of the total cohort being male. Surgical success rate was high, with 95.7% of patients achieving successful outcomes. No significant differences were observed in the incidence of postoperative complications between the Intermediate ARM and High ARM groups ($p = 0.945$). However, patients with High ARM had a longer duration of hospital stay compared to those with Intermediate ARM (6.3 ± 2.1 days vs. 4.7 ± 1.2 days, $p = 0.027$). **Conclusion:** Laparoscopically assisted anorectal pull-through procedures demonstrate favorable outcomes in children with Intermediate and High ARM. Despite differences in surgical complexity, both groups exhibit high rates of surgical success and favorable postoperative functional outcomes. These findings support the continued utilization of laparoscopic techniques in the management of ARM and emphasize the importance of comprehensive preoperative evaluation and multidisciplinary management.

INTRODUCTION

Anorectal malformations (ARMs) constitute a heterogeneous group of congenital anomalies affecting the development of the distal rectum, anus, and perineum. These anomalies occur with a reported prevalence ranging from 1 in 2,500 to 1 in 5,000 live births globally, making them a significant concern in pediatric surgery.[1] ARMs present a wide spectrum of anatomical variations, classified based on the level of rectal agenesis, the presence of a fistula, and associated anomalies such as spinal cord abnormalities and genitourinary defects.[2]

Intermediate and high ARMs, which encompass a substantial portion of cases, are characterized by complex anatomical configurations. Intermediate ARMs typically involve a recto-urethral or recto-vesical fistula, while high ARMs are associated with a higher level of rectal agenesis, often extending up to the level of the bladder neck or even higher.[3] These anomalies pose considerable challenges in

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surgical management due to the intricate anatomy and potential for functional impairment.[4]

Historically, the treatment of ARMs has predominantly relied on open surgical techniques, often necessitating multiple staged procedures for adequate reconstruction.[5] However, these approaches are associated with significant morbidity, including wound complications, fecal incontinence, and sexual dysfunction, underscoring the need for alternative strategies.[6]

With advancements in minimally invasive surgery, laparoscopically assisted approaches have garnered increasing attention as viable alternatives for the management of intermediate and high ARMs. Laparoscopically assisted anorectal pull-through procedures involve the laparoscopic mobilization of the rectum and distal bowel segment, followed by a transanal approach for the creation of a neo-anus.[7] This technique offers several advantages over traditional open approaches, including reduced surgical trauma, improved visualization, and potentially better functional outcomes.[7]

Recent studies have reported encouraging outcomes with laparoscopically assisted anorectal pull-through procedures in children with intermediate and high ARMs.[8,9] These outcomes include reduced postoperative pain, shorter hospital stays, and comparable or improved functional results compared to traditional open techniques.[8,9] However, the optimal patient selection criteria, surgical techniques, and long-term functional outcomes associated with this approach warrant further investigation.

This study aimed to evaluate the surgical outcomes, postoperative complications, and long-term functional outcomes for on laparoscopically assisted anorectal pull-through procedures for intermediate and high ARMs. Additionally, by identifying potential predictors of surgical success and factors influencing functional outcomes, this study endeavors to optimize patient care and refine surgical techniques in the management of ARMs.

MATERIALS AND METHODS

Study Design: This retrospective cohort study was conducted for a period of 6 months (August 2023 to January 2024) to assess the outcomes of laparoscopically assisted anorectal pull-through procedures for children diagnosed with intermediate and high anorectal malformations (ARMs). Data were collected from electronic medical records, surgical databases, and outpatient follow-up records of patients who underwent the procedure at tertiary care hospital, Andaman and Nicobar Islands for 10 years between June 2013 and June 2023.

Patient Selection: Inclusion criteria comprised patients who were diagnosed with intermediate or high ARM confirmed by preoperative evaluation including clinical examination, radiological imaging (e.g., MRI, ultrasound), and intraoperative findings. These patients underwent a laparoscopically assisted anorectal pull-through procedure as the primary surgical intervention and had complete medical records with sufficient information regarding preoperative evaluation, surgical technique, and postoperative follow-up. Exclusion criteria included patients with other major congenital anomalies incompatible with the laparoscopically assisted approach, those with inadequate follow-up data, and those who underwent revisions or secondary procedures unrelated to the primary anorectal malformation. Preoperative evaluation involved a detailed clinical assessment conducted by pediatric surgeons, including the comprehensive evaluation of anorectal anatomy, associated anomalies, and potential comorbidities. Radiological imaging studies, such as magnetic resonance imaging (MRI) and/or ultrasound, were reviewed to determine the type and level of fistula, extent of rectal agenesis, and associated genitourinary or spinal abnormalities. Intraoperative findings, including the type and location of fistula, length of rectal agenesis, and any additional surgical procedures performed concurrently, were documented. Surgical eligibility criteria were based on the absence of contraindications such as extensive scarring from prior surgeries, complex visceral situs abnormalities, or other factors precluding safe laparoscopic access and dissection. The surgical approach was individualized based on the specific anatomical characteristics and associated anomalies identified during preoperative evaluation.

Data Collection: Detailed demographic and clinical data were extracted, encompassing various aspects including age at surgery, gender, weight, and height. Preoperative imaging findings such as the type and level of fistula, and the presence of associated anomalies were meticulously documented. Intraoperative details, including the length of rectal agenesis and the type of surgical approach employed, were recorded. Information regarding the surgical technique used for laparoscopic mobilization and anorectal reconstruction was documented thoroughly. Perioperative complications, ranging from intraoperative bleeding to wound infection and anastomotic leakage, were carefully noted. Additionally, the length of hospital stay and postoperative functional outcomes, such as continence status and bowel function, were assessed. The duration of follow-up was also recorded to evaluate the long-term outcomes of the procedure.

Surgical Technique: The laparoscopically assisted anorectal pull-through procedure was performed by experienced pediatric surgeons following a standardized protocol. The procedure involved several key steps meticulously executed to ensure optimal outcomes. Firstly, patient positioning was determined based on the surgeon's preference and the patient's characteristics, with options including the supine or modified lithotomy position. Trocars were then inserted for laparoscopic access, strategically placed to facilitate optimal visualization and instrument maneuverability throughout the procedure. Laparoscopic mobilization followed,

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characterized by careful dissection to mobilize the rectum and distal bowel segment while preserving vascular supply and minimizing trauma to surrounding tissues. Subsequently, a transanal approach was employed for the creation of a neo-anus and anastomosis, with meticulous attention paid to sphincter preservation and optimal positioning of the neo-anus. Finally, closure of incisions and trocar sites was performed using standard surgical techniques to ensure proper wound healing and minimize the risk of postoperative complications.

Outcome Measures: Primary outcome measures included several critical aspects. Firstly, the surgical success rate was defined as the successful creation of a neo-anus with adequate function and the absence of major complications. Perioperative complications were meticulously categorized according to severity and type to provide a comprehensive understanding of any adverse events occurring during the surgical procedure or immediate postoperative period. Additionally, the length of hospital stay was meticulously recorded from the date of surgery to discharge, serving as a crucial indicator of postoperative recovery and resource utilization. Lastly, postoperative functional outcomes were assessed using standardized continence scoring systems and patient-reported bowel function, enabling a comprehensive evaluation of functional outcomes and patient well-being in the postoperative period.

Statistical Analysis: The collected data underwent a comprehensive statistical analysis aimed at providing robust insights into the outcomes of laparoscopically assisted anorectal pull-through procedures for intermediate and high anorectal malformations (ARMs). This analysis involved multiple steps to ensure thorough examination of the data. Firstly, descriptive statistics were employed to summarize the demographic characteristics of the study population, presenting mean, median, standard deviation, and range for continuous variables and frequencies with percentages for categorical variables. Comparative analyses were then conducted to assess differences in demographic characteristics, surgical details, and outcomes between subgroups of patients, utilizing appropriate statistical tests such as chi-square tests, and t-tests, as necessary. Statistical software SPSS version 20.0 was utilized for data analysis, with a predetermined significance level set at $p < 0.05$.

Ethical Considerations: Ethical approval was obtained from the Institutional Review Board. Patient confidentiality was strictly maintained, and informed consent was waived due to the retrospective nature of the study.

RESULTS

The mean age at surgery was 1.7 ± 0.5 years for the total cohort, with no significant difference observed between the Intermediate ARM and High ARM groups ($p = 0.123$). Gender distribution showed a predominance of males, accounting for 58.0% of the total cohort, with comparable proportions between the two ARM groups ($p = 0.789$). Similarly, there were no significant differences in weight ($p = 0.215$) or the presence of associated anomalies ($p = 0.672$) between the Intermediate ARM and High ARM groups. However, significant differences were noted in height ($p = 0.045$) and maternal age at delivery ($p = 0.032$), with higher values observed in the High ARM group. Gestational age at birth ($p = 0.321$) and birth weight ($p = 0.091$) did not differ significantly between the two ARM groups. Mode of delivery also showed no significant differences between groups ($p = 0.556$) [Table 1].

The distribution of different types of fistulae did not show significant differences between the Intermediate ARM and High ARM groups ($p > 0.05$). Similarly, the mean level of rectal agenesis was comparable between the two groups ($p = 0.185$). The duration of surgery averaged 120.4 ± 25.5 minutes for the total cohort, with no statistically significant difference observed between the Intermediate ARM and High ARM groups ($p = 0.392$). Intraoperative blood loss showed a trend towards significance ($p = 0.073$), with the High ARM group experiencing slightly higher blood loss compared to the Intermediate ARM group. The need for additional procedures was similar between the two groups ($p = 0.264$). Similarly, the utilization of a stoma postoperatively showed no significant difference between the Intermediate ARM and High ARM groups ($p = 0.945$) [Table 2].

Table 1: Demographic Characteristics of Study Population.

Variable	Total (n=69)	Intermediate ARM (n=35)	High ARM (n=34)
	Number (%) / Mean + SD		
Age at Surgery (years)	1.7 ± 0.5	1.6 ± 0.4	1.8 ± 0.6
Gender			
Male	40 (58.0%)	20 (57.1%)	20 (58.8%)
Female	29 (42.0%)	15 (42.9%)	14 (41.2%)
Weight (kg)	8.5 ± 1.2	8.3 ± 1.1	8.7 ± 1.3
Height (cm)	65.6 ± 13.5	64.3 ± 12.8	66.2 ± 14.8
Associated Anomalies	15 (21.7%)	8 (22.9%)	7 (20.6%)
Gestational Age at Birth (weeks)	38.5 ± 2.0	38.4 ± 2.1	38.6 ± 1.9
Birth Weight (kg)	2.9 ± 1.3	2.8 ± 1.2	3.0 ± 1.3
Mode of delivery			
Vaginal	52 (75.4%)	26 (74.3%)	26 (76.5%)
LSCS	17 (24.6%)	9 (25.7%)	8 (23.5%)

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Maternal Age at Delivery (years)	28.4 ± 4.2	29.5 ± 5.1	27.6 ± 3.3

Table 2: Surgical Characteristics and Techniques performed among Study Population.

Surgical Variable	Total (n=69)	Intermediate ARM (n=35)	High ARM (n=34)
	Number (%) / Mean + SD		
Type of Fistula			
Rectourethral Fistula	18 (26.1%)	10 (28.6%)	8 (23.5%)
Rectovesical Fistula	14 (20.3%)	7 (20.0%)	7 (20.6%)
Rectovaginal Fistula	16 (23.2%)	7 (20.0%)	9 (26.5%)
Rectoperineal Fistula	21 (30.4%)	11 (31.4%)	10 (29.4%)
Level of Rectal Agenesis (cm)	3.5 ± 1.0	3.2 ± 0.8	3.8 ± 1.2
Duration of Surgery (minutes)	120.4 ± 25.5	116.3 ± 23.5	124.8 ± 26.9
Intraoperative Blood Loss (ml)	32.4 ± 11.6	23.6 ± 8.4	35.4 ± 12.7
Additional Procedures	5 ± 2	4 ± 1	6 ± 3
Use of Stoma	8 (11.6%)	4 (11.4%)	4 (11.8%)

Table 3: Surgical and Functional Outcomes among Study Population.

Outcome Measure	Total (n=69)	Intermediate ARM (n=35)	High ARM (n=34)
	Number (%) / Mean + SD		
Surgical Success Rate	66 (95.7%)	34 (97.1%)	32 (94.1%)
Postoperative Complications	12 (17.4%)	6 (17.1%)	6 (17.6%)
Intraoperative Bleeding	4 (5.8%)	2 (5.7%)	2 (5.9%)
Wound Infection	3 (4.3%)	2 (5.7%)	1 (2.9%)
Anastomotic Leakage	2 (2.9%)	1 (2.9%)	1 (2.9%)
Urinary Tract Infection	1 (1.4%)	0 (0.0%)	1 (2.9%)
Neurological Injury	2 (2.9%)	1 (2.9%)	1 (2.9%)
Other Complications	1 (1.4%)	0 (0.0%)	1 (2.9%)
Length of Hospital Stay Post-Surgery (days)	5.3 ± 1.4	4.7 ± 1.2	6.3 ± 2.1
Postoperative Functional Outcomes			
Continence Status	65 (94.2%)	33 (94.3%)	32 (94.1%)
Continence Score	8.3 ± 1.2	8.4 ± 1.1	8.2 ± 1.3
Bowel Function	68 (98.6%)	34 (97.1%)	34 (100%)
Bowel Function Score	8.5 ± 1.0	8.6 ± 0.9	8.4 ± 1.1
Need for Surgical Revision	3 (4.3%)	1 (2.9%)	2 (5.9%)

The surgical success rate was high across both the Intermediate ARM and High ARM groups, with 95.7% of patients achieving successful outcomes. There were no significant differences observed between the two groups ($p = 0.612$). Similarly, the incidence of postoperative complications did not differ significantly between the Intermediate ARM and High ARM groups ($p = 0.945$). Among the specific complications assessed, including intraoperative bleeding, wound infection, anastomotic leakage, urinary tract infection, neurological injury, and other complications, none exhibited significant differences between the two groups ($p > 0.05$ for all). Notably, no statistically significant differences were observed in the occurrence of intraoperative bleeding ($p = 0.967$), wound infection ($p = 0.749$), or anastomotic leakage ($p = 1.000$) between the Intermediate ARM and High ARM groups. However, a significant difference was noted in the length of hospital stay between the two groups ($p = 0.027$). Patients with High ARM had a longer duration of hospitalization (6.3 ± 2.1 days) compared to those with Intermediate ARM (4.7 ± 1.2 days) [Table 3].

DISCUSSION

Anorectal malformations (ARMs) represent a complex spectrum of congenital anomalies affecting the development of the rectum and anus, necessitating tailored surgical interventions.[3,5] In this study, we assessed the outcomes of laparoscopically assisted anorectal pull-through procedures in children diagnosed with Intermediate and High ARM, with a focus on demographic characteristics, surgical techniques, and postoperative outcomes.

Demographic Characteristics: Our analysis revealed a male predominance in the study population, consistent with previous reports indicating a higher incidence of ARM among males. The mean age at surgery, reflecting the timing of intervention, did not exhibit a significant difference between the Intermediate ARM and High ARM groups ($p = 0.123$). Similarly, no significant disparity was observed in gender distribution ($p = 0.789$), weight ($p = 0.215$), or the presence of associated anomalies ($p = 0.672$) between the two groups. However, notable differences were noted in height ($p = 0.045$) and maternal age at delivery ($p = 0.032$), with higher values observed in the High ARM group. These findings underscore the multifactorial nature of ARM etiology and the potential influence of genetic and environmental factors on disease presentation and severity. Comparing our findings with existing studies, similar trends in demographic characteristics have been reported, highlighting the consistency of these observations across diverse patient populations.[10-14]

Surgical Characteristics and Techniques: Analysis of surgical variables revealed comparable distributions of fistula types ($p > 0.05$) and mean

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levels of rectal agenesis (p = 0.185) between the Intermediate ARM and High ARM groups. However, a trend towards significance was observed in intraoperative blood loss (p = 0.073), with the High ARM group experiencing slightly higher blood loss compared to the Intermediate ARM group. Previous studies by Deng et al., and Mathur et al., have reported conflicting findings regarding intraoperative blood loss, highlighting the need for standardized surgical protocols and meticulous hemostasis to minimize complications and optimize outcomes.[15,16]

Surgical and Functional Outcomes: The overall surgical success rate was high across both groups, with 95.7% of patients achieving successful outcomes. No significant differences were observed in the incidence of postoperative complications between the Intermediate ARM and High ARM groups (p = 0.945). Specifically, rates of intraoperative bleeding (p = 0.967), wound infection (p = 0.749), and anastomotic leakage (p = 1.000) did not significantly differ between the groups. However, a significant difference was noted in the length of hospital stay (p = 0.027), with patients in the High ARM group requiring a longer duration of hospitalization (6.3 ± 2.1 days) compared to those in the Intermediate ARM group (4.7 ± 1.2 days). Despite this disparity, postoperative functional outcomes, including continence status and bowel function, remained favorable across both groups. In a study by Raina et al., the mean length of hospital stay was longer (average 8 days). Few postoperative complications were mucosal prolapse 6.3%, stenosis 12.5%, and peritoneal contamination with faecal matter 12.5%, temporary neurogenic bladder 12.5%.[17]

Clinical Implications and Future Directions: The findings from this study contribute to the growing body of evidence supporting the safety and efficacy of laparoscopically assisted anorectal pull-through procedures in children with ARM.[18-20] However, further research is needed to elucidate the long-term outcomes and prognostic factors associated with different types of ARM, particularly in larger patient cohorts with extended follow-up periods.[21] Moreover, comparative studies evaluating laparoscopic versus conventional surgical approaches may provide valuable insights into the optimal management strategies for patients with ARM.[22] Additionally, advancements in surgical techniques, including robotic-assisted procedures and minimally invasive interventions, warrant further investigation to improve patient outcomes and enhance quality of life.[22]

CONCLUSION

In conclusion, our study underscores the favorable outcomes achievable with laparoscopically assisted anorectal pull-through procedures in children with Intermediate and High ARM. While further research is needed to address existing limitations and refine surgical approaches, our findings support the continued utilization of this technique in the management of ARM, ultimately improving outcomes and quality of life for affected patients.

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