Impact of appendectomy with Ladd procedure for midgut volvulus

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Abstract

Purpose: The Ladd procedure is the standard surgical technique for midgut volvulus with which a concurrent appendectomy is often performed to prevent diagnostic errors of appendicitis later in life. However, its effect on the Ladd procedure remains unclear. Here we assessed the impact of concurrent appendectomy on the Ladd procedure.

Methods: The medical records of patients who underwent surgery for midgut volvulus with malrotation in 2000–2020 were reviewed. The patients were divided into groups with or without appendectomy for comparison of their characteristics and surgical outcomes.

Results: Seventy patients were evaluated, among whom appendectomy was performed in eight by surgeon preference. Patient characteristics, operative time, blood loss, length of hospital stay, and volvulus recurrence rate did not differ significantly between groups. There were no cases of appendicitis. Bowel obstruction occurred in four cases (50%) in the appendectomy group (one required surgical intervention) versus six cases (9.7%) in the without appendectomy group ($p<0.05$).

Conclusion: In our study, bowel obstruction was more common among patients who underwent appendectomy with the Ladd procedure, suggesting that concomitant appendectomy might increase the risk of postoperative bowel obstruction due to unnecessary adhesions requiring surgical intervention.

Introduction

Midgut volvulus with malrotation in neonates or infants is a surgical emergency [1] for which the Ladd procedure is the standard surgical technique [2]. In some institutions, a prophylactic appendectomy can be performed concurrently with the Ladd procedure to prevent diagnostic errors of acute appendicitis later in life [3]. However, recent studies have reported that the appendix plays an important role in maintaining the gut microbiota [4] and mucosal immunity [5] with an increased incidence of many diseases such as inflammatory bowel disease and colorectal cancer in patients after appendectomy [6]. The incidence of appendicitis after the Ladd procedure is unknown, and it remains uncertain whether the benefits of concurrent appendectomy with the Ladd procedure outweigh its disadvantages. Thus, this study aimed to assess the postoperative impact of appendectomy performed during the Ladd procedure.

Methods

A retrospective review was performed of the medical records of patients who underwent surgery for midgut volvulus with malrotation at our hospital in 2000–2020. This retrospective observational study was approved by the research ethics committee of Saitama Children's Medical Center, which waived the requirement for written informed consent due to its retrospective design. Data regarding patient characteristics such as sex, gestational age, birth weight, age and weight at surgery, number of patients with concomitant congenital disease, and postoperative follow-up period were collected. Surgical outcomes including operative time; blood loss; postoperative hospital stay duration; and number of

patients with recurrent midgut volvulus, appendicitis, or bowel obstruction were also recorded. The patients were divided into two groups based on whether they underwent the Ladd procedure with or without appendectomy, and their characteristics and surgical outcomes were compared.

At our institution, the Ladd procedure was performed via laparotomy with a right upper quadrant transverse incision in all cases. The appendectomies were performed according to surgeon preference. Bowel fixation was not routinely performed.

All statistical analyses were performed using EZR software version 1.54 (Saitama Medical Center, Jichi Medical University, Saitama, Japan), which is based on R statistical software (The R Foundation for Statistical Computing, Vienna, Austria) and R Commander [7]. The categorical univariate analysis was performed using Fisher's exact test, while the continuous variable analysis was performed using the Mann–Whitney U test. Continuous variables are expressed as median and interquartile range, while categorical variables are expressed as count and percentage. Statistical significance was set at $P < 0.05$.

Results

During the study period, 70 cases were evaluated; among them, eight appendectomies were performed (three normal and four inversion appendectomies and one unclear case). The age at surgery in all cases was 0–14 years. Patient characteristics are shown in Table 1. There were no significant intergroup differences in sex, gestational age, birth weight, age and weight at surgery, number of patients with concomitant congenital diseases, or follow-up period. The surgical outcomes are summarized in Table 2. There were no significant intergroup differences in operative time, blood loss, postoperative hospital stay, or number of patients with recurrent midgut volvulus. Appendicitis did not occur in any of the assessed cases. A bowel obstruction occurred in four patients in the appendectomy group, one of whom underwent ileocecal resection for a strangulated bowel obstruction due to adhesion between the terminal ileum and the abdominal wall. Bowel obstruction occurred in six patients in the without appendectomy group; therefore, the rate of bowel obstruction was significantly higher in the former than in the latter group (50% vs. 9.6%, respectively; $p<0.05$).

Table 1

Patient characteristics

Characteristics		Without appendectomy (n=62)	With appendectomy (n=8)	P value
Sex				
	Male	36 (58.1%)	6 (75.0%)	0.46
	Female	26 (41.9%)	2 (25.0%)	
Gestational age, weeks				
	<37	5 (8.1%)	0	1
	37-42	56 (90.3%)	8 (100%)	
	>42	1 (1.6%)	0	
Birth weight, g		2983 [2698-3234]	3015 [2763-3224]	0.88
Age at surgery, days		6 [3-19]	3 [5.5-19.25]	0.79
Weight at surgery, g		2904 [2588-3279]	2750 [2743-3186]	0.68
Patients with concomitant congenital disease		9 (14.5%)	1 (12.5%)	1
Follow-up period, months		46 [14-74]	80 [56-64]	0.13

Continuous valuables are showed with median and interquartile range.

Table 2

Surgical outcomes

Outcome	Without appendectomy (n=62)	With appendectomy (n=8)	P value
Operative time, min	50 [47.0-70.8]	63.5 [62.3-73.8]	0.31
Blood loss, g	4 [0-9]	12.5 [6-15.5]	0.13
Postoperative hospital stay, days	13 [10-24.8]	18 [13-22.8]	0.39
Recurrent midgut volvulus	7 (11.3%)	0	1
Appendicitis	0	0	1
Bowel obstruction	6 (9.8%)	4 (50%)	0.01

Continuous valuables are showed with median and interquartile range.

Discussion

Midgut volvulus with malrotation remains a surgical emergency in neonates and infants and requires immediate surgical intervention [1]. The Ladd procedure is the gold standard surgical technique for midgut volvulus as described by William Ladd in 1936 [2]. The Ladd procedure involves reducing the volvulus by rotating the bowel in a counterclockwise direction, dividing the mesenteric (Ladd) bands, placing the small bowel in the right abdomen and the large bowel in the left abdomen, and performing an appendectomy. An appendectomy is performed to circumvent the diagnostic error of acute appendicitis later in life since it would otherwise be relocated to the left upper quadrant in patients with malrotation [3]. However, the safety and efficacy of appendectomy in the Ladd procedure remain controversial. An appendectomy for midgut volvulus with malrotation is incidental; that is, the appendix is removed during non-appendiceal surgery [8]. As incidental appendectomy has advantages and disadvantages, a single standard management approach is lacking.

The appendix was recently suggested to play an important role in maintaining and replenishing the microbiota of the colon after a diarrhea episode [4]. Moreover, the appendix consists of lymphoid tissue resembling Peyer's patches and is the primary site of immunoglobulin A production [5]. Moreover, appendectomy may be associated with a higher risk of ulcerative colitis, Crohn's disease, *Clostridium difficile* infection, and colorectal cancer [6].

Previous studies indicated that incidental appendectomy may be associated with morbidity [9, 10]. In our cases, bowel obstruction was more likely to occur in patients who underwent appendectomy using the Ladd procedure. In one case, adhesion between the terminal ileum and the abdominal wall caused a

strangulated bowel obstruction that required ileocecal resection. Therefore, appendectomy with the Ladd procedure may cause unnecessary adhesions that induce postoperative bowel obstruction requiring surgical intervention.

There are some limitations to our study. First, it was a single-center, retrospective, observational study with a small sample size. No cases of appendicitis were confirmed in either group. Appendicitis most commonly occurs in the second decade of life, and fewer than 5% of patients diagnosed with it are 5 years of age or younger [11]. The median follow-up period after the Ladd procedure in this study was 80 and 46 months in the appendectomy and non-appendectomy groups, respectively. Therefore, a longer follow-up period might be required to confirm the rate of bowel obstruction after the Ladd procedure.

In conclusion, our findings suggest that concomitant appendectomy with the Ladd procedure increases the risk of postoperative bowel obstruction.

Declarations

Acknowledgments:

None

References

1. Lee HC, Pickard SS, Sridhar S, Dutta S (2012) Intestinal malrotation and catastrophic volvulus in infancy. J Emerg Med 43:e49–e51. https://doi.org/10.1016/j.jemermed.2011.06.135
2. Ladd WE (1936) Surgical diseases of the alimentary tract in infants. N Engl J Med 215:705–708.https://doi.org/10.1056/NEJM193610152151604
3. Badea R, Al Hajjar N, Andreica V, et al (2012) Appendicitis associated with intestinal malrotation: Imaging diagnosis features. Case report. Med Ultrason 14:164–167
4. Babakhanov AT, Dzhumabekov AT, Zhao AV, et al (2021) Impact of appendectomy on gut microbiota. Surg Infect (Larchmt) 22:651–661.https://doi.org/10.1089/sur.2020.422
5. Girard-Madoux MJH, Gomez de Agüero M, Ganal-Vonarburg SC, et al (2018) The immunological functions of the appendix: An example of redundancy? Semin Immunol 36:31–44.https://doi.org/10.1016/j.smim.2018.02.005
6. Lee S, Jang EJ, Jo J, et al (2021) Long-term impacts of appendectomy associated with increased incidence of inflammatory bowel disease, infection, and colorectal cancer. Int J Colorectal Dis 36:1643–1652.https://doi.org/10.1007/s00384-021-03886-x
7. Kanda Y (2013) Investigation of the freely available easy-to-use software 'EZR' for medical statistics. Bone Marrow Transplant 48:452–458.https://doi.org/10.1038/bmt.2012.244
8. Healy JM, Olgun LF, Hittelman AB, et al (2016) Pediatric incidental appendectomy: A systematic review. Pediatr Surg Int 32:321–335.https://doi.org/10.1007/s00383-015-3839-0

9. Andrew MH, Roty AR Jr (1987) Incidental appendectomy with cholecystectomy: Is the increased risk justified? Am Surg 53:553–557
10. Warren JL, Penberthy LT, Addiss DG, et al (1993) Appendectomy incidental to cholecystectomy among elderly Medicare beneficiaries. Surg Gynecol Obstet 177:288–294
11. Graham JM, Pokorny WJ, Harberg FJ (1980) Acute appendicitis in preschool age children. Am J Surg 139:247–250.https://doi.org/10.1016/0002-9610(80)90265-2