Laparoscopic-assisted Swenson pull-through for Hirschsprung's disease

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Background
Many procedures were adopted for the management of Hirschsprung's disease (HD), which progressed from staged procedures to a single-stage surgery. Advances in minimal invasive surgery have led to successful applications of laparoscopic-assisted techniques for the surgical management of HD. This study was conducted to evaluate the feasibility, safety, and the short-term outcome after laparoscopic-assisted Swenson pull-through technique in the management of HD.
Patients and methods
Thirteen patients presented with HD were subjected to laparoscopic-assisted Swenson pull-through technique.
Results
This study included 13 males and five females. The age at pull-through ranged from 2 months to 6 years with a median age of 9 months. The mean operative time for the total procedure was 120 min (100–170 min). No intraoperative complications were reported. The mean length of the excised segment was 24 cm (17–29 cm). The mean length of hospital stay was 5 days (4–7 days). Postoperative enterocolitis was recorded in one patient. Soiling was observed in two patients. Perianal excoriation was observed in three patients. No urinary problems were recorded in all patients. The mean follow-up period was 18 months with no recorded late postoperative complications.
Conclusion
Laparoscopic-assisted Swenson pull-through is a feasible, safe, and suitable technique for the treatment of short-segment HD in children with favorable short-term outcomes.

Keywords:
Hirschsprung's disease, laparoscopic, Swenson

Background

Hirschsprung's disease (HD) is a relatively common congenital disorder of the alimentary tract, which causes intestinal obstruction in children with an incidence of 1/5000 live births [1,2]. The surgical management of HD has developed rapidly from two-staged or three-staged procedures to a single-stage surgery and the clinical practice has been modified in the last three decades from open to trans-anal and laparoscopic-assisted surgery [3–6].

Advancement in minimal invasive surgery scopes, tools, and techniques has resulted in clear visualization of the pelvis and enables precise dissection of its structures so laparoscopic-assisted pull-through procedures have become the main surgical method for the management of classic rectosigmoid HD [7–10].

The feasibility, efficacy, and safety of laparoscopic-assisted operations for HD has been the focus of interests and attention and many considered the laparoscopic-assisted Soave pull-through technique is the procedure of choice for the management of HD [11,12].

The aim of this study was to evaluate the feasibility, safety, and the short-term outcome after laparoscopic-assisted Swenson pull-through technique and to detect the role of laparoscopy in the detection of the transitional zone in questionable cases.

Patients and methods

This is a prospective study conducted on 18 patients presented with HD, who underwent a single-stage laparoscopic-assisted Swenson pull-through operation in our institution in the period from February 2016 to

February 2022. Patients with rectosigmoid HD, patients with a transitional zone reaching up to the descending colon, and patients with unclear transitional zone in preoperative contrast study were included. Exclusion criteria included patients with short-segment HD, who were managed using single-stage trans-anal endorectal or Swenson pull-through techniques, patients with colostomy, patients with major congenital anomalies, and partners who refuse laparoscopic surgery.

Approval was obtained from the Institute's Research Ethics Committee, Tanta Faculty of Medicine, Egypt on December 2015. All guardians consented to participate in the study and were informed about all steps including the operative idea and the postoperative follow up.

HD was diagnosed on the basis of typical clinical manifestation (delayed passage of meconium, constipation requiring continuous suppositories, and enemas), findings of gastrografin enema, and the histopathological examination of rectal biopsy.

Special charts were designed to retrieve the following data: patients' demographics, total time of surgery, amount of blood loss, length of hospital stay, the level of transitional zone, the intraoperative and postoperative complications, and the short-term outcome.

Statistical analysis was done using SPSS v. 20 (IBM, Ne York, New York, USA). We used the simple descriptive analysis: the mean and SD were calculated for numerical variables, whereas frequency and percentage were calculated for categorical variables.

Operative technique

Routine colonic preparation was done (in older children), the preoperative preparation started 1–2 days before surgery by allowing only clear fluids to the child. Colonic irrigations by 10–20 ml/kg body weight of warm saline every 6 h in the first 2 days through a rectal tube passed to a point just above the transition zone then as frequent as 4 h until the output was clear. In neonates and infants, colonic preparation was done in 1 day by rectal irrigations consisting of passing a large lumen tube through the rectum and irrigating with a small amount (10 ml) of saline solution at a time and repeated until the output was clear. Local intestinal antiseptic (erythromycin) was taken orally, 8 and 4 h preoperatively).

A third-generation cephalosporin was given during the induction of general anesthesia. The patient was catheterized under complete aseptic condition. The patient was placed in supine position at the end of the operating table while the surgeon standing on the right side during the laparoscopic part of the procedure, then the patient was put in lithotomy position with his legs elevated up and fixed by a cross bar with elevation of the pelvis at the end of the operating table to complete the trans-anal part of the procedure.

An open technique through a 5 mm incision at the umbilicus was used for insufflation of the abdomen with CO_2. A 5 mm scope was introduced through the umbilical or epigastric trocar. Another 5 mm port was then introduced at the midclavicular line to the right side of the umbilicus but with a little lower level than the scope port. The third port was inserted in the right iliac fossa laterally to the second port (Fig. 1). When a fourth port was needed, a transfixing silk or Proline suture was used for traction and hanging of the colon to the abdominal wall.

Laparoscopic exploration of the abdomen was done and the obvious transition zone in the contrast enema was confirmed. Laparoscopic seromuscular biopsy was taken for histopathology to confirm the site of the transition zone.

Once the transition zone was determined, the bowel was elevated and dissection of the rectosigmoid mesocolon was started adjacent to the wall of the colon using hook monopolar cautery, bipolar or sometimes with ligasure electrocoagulation (Covidien, Dublin, Ireland). The mesenteric window in the mesocolon was extended distally below the peritoneal reflection (Figs 2 and 3).
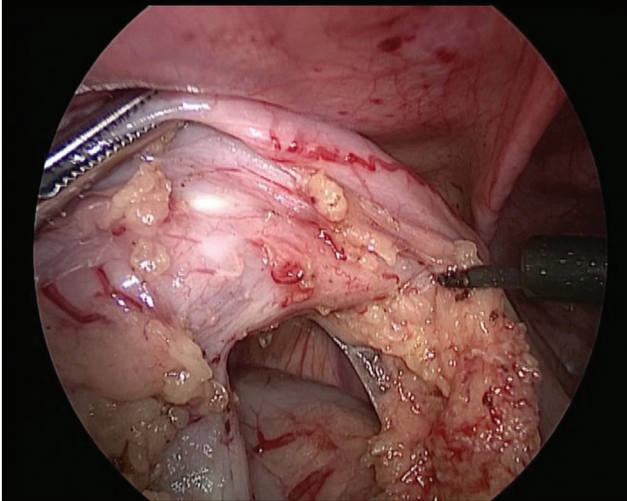
The position of the patient was changed to lithotomy position with slight elevation of the pelvis. The trans-
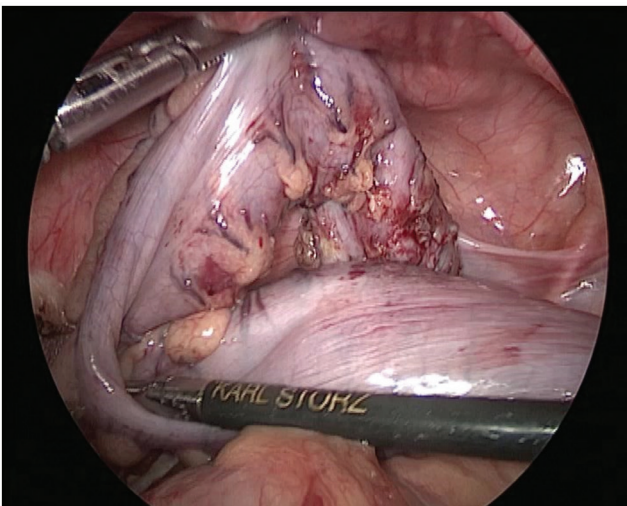
Figure 1
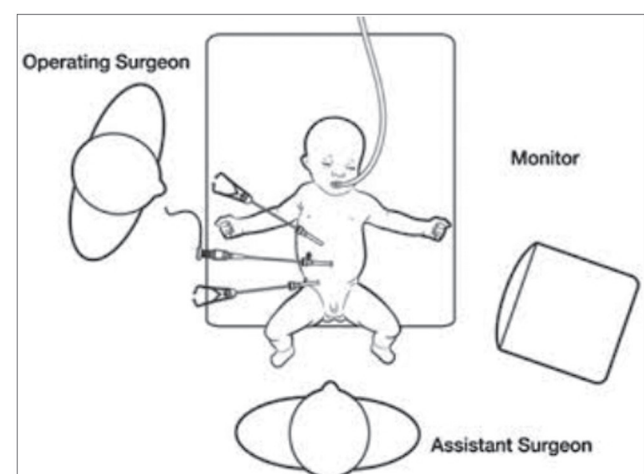
Sites of laparoscopic ports.

Figure 2

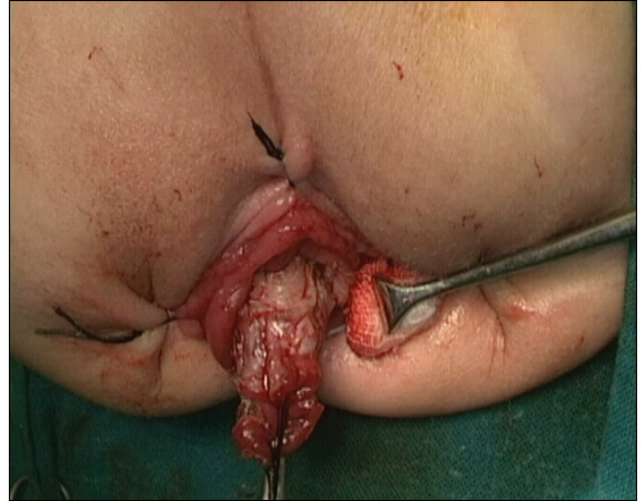Dissection of the rectosigmoid mesocolon adjacent the wall of the colon.

Figure 4

A circumferentially trans-anal full thickness dissection of the rectal wall.

Figure 3

Complete mobilization of rectosigmoid colon till the peritoneal reflection.

Figure 5

Mobilization of the rectum and sigmoid colon outside the anus.

anal part was started by exposure of the rectal mucosa either by using the Lone star retractor system or by using multiple everting silk sutures. Circumferentially interrupted traction (4/0) silk sutures were applied 1–1.5 cm above the dentate line. A needle-point monopolar diathermy was used to make a full thickness incision on the rectal wall posteriorly, 0.5–1 cm above the dentate line and then the incision was extended circumferentially, incising the full thickness of the rectal wall (Fig. 4). Once the Swenson plane was established, the dissection was extended and the rectum was drawn outward using traction sutures. Mobilization of the rectum was continued close to the rectal wall using unipolar or bipolar cauterization probe with coagulation of extrinsic mesocolon vessels. Once the peritoneal reflection was reached, the dissection was performed more easily; the full thickness of the rectum and sigmoid colon was mobilized outside the anus (Fig. 5). The proximal colon was resected 5–10 cm above the transition zone and then full thickness coloanal anastomosis using absorbable Vicryl 4/0 sutures was done (Fig. 6). A rectal tube was inserted specially in neonates to reduce postoperative edema and abdominal distention.

Pneumoperitoneum was established again and the abdomen was inspected for pedicle twist, internal hernia, or bleeding. The ports were removed after evacuation of CO_2 and the port sites were closed. The resected spacemen were sent for histopathological examination after marking of the proximal and the distal end (Fig. 7).

Figure 6
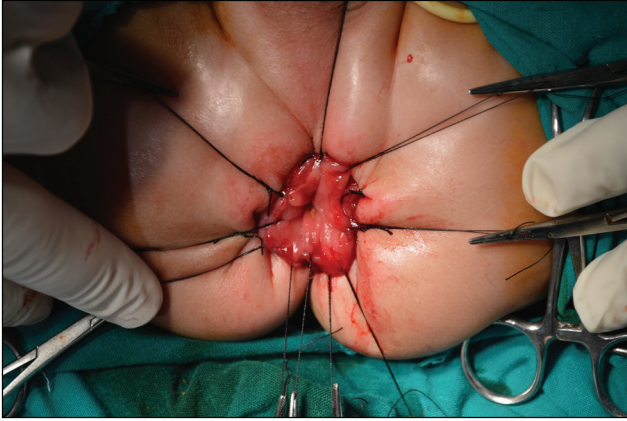
Full thickness coloanal anastomosis using absorbable sutures.

Figure 7

The resected spacemen.

Oral feeding was started after regaining of the intestinal sound. The patient was discharged when tolerating a regular diet appropriate for age. Calibration of the anus was done 2 weeks after operation using a Hegar dilator. Anal dilatation was done and gradually increasing the size of the dilator by 1 U every 15 days and stopped on the basis of the child's age as suggested by Pena [13] for children with anorectal malformations. Patients were followed in the outpatient clinic every 2 weeks for the first 3 months and then monthly thereafter.

Results

Eighteen procedures were successfully completed laparoscopically. The transitional zone was present in the rectosigmoid colon in 10 patients and reaching the descending colon in five patients. Three patients had unclear transitional zone in the preoperative contrast study. Laparoscopic intraoperative frozen section confirmed the transition zone in the sigmoid colon in two patients and in the mid-descending colon in one patient, so the transition zone was confirmed in

Table 1 Operative data

Operative data	n (%)
Transitional zone	
Rectosigmoid	12 (66.7)
Mid-descending colon	6 (33.3)
Length of excised segment	
17–20	10 (55.6)
20–25	2 (11.1)
25–29	6 (33.3)
Injury to surrounding structures	0
Blood transfusion needed	0
Conversion to open	0

the rectosigmoid region in 66.6% and in the mid-descending colon in 33.3% of cases (Table 1).

There has been no conversion to open or trans-anal surgery. There were 13 males and five females. The age at the time of pull-through ranged from 2 months to 6 years with a median age of 9 months.

The mean operative time for total procedure (from the start of incisions till removal of laparoscopic ports) was 120 ± 20.3 min (range, 100–170 min). The trans-anal dissection and coloanal anastomosis were performed easily without difficulties in all patients. The mean blood loss was 24 ml (10–42 ml). No blood transfusion was required in all patients. The mean length of the excised segment was 22 ± 2.9 cm (range, 17–29 cm). There were no intraoperative complications. Peristalsis was regained within the first 48 h in all patients, and full oral intake was achieved in the third to the fourth postoperative day. The mean length of hospital stay was 6 ± 2 days (range, 4–8 days).

Follow-up was scheduled at third, sixth, 12th, and 24th months (median 15 months). The recorded data in the follow-up session were: stool frequency and consistency, fecal incontinence, enterocolitis attacks, development of anal or anastomotic strictures, or adhesive obstruction. The mean adherence to the follow-up plan was 18 ± 2.3 months (range, 12–20 months) with no recorded late postoperative complications. Postoperative regular anal dilatation was done in all patients starting after 2 weeks up to 3 months with no recorded patients suffering from anal or anastomotic stricture.

Postoperative enterocolitis was recorded in one (5.5%) patient, which responded successfully to rectal irrigation with normal saline and intravenous antibiotics and metronidazole. The mean of frequency of bowel movements at discharge was 5 ± 1.8 times/day (range, 3–8). Soiling (defined as one involuntary bowel movement in between two voluntary movements) was observed in two (11.1%) patients in

Table 2 Postoperative data

Postoperative data	n (%)
Stool frequency	
0–1 times/day	0
2–3 times/day	2 (11)
More than 3 times/day	16 (88.9)
Soiling	2 (11.1)
Perianal excoriation	3 (16.7)
Enterocolitis	1 (5.6)
Anal or anastomotic stricture	0
Adhesive obstruction	0
Mortality	0

the late postoperative period, which improved after 6–12 months. Perianal excoriation was observed in the early postoperative period in three (16.6%) patients, which was effectively improved by using topical creams containing zinc-based barriers. No urinary problems were recorded in all patients (Table 2).

Discussion

Historically, the surgical management of HD was staged with diverting stoma as the initial treatment of choice [14]. Since Swenson's initially describe his operation for definitive management of HD, a number of other procedures have been adopted including the Soave abdominal and trans-anal pull-through in which the proximal ganglionic intestine is pulled through the rectal muscle cuff, the Duhamel procedure in which the aganglionic bowel is side to side anastomosed to the normal pulled-through colon.

A major transition in the treatment of HD occurred in the last three decades due to better understanding of the disease and improvement in the surgical and anesthetic equipment: a single-stage protocol was adopted; many studies demonstrated good results and satisfactory outcomes with single-stage operations [10,15–17].

The introduction of a single-stage trans-anal endorectal pull-through by De la Torre and Ortega [18]. This operation potentially minimized the risk of intraperitoneal contamination, adhesion formation, and damaging the pelvic structures. Another transition was the introduction of the trans-anal Swenson pull-through, to avoid the problems posed by leaving a seromuscular cuff in trans-anal endorectal pull-through operations [19].

Recently, laparoscopic-assisted techniques have been adopted to these procedures [10,20]. The laparoscopic-assisted operation has many advantages over the abdominal and the trans-anal techniques: it provides clear visualization of the peritoneal cavity for any associated anomalies; it allows clear delineation of the pelvic structures in small neonates and infants; and it provides adequate mobilization of the colon and minimizing the peritoneal trauma and contamination [10]. In this study, there were three cases with unclear transitional zone in the preoperative contrast study and by using laparoscopy, it allows obtaining seromuscular biopsy for confirmation of the level of resection. The transitional zone was confirmed in the sigmoid colon in two patients and in the descending colon in one patient.

Different sealing devices were used for dissection of the mesocolon during the laparoscopic part. Rothenberg and Chang [21] used an ultrasonic scalpel for controlling the mesocolon in his series. Kumar et al. [10] carefully applied the unipolar diathermy with maintaining a good visualization of the diathermy tip. In this study, sealing of the mesocolon was done carefully using monopolar and bipolar diathermy, which provide a safe and cheaper method for colonic dissection.

The mean operative time was 120 ± 20.3 min (range, 100–170 min). There was no great difference with other series. It was 105 min (range, 66–175 min) in the Kumar et al. [10] study and 148 min in the Deng et al. study [7]. But it was 213 min (143–306 min) in the Yokota et al. [22] study.

The mean blood loss was 24 ml (10–42 ml) and there were no cases of intraoperative blood transfusion. Kumar et al. [10] reported minimal blood loss in laparoscopic Swenson procedure and no patient requiring blood transfusion. It was 10 and 7.5 ml in the Deng et al. [7], and Yokota et al. [22], series.

Single-stage trans-anal Swenson pull-through was demonstrated by Weidner and Waldhausen [23], who avoided intrapelvic dissection by making devascularization of the colon till the peritoneal reflection through the left quadrant mini-laparotomy. Preservation of the sacral nerves and ejaculatory duct was done by keeping the dissection directly on the wall of the colon. Levitt et al. [24] explained the fecal, voiding, and sexual problems that occurred after the initial description of the Swenson operation by the wide dissection in the pelvis and demonstrated that the trans-anal Swenson procedure was better in this aspect and preserve the fecal, voiding, and sexual function. One of the basic principles of the laparoscopic trans-anal pull-through procedure is to make the coloanal anastomosis low enough to avoid the persistent obstructive symptoms but high enough to preserve the dentate line and hence the transitional epithelium

responsible for normal anal sensation [8]. In this study, laparoscopic dissection of the colon was done close to the colon wall and does not proceed beyond the peritoneal reflection and the trans-anal dissection done about 0.5–1 cm above the dentate line with no recorded fecal and urinary dysfunction.

Many factors are responsible for fecal continence: intact sensation, voluntary sphincter contraction, and intestinal motility [25]. Soiling after pull-through procedures occurred in 10–50% of patients, depending on how it is defined. Deng and colleagues reported soiling in one (4.8%) patient and demonstrated that lack of dilatation of the anal canal and lack of overstretching of the anal sphincter in laparoscopic-assisted Swenson procedure resulted in significant lower incidence of soiling and much improvement in continence mechanisms [7]. Others stated that all maneuvers in laparoscopic-assisted Swenson were done under clear vision and dissecting the mesentery was very close to the colon wall by the prolapsing technique, so preservation of the nerves ascending from the pelvis seems to have been achieved [26,27]. In this study, the dentate line was checked immediately after the coloanal anastomosis, and digital rectal examination was done 2 weeks after the operation. The dentate line and the coloanal anastomosis were preserved and the integrity of the anal canal was retained. The procedure has the advantage of pull-through the entire colon to the anus without overstretching of the anal sphincter and hence decreases the incidence of postoperative soiling, which was reported in two (11.1%) patients in the immediate postoperative period and improved by time.

Enterocolitis is one of the complications that may occur before and after surgery of HD with an estimated incidence of 5–50%. It is one of the most common causes of mortality in patients with HD, so early diagnosis and proper treatment with bowel irrigation, broad-spectrum antibiotic and metronidazole therapy are imperative. To have relative low incidence of postoperative enterocolitis, Elhalaby et al. [28] recommended shortening of the seromuscular cuff, low coloanal anastomosis, and routine postoperative anal dilatation particularity in neonates and infants. Family education about the symptoms and the signs of enterocolitis are very important [29]. Enterocolitis was reported in one (5.5%) patient in this study and improved with the conservative treatment including rest of the bowel, systemic antibiotics, and bowel irrigation. Deng et al. [7] also reported one (4.8%) patient in his study.

Perianal excoriation was observed in the early postoperative period in three (16.6%) patients,

which was effectively improved using topical creams containing zinc-based barriers. Deng et al. [7] reported perianal excoriation in four patients after modified laparoscopic Swenson procedure. Yokota et al. [22] reported perianal excoriation in all patients in the early postoperative period and one patient during discharge after modified laparoscopic Swenson procedure. Decrease in time of anal sphincter overstretching was most probably the cause of superiority of the number of cases with minimal degree of soiling and excoriations in early postoperative period in this study.

Digital rectal examination can early detect and manage tightness of the suture line to avoid permanent stricture formation. Meticulous good vascularized anastomosis and routine rectal dilatation was probably the cause of decreasing the incidence of anastomotic stricture in this study. Similar results was reported by Deng et al. [7] and Yokota et al. [22].

Conclusions
Laparoscopic-assisted Swenson pull-through is a feasible, safe, and suitable technique for the treatment of HD in children with favorable short-term outcomes. Laparoscopy allows obtaining a seromuscular biopsy before the irreversible perianal dissection for confirmation of the level of resection, especially in patients with unclear transitional zone.

Limitations
This study was a one-center study with limited number of patients. A large series of patients is required to thoroughly evaluate the results of this technique.

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Nil.

Conflicts of interest
There are no conflicts of interest.

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