Incidence of Infection-related Complications and Optimal Saline Irrigation Volume for Preoperative Bowel Preparation to Reduce Postoperative Infections in Hirschsprung's Disease

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ABSTRACT

Objective: The purpose of this study was to find incidence of infection-related complications and the optimal volume and duration (days) of rectal NSS irrigation that would result in the low post-operative complications following transanal endorectal pull-through (TERPT) in patients with Hirschprung's disease.

Materials and Methods: We conducted a retrospective chart reviews of 131 patients diagnosed with Hirschsprung's disease who underwent TERPT at Siriraj Hospital between January 2006 and December 2020.

Results: Infection-related complications were observed in 23(17.6%) patients, comprising 22(16.8%) cases of anastomotic strictures, 3(2.3%) cases of anastomotic leakages, and 2(1.5%) cases of intraabdominal collections. The median (Q1, Q3) volume of NSS irrigation (ml/kg/day) for those without complications (38.1 (33.9,50)) and those with complications (39.5 (35,45)) was statistically identical (p = 0.945). Similary, the median duration of for both groups was the same (p = 0.854). The mean (SD) volume of irrigated NSS in those with leakage (55.6 (32.7)) and those without leakage (44.3 (17.9)) showed no statistically significant difference (p = 0.291). Patients with post-operative stricture received the same amount of irrigated NSS (40.7 (11.9)) as those without stricture (45.4 (19.2)) (p = 0.138). Similarly, those with hyponatremia received the same amount of irrigated NSS as those without hyponatrema (p = 0.475).

Conclusion: The volume of rectally irrigated NSS did not correlate with infection-related complications such as anastomotic leakage, stricture and intraabdominal collection. However, this study observed a low complication rate, thus, future research should cover a larger population.

Keywords: Hirschsprung; endorectal pullthrough; complications; irrigation; bowel preparation (Siriraj Med J 2023; 75: 763-769)

INTRODUCTION

Hirschsprung's disease (HD) is caused by the absence of ganglion cells in the myenteric and submucosal plexus of the colon, inhibiting the propagation of peristaltic waves. It has an estimated incidence of roughly 1 in 5,000 live births.[1] The most effective surgical treatment involves resection of the aganglionic bowel segment and the identification of normally ganglionated proximal bowel for a level coloanal anastomosis. In 1988[2-4], L De la Torre and J A Ortega transformed the Soave-Boley endorectal pull-through procedure into a purely transanal approach known as the "transanal endorectal pull-through" (TERPT). If the transanal approach cannot be performed flawlessly, a combined method of abdominal

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and transanal approaches, dubbed "abdominal assisted transanal endorectal pull-through" (abdo + TERPT), is used.

The reduction of fecal loading is crucial to minimizing complications related to infection such as wound infection, intraabdominal collection, coloanal anastomosis leakage, wound dehiscence, anastomosis retraction and anastomosis stricture. This can be achieved through adequate bowel preparation.

Various bowel preparation regimens, which include rectal normal saline solution (NSS) irrigation before a definitive pull-through operation, have been followed. The Royal Children's Hospital, Melbourne[5] as well as the Children's Hospital, Pittsburgh[6] recommend NSS irrigation of 20 ml/Kg. However, no studies have compared the efficacy of these regimens. The Division of Pediatric Surgery, Faculty of Medicine Siriraj Hospital uses a preoperative bowel preparation regimen with rectal NSS irrigation of 20-50 ml/Kg/session, administered twice a day. The effectiveness of this quantity of NSS is neither proven nor known to be sufficient to do rectal NSS irrigation. Additionally, pre-operative reduction of stool production by altering the diet was implemented. At Siriraj Hospital, a low residual diet was introduced three days prior to the operation. A liquid diet was prescribed on the day prior to the operation, and only a clear liquid diet was allowed on the day of the operation. The required duration for this dietary change regimen remains uncertain, and excessive rectal NSS irrigation might result in hyponatremia.

Neither the optimal volume nor duration of NSS irrigation have been established with scientific evidence. Thus, this study was conducted to determine the most suitable volume and duration of rectal NSS irrigation to minimize infection-related complications following pull-through operations.

MATERIALS AND METHODS

After obtaining approval from the Siriraj Institutional Review Board (COA. no Si 757/2020), a retrospective study was carried out in children diagnosed with Hirschsprung's disease who underwent either a transanal endorectal pull-through or abdominal assisted transanal endorectal pull-through at Siriraj Hospital between January 2006 to December 2020. Children diagnosed with kidney disease causing hyponatremia, those who were immunocompromised, those who had previously underwent colostomy, and those with incomplete medical information were excluded from the study.

Infection-related complications were defined as complications occuring within three months postoperatively including wound infection, intraabdominal collection, coloanal anastomosis leakage, wound dehiscence, anastomosis retraction and anastomosis stricture.

Patients' demographic data, transitional zone level, preoperative bowel preparation (volume (cc/kg/day) and duration (days)), types of operation, and complications following either transanal endorectal pull-through or abdominal assisted transanal endorectal pull-through were collected. Complications, such as surgical site infection, anastomotic leakage, abscess at anastomosis, intraabdominal collection, wound dehiscence, anastomotic stricture, post-operative hyponatremia, were also recorded. The collected data were analyzed using SPSS software version 18 (SPSS Inc. Released 2009. PASW Statistics for Windows, Version 18.0. Chicago: SPSS Inc). Continuous data were expressed as either median (Q1, Q3) or mean (standard deviation) depending on the distribution of the data and categorical data was expressed as numbers and percentages. A Chi-square test was used to compare proportional data and the Mann-Whitney U test was used to compare continuous data. Multiple binary logistic regression analysis was used to adjust confounding factors. A p-value of <0.05 was considered statistically significant.

RESULTS

This study included 131 patients diagnosed with Hirschsprung's disease, of whom 85 (64.9%) were male and 46 (35.1%) were female. Ninty-nine patients underwent TERPT, while 32 patients recieved the abdominal assisted TERPT. Postoperative infection-related complications were observed in 23 (17.6%) patients, including 22 (16.8%) anastomotic stricture, 3 (2.3%) cases of anastomotic leakages, and 2 (1.5%) instances of intraabdominal collection.

Patients' characteristics, with surgical complications (n = 23) and without surgical complications (n = 108), are shown in Table 1.

Among the two groups, there were no significant differences in terms of gender, age, weight, and transitional zone level (p = 0.998, 0.224, 0.629 and 0.732 respectively). The need for abdominal-assisted TERPT was found to be identical among patients with and without complications (p = 0.838)

Table 2 demonstrates the comparison between patients with and without surgical complications, considering factors such as pre-operative volume of NSS irrigation, duration of NSS irrigation, re-operation requirement, and length of hospital stay.

In relation to overall complications, the median (Q1, Q3) volume of rectal NSS irrigation (ml/kg/day) for patients

TABLE 1. Patients' characteristics: A comparison of those without surgical complications and those with surgical complications.

	No surgical complication (n=108)	Surgical complication (n=23)	Total (n=131)	P-value
Gender				0.998[a]
Male (%)	68 (63.0%)	17 (73.9%)	85 (64.9%)	
Female (%)	40 (37.0%)	6 (26.1%)	46 (35.1%)	
Age (Median (Q1,Q3)) (days)	30 (21,202.5)	30 (19,60)	30 (21,180)	0.224[b]
Weight (Median (Q1,Q3)) (kg)	4.1 (3.3,6.6)	4.0 (3.1,4.8)	5.9 (3.3,6.0)	0.629[b]
Transitional zone				0.732[a]
Rectum (%)	29 (26.9%)	7 (30.5%)	36 (27.5%)	
Rectosigmoid colon (%)	61 (56.5%)	11 (47.8%)	72 (55.0%)	
Long segment (%)	18 (16.6%)	5 (21.7%)	23 (17.6%)	
Operation				0.838[a]
TERPT (%)	82 (75.9%)	17 (73.9%)	99 (75.6%)	
Abdominal assisted TERPT (%)	26 (24.1%)	6 (26.1%)	32 (24.4%)	

TERPT: Transanal endorectal pull-through
[a]Chi-square test, [b]Mann-Whitney Test
Q1: The lower quartile, first quartile
Q3: The upper quartile, third quartile

TABLE 2. Comparison of pre-op volume of NSS irrigation, duration of NSS irrigation, re-operation frequency, and length of hospital stay between those without surgical complications and those with surgical complications.

	No surgical complication (n=108)	Surgical complication (n=23)	Total (n=131)	P-value
NSS irrigation volume (median (Q1,Q3)) (ml/kg/day)	38.1 (33.9, 50)	39.5 (35, 45)	38.4 (34.1, 48.7)	0.945[b]
Duration of NSS irrigation (median (Q1,Q3)) (days)	7.0 (5,10)	7.0 (4, 10)	7.0 (4, 10)	0.854[b]
Re-operation				<0.001[a]
Yes (%)	108 (100%)	2 (8.7%)	110 (84.0%)	
No (%)	0	21 (91.3%)	21 (16.0%)	
Length of hospital stay (median (Q1,Q3)) (days)	15.0 (10.2, 20)	18.0 (10, 25)	16 (10, 21)	0.204[b]

[a]Chi-square test, [b]Mann-Whitney Test
Q1: The lower quartile, first quartile
Q3: The upper quartile, third quartile

without post-operative complications (38.1 (33.9,50)) was comparable to that of patients with complications (39.5 (35,45)), showing no significant difference (p = 0.945). Likewise, the median (Q1, Q3) duration of rectal NSS irrigation was identical in both groups (7.0 (5, 10) days vs. 7.0 (4, 10) days) (p = 0.854). The incidence of each infection-related complication and a comparison of total saline irrigation volume (ml/kg/day) between those with each complication and those without each complication are described in Table 3.

Anastomotic leakage did not show a correlation with volume of rectal NSS irrigation. The mean (SD) volume of rectal NSS irrigation (ml/kg/day) for patients with leakage leakage (55.6 (32.7)) and those without leakage (44.3 (17.9)) displayed no significant difference (p = 0.291). However, the incidence of leakage in this series was only 2.3%.

Anastomotic stricture, the most common complication in this study (22 (16.8%)) did not show a difference in rectal NSS irrigation volumes. Patients with anastomotic stricture were irrigated with NSS at a mean volume of 40.7 (11.9) ml/kg/day, which was not significantly different from the mean volume of 45.4 (19.2) ml/kg/day for patients without anastomotic stricture (p = 0.138).

In our study, patients with hyponatremia received the same amount of rectal NSS irrigation as those without hyponatremia (p-value = 0.475).

In our study, the patient with Hirschsprung's disease without complications who received the minimal volume of rectal NSS irrigation received 16.19 ml/kg/day and irrigation duration for this patient was 5 days.

DISCUSSION

Prior to conducting a transanal endorectal pull-through/ abdominal assisted transanal endorectal pull-through, preoperative bowel preparation is required to minimize the amount of stool retained in the bowel.

There were three methods of bowel preparation before such operations:

1. Laxatives. These drugs induce strong contractions of the colon and rectum, and thereby facilitate stool evacuation. Two commonly used laxatives include Senna (anthraquinone group) and Bisacodyl (a derivative of the diphenylmethane group). The use of these drugs is contraindicated in cases where obstruction of the colon and rectum is present.

2. Drugs with osmotic effects: These include polyethylene glycol (PEG) and its variations such as

TABLE 3. Incidence of infection-related complications and comparison of total saline irrigation volume (ml/kg/day) between those with each complication and those without each complication.

	Number of patients (total n=131)	NSS irrigation volume (mean (SD)) (ml/kg/day)	P-value[a]
Anastomotic leakage			0.291
Yes	3 (2.3%)	55.6 (32.7)	
No	128 (97.7%)	44.3 (17.9)	
Anastomotic stricture			0.138
Yes	22 (16.8%)	40.7 (11.9)	
No	109 (83.2%)	45.4 (19.2)	
Intra-abdominal collection			0.089
Yes	2 (1.5%)	66.4 (38.1)	
No	129 (98.5%)	44.2 (17.9)	
Re-operation			0.740
Yes	21 (16.0%)	43.4 (16.7)	
No	110 (84.0%)	44.8 (18.6)	
Hyponatremia			0.475
Yes	2 (1.5%)	36.5 (14.2)	
No	129 (98.5%)	46.3 (19.2)	

[a]Independent-samples T test
SD: Stardard Deviation

PEG preparation with electrolytes (PEG-ELS) or PEG-3350 without electrolytes. These substances should not be used if an obstruction is suspected.

Regiments utilizing laxatives and drugs with osmotic effects are frequently used for bowel preparation prior to colonoscopy in pediatric patients.[7] However, they are not suitable for preoperative bowel preparation in patients with Hirschsprung's disease.

3. Rectal NSS irrigation. This preoperative bowel preparation method, performed with a catheter, is a safe and suitable approach for preparing for surgery in cases of Hirschsprung's disease. Other hypotonic solutions, including distilled water, tap water, or other types of water, are believed to potentially include hyponatremia due to water intoxication. This condition occurs when the colon and rectum absorb water.

Proper bowel prepartion prior to surgery is crucial. If the colon is not sufficiently cleaned, either due to inadequate volume of colonic irrigation or insufficient frequency of irrigation, this can lead to fecal stagnation, and heightened risk of post-surgical infection.

Clinical guidelines for rectal NSS irrigation vary. The Royal Children's Hospital, Melbourne recommends pre-operative bowel preparation with NSS rectal irrigation up to a maximum of 20 ml/Kg per session, not exceeding a total volume of 250 ml.[5] The Children's Hospital, Pittsburgh recommends a maximum NSS irrigation of 20 ml/Kg per session, but does not specify a total maximum volume of NSS.[6] The Great Ormond Steeet Hospital, London, United Kingdom, recommends that rectal irrigation should continue with NSS until the stool appears watery and free of fecal retention.[8] In patient with enterocolitis, treatment includes broad spectrum antibiotics and rectal irrigation. Immediate rectal washout with saline (10-20 ml/Kg) using a large bore soft tube should be initiated immediately and repeated from 2-4 times per day until appropriate decompression is achieved, as determined by clinical examination.[9,10]

The optimal duration of preoperative bowel preparation with daily NSS irrigation remains a topic of discussion. Songkhlanakarin University hospital in Thailand reported that rectal irrigation for three days prior to surgery failed to adequately cleanse the bowels.[11] However has also been reported that rectal NSS irrigation can be used effectively on the day before surgery, alone, with the first irrigation in the evening before the operation and a second irrigation on the morning of the operation. However, this method requires a large volume of NSS (500-2000 ml (mean 1000 ml)) per colonic irrigation session.[12]

At the Division of Pediatric Surgery, Department of Surgery, Faculty of Medicine Siriraj Hospital, preoperative bowel preparation with normal NSS irrigation has been standard practice for over 40 years. For children under one month of age, the protocol involves NSS irrigation of no more more than 20 ml/Kg per session, twice a day, not exceeding 40 ml/Kg per day. For children older than one month, the quantity of NSS used in colonic irrigation does not exceed 50 ml/Kg per session, with colonic irrigation performed twice daily. Thus, the total daily volume of NSS irrigation does not surpass 100 ml/Kg/day. Nevertheless, questions remain regarding the ideal quantity of NSS irrigation and the optimal number of days required for bowel preparation before surgery. These were key questions of this study.

The demographic data in this study (age, weight, transitional zone, type of operation) showed no significant differences between patients who developed complications and those who did not. This allowed for a focused examination of potential effects of NSS irrigation, without these factors acting as confounding factors.

The findings from our study indicate no statistically significant correlation between volume of rectal NSS irrigation and overall postoperative complications. Patients who did not develop postoperative complications received a mean (Q1, Q3) volume of NSS similar to that of those who developed complications (38.1 (33.9, 50) ml/kg/day vs. 39.5 (35, 45) ml/kg/day) (p-value = 0.945). Moreover, the mean duration of irrigation between these two groups showed no significant difference (p = 0.854). The minimum NSS volume of rectal NSS irrigation in a patient who did not experience any complications in this study was just 16.19 ml/kg/day and the duration of irrigation for this patient was five days.

The incidence of anastomotic leakage showed no correlation with volume of rectal NSS irrigation. The mean (SD) volume of rectal NSS irrigation in patients with leakage was not statistically different from those without leakage (55.6 (32.7) ml/kg/day, vs. (44.3 (17.9) ml/kg/day) (p-value = 0.291). A possible reason for the lack of correlation between the amount of rectal NSS and anastomotic leakage could be the low incidence of leakage in our series. In our patient's cohort, anastomotic leakage occurred in only 2.3% of cases whereas other studies reported incidences of 5% to 10%.[13-15] A low incidence of leakage requires a larger sample sample size to statistically identify any differences in the volume of NSS irrigation.

Anastomic stricture following the pull-through procedure was the most common complication in our series, (n = 22 (16.8%)). Known risk factors for anastomotic stricture include anastomotic ischemia, cuff ischemia,

anastomotic leak, and small circular anastomosis.[16,17] Concealable leaks can subsequently lead to stricture of the colonanal anastomosis. In this study, the mean (SD) volume of NSS irrigation for patients who developed postoperative stricture (40.7 (11.9)) was not significantly different from those without stricture (45.4 (19.2)) (ml/Kg/day) (P = 0.138). Given that the risk of anastomotic leakage in our study was only 2.3%, the higher incidence of anastomotic stricture could be the result of an overly tight coloanal anastomoses, which may result in minor degree of anastomotic ischemia and stricture. However, our findings suggest that stricture of coloanal anastomosis was not associated with volume of rectal NSS irrigation.

In our study, we found that the volume and duration of NSS irrigation were similar for patients with infection-related surgical complications, such as anastomotic leakage, anastomotic stricture, intraabdominal collection and others, and those without complications. These results were corresponsed with our previous preliminary study.[18] The absence of correlation between the volume of rectally irrigated NSS and severe infecton-related complications might be due to low incidences of those complications in our series.

Theoretically, increasing NSS volume could elevate the risk of hyponatremia. However, in our study, those with hyponatremia received the same volume of rectal NSS irrigation as those without hyponatremia (p-value = 0.475).

Our study did have some limitations.

First, the study was designed retrospectively, which means there may be missing information. We were only able to include 131 patients who had complete medical records.

Second, the number of patients with infection-related complications was relatively small. This made it challenging to compare the group with post-operative complications and the group without complications, particularly in relation to different volumes and duration of rectal NSS irrigation. Due to the relatively low complication rate, further research is needed on a larger population.

Third, the generalizability of our findings is limited. The study was conducted in a single university hospital, and as such, the method and technique of rectal NSS irrigation may differ from those used in other institutions. Morover, the operative technique of transanal endorectal pull-through or abdominal assisted transanal endorectal pull-through may differ as well. Therefore, the incidence rates of post-operative complications we observed might not be applicable elsewhere.

CONCLUSION

Our study found that the volume of rectally irrigated NSS was not correlated with post-operative infection such as anastomotic leakage, anastomotic stricture and intraabdominal collection. The minimum volume of rectal NSS irrigation for patient with Hirschsprung's disease without complications in this study was 16.19 ml/kg/day over a duration of 5 days.

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Conflicts of interest

The authors have no conflicts of interest to declare.

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