# Outcomes of children with long-segment and total colon Hirschsprung disease following pull-through

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## ABSTRACT

**Introduction: Hirschsprung disease (HSCR) is a congenital disorder caused by the absence of ganglion cells, which leads to a functional obstruction in infants. HSCR is divided into short, long and total colon aganglionosis (TCA). However, post-operative outcome assessment of patients with long-segment and TCA is scarce. We determined the functional outcomes, Hirschsprung-associated enterocolitis (HAEC) and complications of long-segment and TCA HSCR's children following pull-through surgery.**

**Materials and Methods: Descriptive analysis research was done for children with HSCR long-segment and TCA who underwent an operation at our institutionfrom 2013 to 2020. We assessed the functional outcome and HAEC by the Krickenbeck and the HAEC scoring, respectively.**

**Results: We ascertained 13 HSCR long-segment and six TCA. We performed the following surgical procedures: Duhamel (n=7), Martin (n=4), Kimura (n=1), transabdominal Yancey-Soave (n=3) and transanal endorectal pull-through (n=4). All long-segment patients revealed good functional outcomes, whereas two TCA children suffered soiling and failed to achieve voluntary bowel movement. HAEC was noted in three long-segment and four TCA patients. Furthermore, surgical site infection and diaper rash were noticed in 10 and two patients, respectively.**

**Conclusion: Long-segment patients might have better functional outcomes TCA group, whereas the frequency of HAEC is compatible among arms. Long-term follow-up is important and necessary to identify complications early and define the proper treatment. Our study comprehensively analyzes functional outcomes, HAEC and complications of children with HSCR long-segment and TCA after definitive surgery in a developing country.**

**KEYWORDS:**
*Hirschsprung disease; functional outcomes; HAEC; long-segment; total colon aganglionosis*

## INTRODUCTION

Hirschsprung disease (HSCR) results from the incomplete development of the enteric nervous system, leading to the absence of ganglion cells in the intestines. This leads to impaired colonic function and intestinal obstruction.[1] Globally, the incidence of HSCR is approximately 1:5,000 live births,[1] with an incidence of around 1:3250 births in Indonesia.[2] Eighty percent of cases had a short segment of involvement affecting solely the rectosigmoid colon. Less commonly, extension beyond the sigmoid colon occurs (long segment, 15%), entailing the entire large bowel (total colonic aganglionosis, TCA, 5%) or, in rare cases, the complete bowel (total intestinal aganglionosis).[3]

Neonates with HSCR often present delayed meconium passage, feeding intolerance, abdominal distention and bilious emesis, indicating possible intestinal obstruction. As children advance beyond the neonatal phase, they may experience persistent constipation resistant to oral laxatives, necessitating rectal therapies. They might also exhibit symptoms such as vomiting, abdominal distention and failure to thrive.[4]

The surgical treatment for HSCR involves a pull-through procedure to remove the aganglionic colon segment and connect the ganglionized part to the anus with a functional sphincter.[5] Despite favourable outcomes after surgery, complications such as Hirschsprung-associated enterocolitis (HAEC), constipation, prolapse, perianal abscess and uncontrolled defaecation can arise.[1-3] HAEC is a life-burdening condition that can occur before and after the patient performs a pull-through.[6] In addition to HAEC, other frequently encountered complications, such as diaper rash, enterocutaneous fistula and surgical site infection (SSI).[7,8]

One of the risk factors for an unfavourable post-operative outcome is the length of the aganglionic colon—the longer the aganglionosis colon, the worse the outcome.[9] Other risk factors suspected of influencing post-operative outcome were sex, age at definitive surgery, nutritional status and surgical technique. Moreover, most studies on outcomes of children with HSCR long-segment and TCA are from developed countries.[9-11] Therefore, our study determined the variables that might influence the functional outcome and complications, particularly in HSCR patients with long-segment and TCA, from a specific developing country.

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## MATERIALS AND METHODS

*Subjects*

The study participants comprised individuals selected based on the inclusion and exclusion criteria. Specifically, inclusion criteria encompassed HSCR long-segment and total colon aganglionosis children who had undergone pull-through surgery and were under 18 years of age during the period spanning from January 2013 to August 2020 at our institution.[12] The exclusion criteria for this study were incomplete medical records and multiple operations.

*Research Design*

This was a retrospective study. Data were taken from medical records, including patient characteristics: type of aganglionosis, nutritional status, age at pull-through, pull-through technique and sex, as independent variables on functional outcome, HAEC and complications as the dependent variable.

The types of aganglionosis studied in this study are long-segment and TCA. The nutritional status of the patients was divided into good and poor nutrition. Poor nutrition was determined as a weight-for-age Z score $< -2$.[13] Pull-through procedures were grouped into Duhamel and non-Duhamel procedures (Martin, Yancey-Soave, Kimura and transanal endorectal pull-through [TEPT]). Pull-through procedures have been performed according to previous reports.[5,14] Functional outcomes after pull-through were assessed using the Krickenbeck classification, which includes voluntary bowel movement, soiling and constipation.[15] HAEC was assessed using 16 HAEC score criteria, which was used to establish a diagnosis with a score of ≥4 or ≥10.[16] Complications included SSI and diaper rash. SSI was classified according to the National Nosocomial Infections Surveillance of the Centres for Disease Control and Prevention: incisional and organ/space SSIs. This study only included incisional SSI. Diaper rash was determined as an inflammation of the skin of the diaper area, including the perianal and perineal region.

*Data Analysis*

The research data were analysed descriptively using frequency, which was then expressed as a percentage or using the median and interquartile range according to the form of the data presented. Meanwhile, the Chi-square or Fisher Exact test was used to analyse significant differences and relationships between nominal variables.

## RESULTS

*Patient's Characteristics*

Table I shows the characteristics of the subjects, including sex, nutritional status before pull-through, age at pull-through and pull-through technique grouped by type of aganglionosis.

*Outcome Based on Patient's Characteristics*

Table II shows the assessment of patient outcomes based on patient characteristics. Functional outcome assessments could not be carried out on the entire population of the study subjects because eight patients were less than 3years old, and one patient was still having a stoma.

*Association Between Outcomes and Patient Characteristics*

This study found that the type of aganglionosis did not have a significant association with functional outcomes. Likewise, other factors, namely sex, nutritional status before pull-through and age at pull-through, did not have a statistically significant association with functional outcomes. The HAEC assessment with patient characteristics did not have a statistically significant association ($p>0.05$) (Table III).

## DISCUSSION

In this study, there were 13 HSCR patients with long-segment aganglionosis (4%) and 6 HSCR patients with TCA (1.8%) from a total population of 328 HSCR patients who had undergone pull-throughs from 2013 to 2020. This observed lower incidence of the long-segment type and TCA is consistent with findings from previous studies, which also reported the rarity of patients exhibiting extended or comprehensive colon aganglionosis.[3,4,9] The total ratio between male and female patients in this study was 17:2. When considering the specific type of aganglionosis, the male-to-female ratio among patients with long-segment aganglionosis stood at 12:1, while the ratio for those with total colon aganglionosis (TCA) was 5:1. A previous study has indicated variability in sex ratios, attributable to discrepancies in sample sizes and sampling durations, resulting in a more diversified collection of cases. In instances of short-segment disease, a male-to-female ratio of 3:1 to 4:1 is frequently observed, while the sex bias shifts to 1:2 to 2:1 in long-segment disease cases.[4]

Our findings revealed that 23.1% of patients diagnosed with long-segmentaganglionosis exhibited poor nutritional status. In parallel, 66.7% of patients diagnosed with TCA experienced poor nutrition. This correlation was similarly observed in a previous report that 54.5% of patients with extensive colon aganglionosis were found to have poor nutrition.[17] Notably, most patients included in this study underwent temporary stoma placement as a preliminary step before definitive therapy. The rationale behind stoma placement lies in its ability to stabilise patients exhibiting severe malnutrition or alleviate significant dilation in the proximal intestine. This intervention contributes to reducing the risks associated with preoperative complications that could lead to mortality and morbidity.[5]

This study showed that patients with a long-segment type of aganglionosis mostly performed pull-throughs at 0–24 months (77%) with a median of 16 months and an interquartile range of 7 months. Then, patients with TCA type also mostly did pull-throughs at 0–24 months (66.7%) with a median of 15 months and an interquartile range of 17.75 months. As long as there are no significant comorbidities for the patient, many surgeons prefer to conduct a pull-through shortly following the diagnosis. Preoperative enterocolitis is considered to be avoided with this approach, as well as extended hospital stays and complications from prolonged use of the stoma.[5,18]

Our study shows that the Duhamel procedure is the most commonly used pull-through technique in patients with long-segment aganglionosis (46.2%). In the TCA type, the

**Table I: Patient's characteristics**

| Characteristics | Type of HSCR aganglionosis | |
|---|---|---|
| | Long-segment n = 13 | TCA n = 6 |
| Sex | | |
| Male | 12 (92%) | 5 (83%) |
| Female | 1 (8%) | 1 (17%) |
| Nutritional status before pull-through | | |
| Good | 10 (77%) | 4 (67%) |
| Poor | 3 (23%) | 2 (33%) |
| Age at pull-through | | |
| 0–24 months | 10 (77%) | 4 (67%) |
| > 24 months | 3 (23%) | 2 (33%) |
| Pull-through technique | | |
| Duhamel | 6 (46%) | 1 (17%) |
| non-Duhamel | 7 (54%) | 5 (83%) |

HSCR: Hirschsprung disease

**Table II: Outcome based on patient's characteristics**

| Characteristics | Outcome | | | | | |
|---|---|---|---|---|---|---|
| | Functional outcome (n = 10) | | Constipation | HAEC (n = 19) | | Complications (n = 19) |
| | VBM | Soiling | | ≥ 4 | ≥ 10 | |
| HSCR type | | | | | | |
| Long | 7 | 0 | 0 | 3 | 2 | 9 |
| TCA | 1 | 2 | 0 | 4 | 1 | 3 |
| Sex | | | | | | |
| Male | 7 | 2 | 0 | 5 | 2 | 12 |
| Female | 1 | 0 | 0 | 2 | 1 | 0 |
| Nutritional status | | | | | | |
| Good | 6 | 1 | 0 | 6 | 3 | 10 |
| Poor | 2 | 1 | 0 | 1 | 0 | 2 |
| Age at pull-through | | | | | | |
| 0–24 months | 5 | 1 | 0 | 5 | 2 | 7 |
| > 24 months | 3 | 1 | 0 | 2 | 1 | 5 |
| Pull-through technique | | | | | | |
| Duhamel | 5 | 0 | 0 | 3 | 2 | 5 |
| Non-Duhamel | 3 | 2 | 0 | 4 | 1 | 7 |

HAEC: Hirschsprung-associated enterocolitis

**Table III: Association between outcomes and patient characteristics**

| Characteristics | Outcome | | | | | |
|---|---|---|---|---|---|---|
| | Functional outcome | | Constipation | HAEC | | Complications |
| | VBM | Soiling | | ≥ 4 | ≥ 10 | |
| HSCR type | | | | | | |
| *p-value* | 0.072 | 0.072 | NA | 0.129 | 1.0 | 0.617 |
| Odds ratio | 25.0 | 25.0 | | 6.67 | 1.10 | 0.44 |
| (95% CI) | (0.75–832.99) | (0.75–832.99) | | (0.79–56.22) | (0.08–15.15) | (0.06–3.24) |
| Gender | | | | | | |
| *p-value* | 1.0 | 1.0 | NA | 0.123 | 0.298 | 0.136 |
| Odds ratio | 1.0 | 1.0 | | 15.0 | 7.50 | 0.09 |
| (95% CI) | (0.03–33.32) | (0.03–33.32) | | (0.60–374.82) | (0.33–173.28) | (0.004–2.15) |
| Nutritional status | | | | | | |
| *p-value* | 1.0 | 1.0 | NA | 0.603 | 0.53 | 0.305 |
| Odds ratio | 3.0 | 3.0 | | 0.33 | 0.30 | 0.27 |
| (95% CI) | (0.12–73.64) | (0.12–73.64) | | (0.03–3.80) | (0.01–6.85) | (0.03–2.25) |
| Age at pull-through | | | | | | |
| *p-value* | 1.0 | 1.0 | NA | 1.0 | 1.0 | 0.125 |
| Odds ratio | 1.67 | 1.67 | | 1.20 | 1.50 | 11.0 |
| (95% CI) | (0.07–37.73) | (0.07–37.73) | | (0.15–9.77) | (0.11–21.31) | (0.51–2336.2) |
| Pull-through technique | | | | | | |
| *p-value* | 0.444 | 0.444 | NA | 1.0 | 0.523 | 0.656 |
| Odds ratio | 7.86 | 7.86 | | 0.67 | 0.23 | 0.56 |
| (95% CI) | (0.28–217.12) | (0.28–217.12) | | (0.09–4.54) | (0.02–3.13) | (0.07–4.14) |

NA, not applicable; HAEC, Hirschsprung-associated enterocolitis.

technique most often used (50%) is the Martin procedure, which is a modification of the Duhamel procedure and 16.7% of patients underwent the unmodified Duhamel pull-through. More prospective studies are needed to establish one technique's superiority over another. Notably, all three procedures have been extensively performed worldwide, yielding comparable outcomes in substantial long-term studies.[5]

Overall, two patients experienced functional disturbances, especially in the soiling. In patients with extensive colonic aganglionosis, the pull-through procedure becomes more complex. The anastomosis level of the bowel pull-through is considered principal for faecalcontinence, regardless of whether a transanalor transabdominal surgical method is used. Moreover, extreme stretching of the anus during transanal approach, can lead todamage of external sphincter, resulting in faecal incontinence. Another aetiology that can affect the functional outcomes after definitive surgery is the twisting of the pull-through bowel.[7]

This study shows that 36.8% of patients have HAEC with a cut-off level of ≥4, and 15.8% of patients show HAEC with a cut-off level of ≥10. Decreasing the cut-off level to 4 increases the frequency of HAEC after performing a pull-through to about three times compared to the cut-off score of 10.[15] In addition, a longer colonic aganglionosis indicates a more significant reduction in the gut immune system, producing potentially pathogenic bacteria if intestinal stasis occurs.[19]

Among the 19 patients, 12 patients had complications (63.2%). Ten patients (52.6%) experienced SSI, and two patients (10.5%) had diaper rash. The risk of SSI has generally been shown to be highest following colorectal surgery. The incidence of SSI was observed to range from 1.7% to 19.2% in HSCR evaluations.[7] Meanwhile, other complications like diaper rash or perianal excoriation in patients with TCA have a high incidence because a total colectomy with an ileoanal anastomosis is usually performed. Hence, the frequency of bowel movements increases.[17]

Our study shows that the type of aganglionosis did not have a significant association with functional outcomes. Other factors, namely sex, nutritional status and age at pull-through, also did not correlate statistically with functional outcomes. Regarding age at pull-through, our findings were compatible with a recent systematic review that concluded that no beneficial impact of delaying pull-through for patients with TCA, particularly on diaper rash frequency.[8]

The HAEC frequency and patient characteristics had no statistically significant association ($p>0.05$). Moreover, the association between complications and patient characteristics was not statistically significant. Notably, the small sample size is a weakness of our study; therefore, it is necessary to use a larger sample to clarify the findings of this study.

Several novelties have been noted in our study, including: 1) we provided new data on functional outcomes of long-segment and TCA children from a developing country (vs. developed countries[9-11]); and we comprehensively analysed the functional outcomes, HAEC and complications in HSCR patients with long-segment and TCA (vs. post-operative complications[10] vs. HAEC[16,19]).

Limitations of our study should be considered during the interpretation of our findings, including small sample size, retrospective design and one-centre study. Moreover, our findings were based on overall means without accounting for other potential factors that might affect the results, including the surgeon experiences and pull-through technique preference by attending surgeons.

## CONCLUSION

Long-segment patients might have better functional outcomes TCA group, whereas the frequency of HAEC is compatible among arms. Long-term follow-up is important and necessary to identify complications early and define the proper treatment. Our study comprehensively analyzes functional outcomes, HAEC and complications of children with HSCR long-segment and TCA after definitive surgery in a developing country.

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