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Original Research Article

Extending Specialist Surgical Coverage for Children to Underserved Areas: *Management of Pediatric Colorectal Diseases at a Secondary-Level Health Facility with Upgraded Capacities*

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Abstract: ***Introduction*:** The paper discusses the challenges in providing care for children from underserved rural areas, for complex surgical conditions. It highlights the need to empower selected secondary hospitals to handle paediatric cases that represent a significant burden of surgical admissions, such as Pediatric Colorectal Diseases (PCRD), and risk inappropriate treatment when seen at a peripheral health facility level, as financial or transportation difficulties constrain access to a specialist hub. ***Materials and Methods*:** The study examines the capacity acquired by a secondary health facility to provide surgical care for Anorectal Malformations (ARM) and Hirschsprung's Diseases (HSCR) in terms of diagnostic accuracy, appropriate management, reduced complications, and favourable outcomes. The hospital serves a large catchment area with approximately 10 million people, including 45% who are under the age of 15. ***Results*:** Among 966 paediatric surgical admissions during the study period, ninety-four were referred for colorectal disease (ARM and HSCR). The document details the types of surgeries performed, complications encountered, and outcomes achieved. Posterior Sagittal Anorectoplasty (PSARP) was performed in 28 out of 42 ARM cases observed (66%) at a mean age of three years, and four were scheduled for treatment in a short time. Forty-six out of 48 HSCR cases could be treated with a favourable outcome by abdominoperineal pull-through or posterior rectal sphincterotomy. ***Conclusion*:** Extending specialist surgical coverage for children through selected secondary facilities with upgraded local capacities can significantly improve the management of Pediatric Colorectal Diseases in underserved areas, making appropriate staged treatments and close postoperative follow-up more accessible.

Keywords: Pediatric Surgery, Low Resources, Anorectal Malformations, Hirschsprung's Disease.

INTRODUCTION

The scarcity of paediatric surgeons and tertiary referral health facilities challenges access to specialist care for children in sub-Saharan Africa. As far as advanced and comprehensive management of complex congenital malformations and tumours is reserved for a few specialist facilities in central urban areas, financial, social, and cultural restraints and transportation difficulties continue to exclude from treatment many children living in vast, unconnected rural regions.

For a long time, it has been recommended that selected secondary hospitals be empowered to handle general paediatric surgical (GPS) conditions that do not require high technical skills and advanced pre-and postoperative care facilities. [1, 2] Trained general surgeons can safely manage GPS, which includes 90% of circumcisions, orchidopexies, and inguinal herniotomies.

Pediatric colorectal diseases (PCRD) require advanced management and should be treated by specialised surgical competence. Nevertheless, they also represent a significant portion of the surgical burden of congenital abnormalities in Sub-Saharan Africa (SSA) and the most frequent cause of acute intestinal obstruction in the paediatric age group [3]. Anorectal Malformations (ARM) or Hirschsprung's Disease (HSCR) in children living in a low-resource context (LRC) are consequently at risk of potential mismanagement by non-specialist health providers when referred as an emergency at a peripheral hospital [4].

General surgeons at a secondary health facility level, who have received specific training, can offer appropriate treatment for PCRD in patients residing within the hospital's catchment area and unable to afford long-distance travel to a specialist facility. This solution

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can also facilitate staged management and long-term follow-up, as PCRD frequently requires.

MATERIALS AND METHODS

Aims: This study examines the capacity of the Consolata Hospital Ikonda (CHI) surgical department to provide PCRD care, focusing on diagnostic accuracy, appropriate surgical approaches, reduced complication rates, and favourable outcomes.

Study Setting: The hospital is a 404-bed private, charitable institution in the southern highlands of Tanzania, serving as a regional referral hospital for the Makete district. The hospital serves a large catchment area with approximately 10 million people, 45% of whom are under 15. The hospital's radiology department, which is active and equipped with specific equipment, plays a crucial diagnostic role. A histopathology laboratory, which became operational in 2022, is also available. CHI has a high surgical workload, with 6,117 major and 1,928 minor procedures performed annually in 2023.

Cases under 18 were 948 only (11.7%) in 2022, including trauma, orthopaedics, ENT conditions, hernia repairs, congenital anomalies, neoplasms, and infections in children. Congenital anomalies include mainly abdominal and urological conditions and account for 11%. The average paediatric patient's age is 5.9 years [95% confidence interval (CI) = 5.90 ± 0.27; median: 5; SD: 4.16]; 54% of patients are younger than five. The rate of neonatal surgeries is low, at 0.63%, and the number of surgeries on infants (those younger than one year old) accounts for 4%. The male-to-female ratio is 1.6:1. Among all the procedures, only 3% are emergency procedures. The nearest paediatric tertiary centre is approximately 800 kilometres away, and the hospital's team of certified general surgeons, one urologist, and one orthopaedic surgeon are currently caring for children.

Since 2016, the hospital has received paediatric surgical outreach support and benefitted from specialist distant consultations. Since 2022, one general surgeon at CHI has received regular coaching and mentorship from outreach visiting specialists and a grant from the Jepa-Limmat Foundation for the College of Surgeons of East, Central, and Southern Africa (COSECSA) paediatric surgical graduation. The aim was to upgrade the surgical coverage of children's diseases at the Consolata Hospital from basic to advanced care.

Study Population: The present study includes all cases under 18 years of age requiring surgery for Colorectal diseases (ARM and HSCR) and admitted to CHI between April 2022 and May 2025.

Data Collection: Cases have been grouped according to diagnosis (ARM or HSCR). Gender, age at admission, presentation, diagnostic workup, associated pathologies, type of management, clinical course, and short- and long-term outcome (not less than six months) have been extracted from hospital files. Problems in management, complications, and fatalities have been examined and discussed.

Data Entry: The GraphPad Prism 8.4.0 statistical package (San Diego, CA, USA) was used for data entry and analysis of frequency distributions and percentages.

Ethical Standard: The study was conducted in accordance with the 1964 Helsinki Declaration and its subsequent amendments, or with comparable ethical standards.

RESULTS

Among 966 paediatric surgical admissions in the study period (excluding ENT, urological and Orthopaedic cases), ninety-four were referred for a colorectal disease (ARM and HSCR). They represented the first group (9.7%) of primary surgical conditions observed.

Table I: Patients admitted for Pediatric Colorectal Diseases at CHI

PCRD (90 cases)		Gender	Mean age at presentation & Range	Previous surgery	Type
ARM	**42**	**Males 15**	2 years & 8 months (Range 16 yrs -1 m)	Colostomy 10 *(complicated 4)* Failed PSARP 1	2 Recto Vesical Fistula 2 Recto Prostatic Fistula 3 Recto Bulbar Fistula 1 Recto Urethra Perineal Fistula 7 Recto Perineal Fistula
		Females 27	2 years & 8 months (Range 18 yrs - 2 m)	Colostomy 14 *(complicated 3)* Failed PSARP 2	19 Recto Vestibular Fistula 1 Rectal atresia 4 H-type fistula 3 Recto Perineal Fistula
HSCR	**48**	**Males 33**	4 years (Range 17 yrs – 1m)	Colostomy 16 *(complicated 3)*	21 Recto sigmoid 12 Short Segment
		Females 15	3 years & 8 months (Range 11 yrs – 1m)	Colostomy 6 *(complicated 1)* Failed Pull-through 1	11 Recto sigmoid 4 Short Segment

Among children at CHI. Table I describes the distribution of our cases by gender, age, presentation, and type.

Anorectal Malformations:

Three children with ARM (one male and two females) had a previous perineal corrective surgery in another hospital, which resulted in a misplaced new anus. One of them, a two-year-old female, still had a diverting colostomy and accepted a perineal surgical revision. The other two were incontinent, but only one nine-year-old male accepted a PSARP redo after a new diverting colostomy.

Sixty-six per cent of males with ARM and 51% of females had a colostomy at referral. Among 24 stomas, nine (37%) presented a complication (a short distal loop, a prolapsed loop, or the two stomas too close to exclude the distal loop from stools). Four out of nine colostomies (44%) required some surgical revision before a Posterior Sagittal Anorectoplasty (PSARP) could be performed. Another six cases (four females and two males, aged between six years and five months) were scheduled for PSARP in the short term, but three have missed the admission date so far and have been lost to follow-up.

Among eighteen patients without a stoma on admission (M/F, 5/13), a one-step PSARP without Colostomy was possible in two males and two females, aged within the first three months of life and with a low rectoperineal fistula. In seven cases (three males and four females), a sigmoid-divided colostomy was performed before PSARP. One of seven females without a stoma (three H-type fistulae, three large recto-vestibular fistulae and one with the sequelae of a failed anoplasty) died before treatment for an associated cardiopathy. It was the only significant associated congenital malformation recorded among ARM. The other six cases either refused the temporary Colostomy before PSARP or were lost from follow-up before any treatment could be planned.

In conclusion, a staged or one-step PSARP has been performed in 28 (13 males and 15 females) out of the 42 ARM cases observed (66%) at a mean age of three years (Range: one month to seventeen years) (Table II).

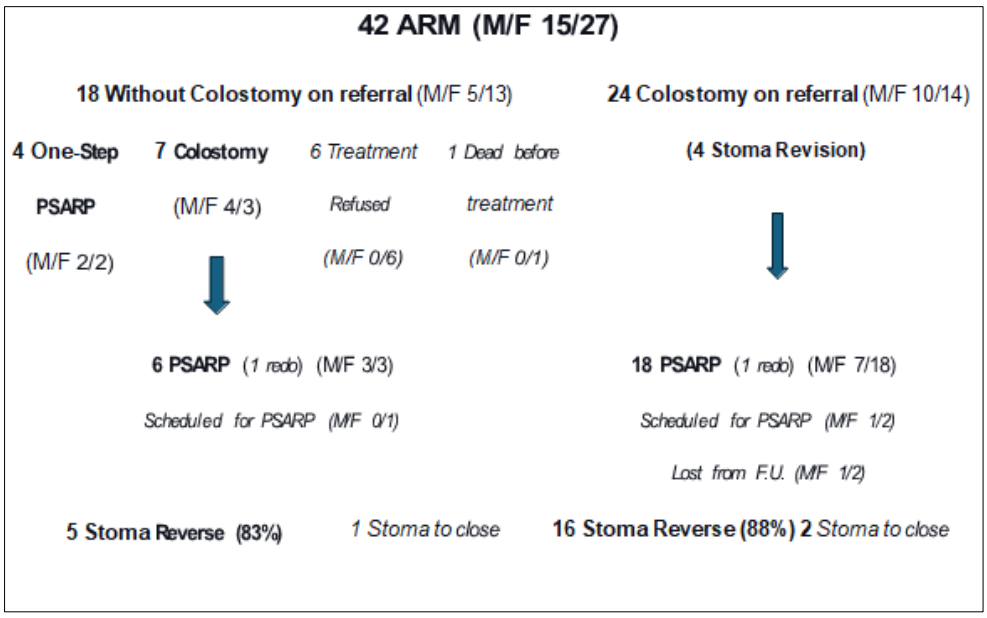

Table II: Surgery for ARM at CHI

Three cases required an abdominal perineal approach for a high ARM (rectovesical or recto-prostatic fistula). A muscle electric stimulator was always employed to identify the muscular complex.

PSARP was always preceded by meticulously cleansing the intestine of faecal content. Antegrade and retrograde bowel irrigation were employed in female patients with a stoma and a vestibular fistula, sometimes after a dilatation. A high-pressure antegrade colostogram was performed in all male patients before PSARP, unless a perineal fistula was evident. Among late-referred male patients (up to 16 years) who underwent a colostomy during the neonatal period, the removal of hard faecal stones in the distal loop was sometimes challenging.

Early postoperative PSARP complications included six cases (22%) of perineal wound infection, which required a limited surgical revision. The accidental removal of the bladder catheter in two cases caused a temporary urinary leakage from the perineal wound, which required a new catheter in place for one month, associated, in one case, with a temporary cystostomy.

Compliance with post-PSARP dilatations, readmission on time for colostomy reversal, and attendance at follow-up were added challenges. Devices to follow the dilatation protocol at home, which are typically started 2-3 weeks after the PSARP procedure, are often unavailable. A solution introduced at CHI was to supply families before discharge by paying a small refundable deposit with a disposable cervical bougie set from calibre 7 to 13. Families were taught to increase the calibre of the sound progressively. For older patients, lubricated rectal tubes of appropriate size were dispensed.

Colostomy reversals were done in twenty-one cases out of twenty-four staged PSARP (87.5%) at a mean distance of 7 months from PSARP (Range 3-14 months), provided that the dilatations achieved the expected results in terms of anal size. The missed stoma reversal in the expected time was due to the inability to cope with the scheduled readmission or to respect the anal dilatations protocol.

Poor prevention of intraoperative contamination, infectious comorbidities such as HIV infection and malnutrition, and insufficient nursing care contributed to complications after Colostomy reversal in three cases out of 21 (14%), with associated skin suture disruption or anastomotic dehiscence and prolonged hospital stay. A regular follow-up of more than one year after a post-PSARP colostomy reversal could be documented in 14 out of 21 cases (66%). Constipation due to a tight or fibrotic anal ring was observed in one case and was treated by strictureplasty. Excision of redundant anal mucosa was required in another patient. Poor faecal control or significant soiling was observed in only two cases.

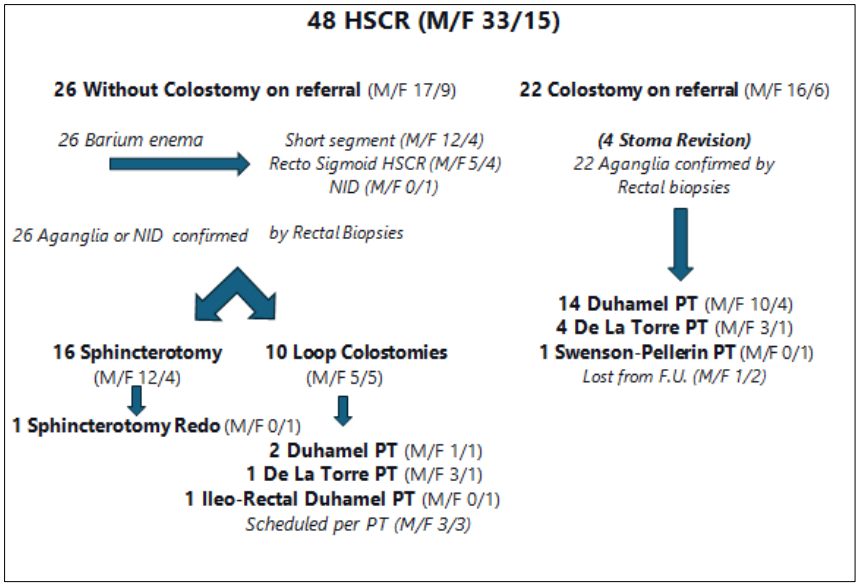

Table III: Surgery for HSCR at CHI

Hirschsprung's Disease:

A series of 48 patients admitted for HSCR (M/F: 33/15) has been included in the study. (Table III) Moreover, twenty-two cases (M/F 16/6) presented on admission, a levelling colostomy was done in another hospital without any previous radiological or histological study for acute abdominal distention, chronic constipation; HSCR was confirmed at CHI by multiple rectal biopsies. The mean age was five years. One girl among them was referred to us after an unsuccessful pull-through done elsewhere. Another three cases, referred for HSCR from other hospitals after a levelling stoma for chronic constipation (one terminal and two loop colostomies) done in emergency between one and five years of age, were not included in the study after aganglionosis was not confirmed by rectal biopsy at CHI.

A terminal stoma with an extended distal rectosigmoid resection and a residual short rectal stump was found in nine cases. The other thirteen cases had a loop or divided sigmoid levelling Colostomy. No rectal or intraoperative colonic biopsies were recorded. Four patients required a stoma revision for stenosis or prolapse. After bowel biopsies at the colostomy site confirmed the presence of a regular ganglionic pattern, a straightforward one-step pull-through of the functional stoma was performed on nineteen out of twenty-one patients (M/F 13/6).

In fourteen cases, a Duhamel side-to-side anastomosis was performed using a linear stapler (Auto Suture PolyGia 75 Single-Use Stapler with Absorbable Staples). Four De La Torre transanal endorectal pull-through procedures were also performed. For the patient with a previous failed pull-through, a one-step Swenson Pellerin procedure [5], with a transanal intestinal stump removal after a few days was preferred.

One two-year-old female patient died after a Duhamel procedure for Ventricular Nodal Re-entrant Tachycardia, not responding to the locally available medications. We had one limited anastomotic leak and cuff abscess after a De La Torre procedure and one para-anastomotic abscess after a Duhamel procedure requiring an emergency temporary colostomy. The first patient died of sepsis, and the other recovered, and the stoma could be closed a few months later without sequelae. Another patient needed a surgical revision for twisting of the pulled-through bowel after a De La Torre procedure. Two patients who developed anastomotic stenosis after one De La Torre and one Duhamel procedure responded to dilatations. At a six-month follow-up, pull-through was followed in all cases by relief of constipation, and all patients were able to pass stool normally after recovering from the procedure without the need for laxatives or other medications.

Twenty-six more patients (M/F 17/9) were admitted for a clinical history of severe constipation and abdominal distention since birth at a mean age of four years (range 1 month to 17 years). Multiple surgical biopsies of the rectum achieved a definitive diagnosis of aganglionosis. A Fluoroscopy-guided barium enema was used on admission to complete the investigation. The radiological exam was performed without bowel preparation using a diluted barium suspension in normal saline to prevent fluid absorption by the surface of the dilated colon. The contrast medium was slowly introduced by gravity through a small-calibre cannula inserted in the anus for a few centimetres and withdrawn soon after to avoid any overdistention of the rectal wall, which could mask the transition in diameter between the dilated, normally innervated colon proximal to the narrowed distal a-ganglionic segment.

Based on the radiology imaging, sixteen short-segment HSCR (Figure 1)

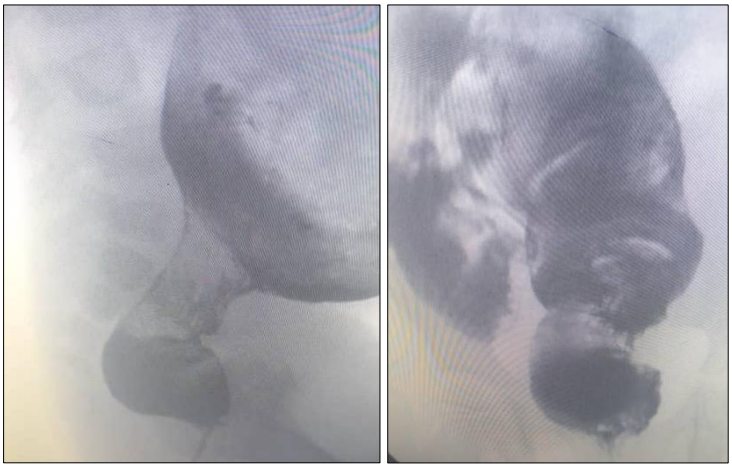

Figure 1: Barium Enema images of short-segment HSCR

Cases were identified (mean age 5 years; range 1,5-17 years) and treated by a Posterior Sphincterotomy. All patients' ability to pass stool improved promptly, except for one, who required a redo of the procedure before effective and long-lasting relief of constipation symptoms was achieved. In another nine cases, the barium enema documented a transition zone at the rectosigmoid level (Figure 2).

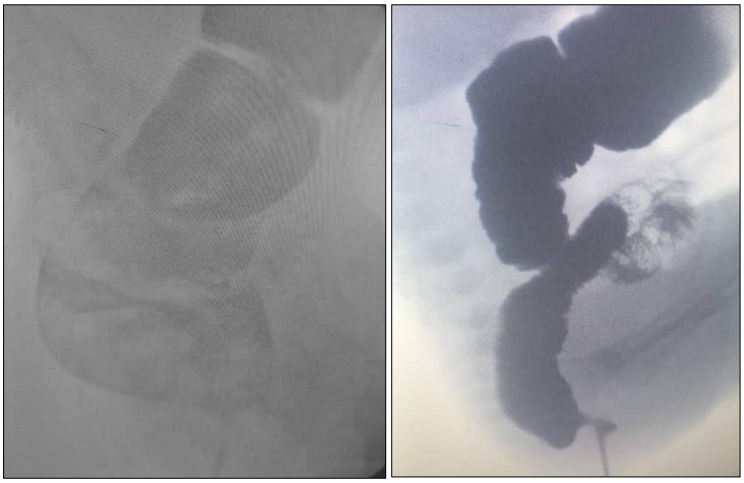

Figure 2: Barium Enema images of Recto sigmoid HSCR

A loop-level colostomy was made in all, together with multiple intraoperative colonic biopsies to confirm the ganglion level. The stoma site was ganglionic and was normally functioning, and it was pulled through between three months and one year later in three cases Duhamel and one De La Torre procedure). All had an uneventful postoperative course, full recovery, and relief from symptoms. Another six patients are scheduled for pull-through in a short time.

A one-and-a-half-year-old girl with persistent stool retention since birth, increasing distension of the colon and failure to thrive were also observed. Barium enema showed a grossly dilated large bowel without a clear-cut image of the transition zone. Sigmoid levelling Colostomy failed to reduce colonic distention and to facilitate bowel emptying. Rectal and intraoperative specimens showed smaller ganglia in myenteric plexuses and lower in number than expected; a marked reduction of intramuscular nerve fibres around the myenteric plexus was also observed in several segments of the intestine. The pathology report suggested total colonic hypoganglionosis, and colonic resection with terminal ileostomy was performed. After a few months needed to recover from severe malnutrition, an ileorectal pull-through with the Duhamel technique was performed. The procedure restored normal bowel function, characterised by the emission of solid stool and a return to normal child growth.

DISCUSSION

Colorectal diseases are a relevant and challenging portion of the paediatric surgical burden in Sub-Saharan Africa. Among them, ARM is quoted as the leading cause of intestinal obstruction from congenital malformations in Africa. Nevertheless, prevalence could be overestimated due to the hidden mortality of other life-threatening gastrointestinal abnormalities. HSCR shares a dominant position with ARM among colorectal surgical diseases presenting in children. However, incidence is still far from being reliably quoted. Many cases present a broad spectrum of nonspecific and misleading symptoms, as well as delays in seeking, accessing, and receiving care. Surgeries for both conditions require in-depth knowledge, meticulous preparation, and precise technique. In vast, underserved rural areas, far from specialist tertiary facilities, patients with a PCRD are commonly referred to a primary or secondary health facility, which is often inadequately equipped to handle these conditions. Mismanagement may preclude a successful further treatment and expose patients to complications and permanent disability. ARM and HSCR require accurate diagnostic workouts, staged surgeries, and long-term follow-up. These are frequently unaffordable or inaccessible for people living in vast, underdeveloped, and impoverished rural areas far from specialist tertiary centres [6].

An alternative option could be for second-level health facilities to offer their catchment areas appropriate treatment and follow-up for the most common children's surgical conditions through surgeons who have received specific paediatric training. A preliminary assessment of the paediatric population's specific needs will be mandatory to upgrade second-level facilities and extend their coverage to more complex paediatric diseases. Diagnostic facilities and essential infrastructure to operate safely must be in place, and nurses and anaesthetists should be familiar with paediatric case management and postoperative care. A referral system to a specialist Hub must be formally established for patients requiring more complex interventions or advanced care that cannot be provided on-site.

CHI gradually developed in-house paediatric surgical capabilities through specialist outreach, focusing on a dedicated coaching program for local health providers [7], and grants for specialist academic qualifications from COSECSA (College of Surgeons of East, Central, and Southern Africa).

Surgical camps can play a crucial role in this process. They must always be focused on education. Visiting specialists work alongside local health providers using a mentorship model to facilitate ongoing learning and progressive ownership of paediatric surgical practice, ensuring long-term sustainability [8].

The bulk of our PCRD cases consisted of HSCR and ARM. Usually, males are slightly more affected than females from ARM (1.2 to 1). According to CHI data, the male-to-female ratio is 1:1.8, similar to other sub-Saharan African reports. It could be explained by the usual presence of rectovestibular or vaginal fistula in females, which prevents intestinal obstruction and delays referral. Male patients with a recto-urinary fistula are rapidly obstructed and risk not surviving long enough to receive medical attention, sometimes dying undiagnosed before referral. The mean age at referral was not significantly different between males and females. Still, it was much higher than is usually recorded in high-resource contexts, where most ARM patients are newborns [9]. Our series had only two neonatal referrals, one male and one female. Although association with other congenital anomalies is usually reported with ARM [10], only one was recorded from our series. It can be explained by the low rate of neonatal admissions in our series and the possible hidden mortality before referral associated with more severe abnormalities [11].

Neonatal cases were also a minority among referrals for HSCR in our series (6.2%). The mean age at referral for our non-neonatal cases was four years. Patients had a history of severe chronic constipation, which is a highly sensitive symptom but not specific [12].

Forty-six among our ninety ARM and HSCR patients (51%) had an intestinal stoma on admission, with an associated complication rate of 23%. A sigmoid-

divided colostomy, as recommended before a PSARP [13], was found only in 50% of children with ARM. Antegrade washout of the distal loop before PSARP was often uneasy due to the inspissated meconium remnants not being removed during emergency diversion. Colon diversion for HSCR patients carried a minor complication rate (15%), mainly related to prolapse or stenosis. The diversion for a suspected HSCR at a primary health level had been made in an emergency, based only on long-lasting constipation, acute obstruction, with a colonic distention at plain abdominal X-ray, without any contrast radiological study or rectal biopsy. In three cases, the stoma was closed after aganglionosis was excluded.

Our surgical options for ARM were based on PSARP [14], under stoma protection. We have performed one-step PSARP in a minimal number of young patients with low recto-perineal fistulas. The benefit of reducing the number of procedures and hospital stays must be balanced with the high risk of perineal wound infection after one-step PSARP, which is increased by late referral, malnutrition and inadequate postoperative nursing in a low-resource setting [15]. Nevertheless, we observed a perineal infection in 22% of all PSARP procedures, and an abdominal wound infection after Colostomy reversal in 17%. All needed a minor surgical revision. This complication rate is within the low Range of those reported from similar surgical contexts [16, 17].

The most noticeable results in our series of ARM cases were the high number of people who could benefit from a PSARP procedure [28 out of 42 (66%)]. Twenty-one out of 24 with previous Colostomy (87.5%) had their intestinal diversion reversed in due time, and after that, 14 out of 21 (66%) could be followed for a year or more, adhering to the prescribed dilation protocol. These figures are higher than expected in under-resourced areas. It is frequently reported [17-22], from LRC that a reduced number of ARM cases (around 40%) access corrective treatment after the initial diagnosis, or are still missing the colostomy reversal, a long time later (up to 70%). Many cases are also lost from follow-up and do not fulfil the dilatation protocol, with the risk of anal stenosis. These figures may be explained in many cases by uneasy access to specialist facilities for care and close follow-up from poorly connected areas.

A few cases at neonatal onset characterise the presentation of HSCR to a primary or secondary health facility in under-resourced areas. Most of them are likely to die before referral. They are overrated by a high number of long-term, chronically obstructed, malnourished cases presenting with acute abdominal distention and sometimes with perforation [12]. The lack of pathology services at the primary level limits recourse to rectal biopsy for differentiating HSCR cases from functional constipation. Stoma reversals were needed in three children, not included in the present study, after a rectal biopsy on admission at our hospital did not confirm aganglionosis.

Although contrast studies are a reliable diagnostic tool for identifying the a-ganglionic tract [22, 23], they are rarely feasible due to the unavailability of X-ray equipment or a lack of trained personnel. Consequently, the most common early treatment recorded among our cases was a levelling colostomy performed in an emergency at a primary level, based solely on clinical presentation and plain radiological findings. In about half of those twenty-two patients referred with a levelling colostomy and included in our series, a sigmoid terminal colostomy was recorded; all the distal colonic tract had been resected, leaving a short residual rectal stump. It was not possible to retrospectively speculate about the original level of aganglionosis. All diverted patients were treated by pulling through the stoma after HSCR was confirmed by rectal biopsy, and the presence of ganglia was noted at the colostomy level.

Barium enema was performed at CHI in all undiverted cases, and a megarectum with an abrupt narrowing was documented in 61% of them. After a cleaning enema, a posterior sphincterotomy and rectal myotomy were performed [24], followed by relief of constipation in all except one patient, who required a new myotomy. Aganglionosis was documented in all surgical specimens. Sphincterotomy may also be resolutive [25], for functional, long-lasting (more than 6 months) constipation without HSCR.

Sigmoid tract aganglionosis and one case of total colonic hypoganglionosis were identified among our series (39%), and all required a pull-through procedure after a temporary loop colostomy and intraoperative multiple colonic biopsies to confirm the level of bowel aganglionosis. Frozen sections are still unavailable at CHI to consent to a one-step pull-through. However, a recent report shows that this approach is feasible based only on the barium enema findings of the transition level [26].

Our figures confirm that the epidemiology of HSCR in an LRC is highly influenced by a low rate among hospital referrals of cases with neonatal onset, which represent the most severe clinical forms of the disease and are associated with a high rate of early unrecorded mortality. Consequently, there is a higher proportion of chronically obstructed cases with a more limited a-ganglionic tract, which is compatible with a long-term clinical course before seeking medical attention [12]. Therefore, a reliable barium enema may reduce the need for a levelling colostomy and pull-through, and identify cases that respond to a simple sphincterotomy.

In conclusion, extending paediatric surgical specialist coverage through selected secondary facilities

with upgraded local capacities, like CHI, may reduce the risk of mismanagement for PCRD in those LRCs far from specialist tertiary facilities. Appropriate staged treatments and close postoperative follow-up are made more accessible for children living in the hospital's close-connected catchment area, who have fewer financial and transportation difficulties.

Ethical Standards

All procedures were performed in accordance with the 1964 Helsinki Declaration and its subsequent amendments, or with comparable ethical standards.

Competing Interests: The authors declare that they have no competing interests.

Authors' Contributions: All authors contributed equally to the work.

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