Original Article

Single-stage Transanal Endorectal Pull-Through for Hirschsprung's Disease: A Retrospective Study of Surgico-pathological Correlations and Technical Considerations

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Abstract

Background: Transanal endorectal pull-through (TEPT) is a well-established operation for the management of rectosigmoid and short-segment Hirschsprung's disease (HD). A well-performed contrast enema (CE) is an essential road map for the surgeon when attempting the TEPT. We looked at the surgicopathological–radiological correlations and technical considerations of this procedure and discussed our experience over a decade. TEPT essentially relies on radiological mapping of the disease correlating with intraoperative and pathological findings. Some investigators opine that the radiological correlation of the transition zone (rTZ) with the pathological transition zone (pTZ) is accurate whereas others disagree. We review our experience in managing HD patients with TEPT, in terms of pre-operative workup and operative and pathological considerations. **Materials and Methods:** A retrospective study was done in a single unit, from January 2010 to January 2020. Forty-seven patients who met the inclusion criteria such as short-segment HD and uncomplicated HD underwent CE before surgery. The patients included in the review underwent a primary TEPT. For each patient, we identified the radiological transition zone (rTZ) on the contrast enema, the gross transition zone (gTZ) on intraoperatively visual examination, the frozen section transition zone (fTZ) on intraoperative analysis of the frozen section specimens (fTZ), and the pathological transition zone (pTZ) on permanent paraffin blocks of the specimens. We determined the strength of correlation of the rTZ, the gTZ and the fTZ with reference to the pTZ. **Results:** Forty-seven patients underwent single-stage transanal pull-through. There were 40 males. There were 8 neonates, 20 infants and 19 children (>12 months of age). The mean age at diagnosis was 8.7 days (3–20 days) for the neonates, 5.11 months (2–12 months) for the infants and 4.3 years (1.5–9 years) for children. In our study, 85% correlation was noted between the rTZ and the pTZ ($\tau b = 0.362$, $P = 0.006$). There was an excellent correlation between the intraoperative gTZ, fTZ and the pTZ in all patients except one (97.8%, $\tau b = 0.942$, $P < 0.001$). **Conclusions:** The TEPT is a feasible option to manage carefully selected patients with rectosigmoid HD. The presence of robust support from pathology and a properly carried out CE are essential parameters to be considered before successfully undertaking these operations. The functional outcomes of TEPT are comparable with other procedures for HD with the added advantage of it being a scar-less and a stoma-less approach.

Keywords: Contrast enema, frozen section, Hirschsprung's disease, transanal endorectal pull-through, transition zone

Introduction

Hirschsprung's disease (HD) is a complex neurocristopathic developmental anomaly that causes functional intestinal obstruction at various levels.[1] Surgical management includes reconstruction of the normally innervated and ganglionated bowel, down to the anal canal. Several reconstructive procedures have been described since Swenson's procedure in 1948.[2] The commonly performed procedures include the Soave and Duhamel procedures, with various modifications described over the decades. In the late 1990s, transanal Soave's was described, by De La Torres, Ortega-Salgado and Langer after a series of initial operations in infants.[3,4] Unlike

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laparotomy and laparoscopy, the transanal route largely avoids intraperitoneal dissection and has been proven to cause less pain, shorter hospital stays and a better cosmetic result than open surgery. The added advantages of a stoma-less and scar-less operation make it more readily acceptable to the parents and caregivers of these children.

The basic premise of the transanal endorectal pull-through (TEPT) is that the radiological mapping of the disease should correlate well with the intraoperative and the pathological findings. A water-soluble contrast enema (CE) is a widely employed tool to diagnose HD and determine the level of the radiological transition zone (rTZ). Reliable identification of the transition zone ensures pulling down adequately ganglionated bowel for improved outcomes in these patients.

There are numerous reports in the literature discussing the pros and cons of TEPT. Most studies discuss good functional outcomes; however, there are conflicting reports about the surgicopathological-radiological correlation in the literature. Some investigators claim that the radiological correlation of the transition zone (rTZ) with the pathological transition zone (pTZ) is accurate,[5-7] whereas others disagree.[8-10] This review discusses our experience in managing HD patients who have undergone TEPT for over a decade, in terms of pre-operative workup and operative and pathological considerations.

Materials and Methods

After approval from the Institutional Ethics Committee vide letter no. NK/6371/study/357 dated 12 September, 2020, we carried out a retrospective analysis of patients with HD who had undergone TEPT over a 10-year period from January 2010 to January 2020.

The diagnosis of HD was based on the clinical presentation and the findings of the CE. In the neonatal group, meconium ileus, intestinal atresia and meconium plug syndrome were ruled out by standard diagnostic methods. Functional constipation was excluded by careful history and physical examination in older children. The patients with short-segment HD (rTZ) up to sigmoid colon were included in the review. We included patients with added criteria of (i) no features of enterocolitis, (ii) no evidence of bowel perforation at diagnosis, (iii) with a good general condition and (iv) without preliminary colostomy. Patients with long-segment disease including total colonic aganglionosis, patients who did not 'decompress' well even on rectal washes and those with known syndromes like Downs were excluded from the study.

At admission, all patients were adequately resuscitated by correcting dehydration, dyselectrolytaemia, if any, and administration of broad-spectrum antibiotics. All patients underwent basic haematological and biochemical investigations and an abdominal radiograph. Patients with signs of bowel perforation and/or features suggestive of enterocolitis were excluded and managed in a separate arm as per the institutional protocol [Figure 1]. Patients who did not decompress on rectal washes were taken up for a stoma. As a protocol, all suitable cases were subjected to a water-soluble, non-ionic CE at the earliest. Rectal washes and digital rectal examinations were withheld for at least 24–48 h before the CE.

Contrast enema

The CE was performed with an infant feeding tube placed just inside the anal canal and the contrast was introduced by gravity and not pushed with any force to minimise the operator-dependent error. The radiographs were taken immediately with an anteroposterior as well as lateral view followed by a delayed 24 h film when indicated. The diagnosis of HD was made on CE when the transition zone was seen and defined as a 'funnel-shaped' area between the dilated proximal colon and the narrow spastic colon [Figures 2 and 3].

Sudden expansion proximal to the stenotic bowel, irregular colorectal contractions and retained contrast in a 24 h film were kept as strong indicators of suspicion of HD. CE was reported by a paediatric radiologist and independently interpreted by the operating surgeon. The presence or absence of the radiological transition zone (rTZ) was the key factor in the diagnosis of HD. Patients with rTZ at either rectum, rectosigmoid, distal or proximal sigmoid were considered for TEPT, provided the patient decompressed well on washouts. Patients with no TZ despite a strong clinical suspicion underwent a full-thickness rectal biopsy (FTRB). Patients with rTZ at a level proximal to the sigmoid or those who did not decompress or had recurrent Hirschsprung-associated enterocolitis were managed by Hartmann procedure or a divided sigmoid colostomy followed by a modified Duhamel pull-through procedure and were excluded from the study.

Pre-operative preparation

Once bowel decompression was done by frequent rectal irrigations, the patients were planned for TEPT. Standard bowel preparation was carried out before surgery.

Surgical procedure and pathological analysis

After induction of general anaesthesia, the patient was placed in the lithotomy position with the pelvis elevated with a size-appropriate sandbag. IV antibiotics (cefotaxime 50 mg/kg) were given at the time of induction. The bladder was catheterised and nasogastric intubation was done in all patients.

The anal canal was exposed using silk stay sutures. A circumferential row of silk stay sutures (4–0 or 5–0, depending on the patient's age), was taken at 0.5 to 1.0 cm proximal to the dentate line. A submucosal dissection was begun after incising the rectal mucosa just distal to the stay sutures, initially using No. 15 scalpel blade and then lifted with a fine right-angle (Mixter®) dissector. This was followed by incisions using a fine-tip needle diathermy, using alternate low cutting and coagulating monopolar current. Once the correct submucosal plane was achieved, the dissection was proceeded proximally using blunt dissection.

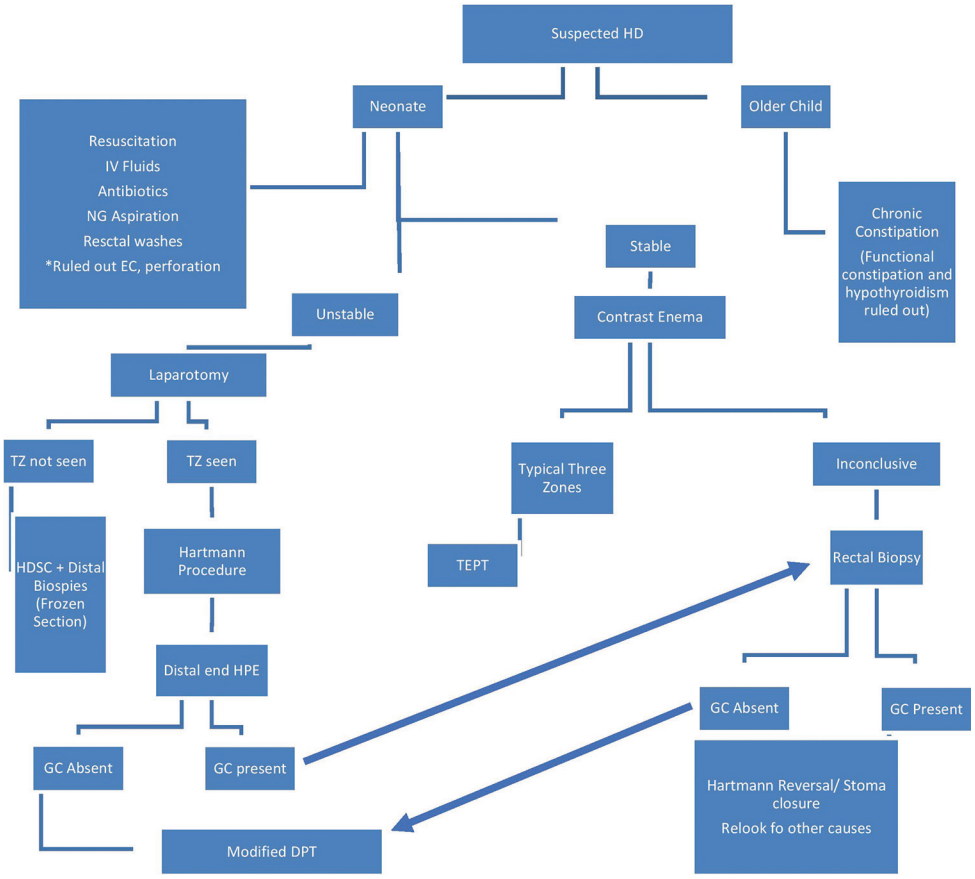


Figure 1: An algorithm showing the management protocol for patients with HD. HD: Hirschsprung's disease, TEPT: Transanal endorectal pull-through, CE: Contrast enema

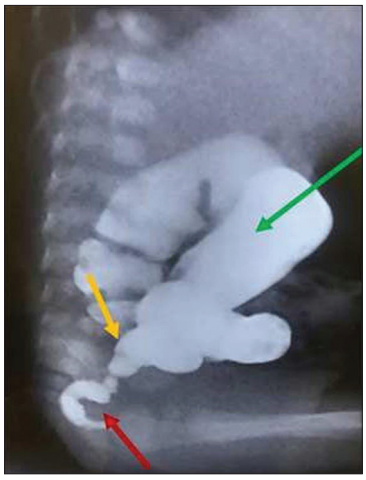


Figure 2: Contrast enema: Red arrow narrow spastic zone; Yellow arrow Transition zone; Green arrow normal dilated bowel

Adequate traction on the mucosal tube is the key factor to staying in the correct submucosal plane. Any small submucosal infiltrating vessels were carefully cauterised along the way using bipolar cautery.

As the peritoneal reflection was reached, 2 silk stay sutures were taken to control the upper end of the muscular cuff which was then incised circumferentially to make the dissection now 'full-thickness'. At this juncture, it becomes pertinent to mark the bowel with a suture to maintain the correct orientation and to avoid twisting the pulled-down bowel. Mobilisation of the colon was further carried out by dividing and ligating the rectosigmoid vessels close to the bowel till the dilated portion of the colon is reached. We mobilised the colon till about 5–7 cm above the gross transition zone (gTZ) to avoid the possible hypoganglionosis in this area and eventually prevent pull-down of inadequately ganglionated bowel.

Once the gTZ is reached, the frozen section biopsies are sent from at least 4 areas. The first two are sent from the mucosal tube at a varying distance (a, b) and the third from the gTZ (c) and the 4th from 5 to 7 cm proximal to the gTZ (d) [Figure 4]. The pathologist is blinded to the radiological findings, measures the resected bowel and reports the varying levels of aganglionosis. The level 'D' is reported on priority. Once the D section shows the presence of ganglion cells, the muscular cuff was incised longitudinally at a 6 o' clock position and then colo-anal anastomosis was completed with absorbable polyglactin suture (4-0). If the level D biopsy did not show ganglion cells, the dissection was continued proximally and sequential biopsies were sent at every 5 cm, till ganglionic bowel was reached. After the colo-anal anastomosis completion, an anal pack is kept. The anal pack is removed the next morning and the patient is kept nil per oral till he/she

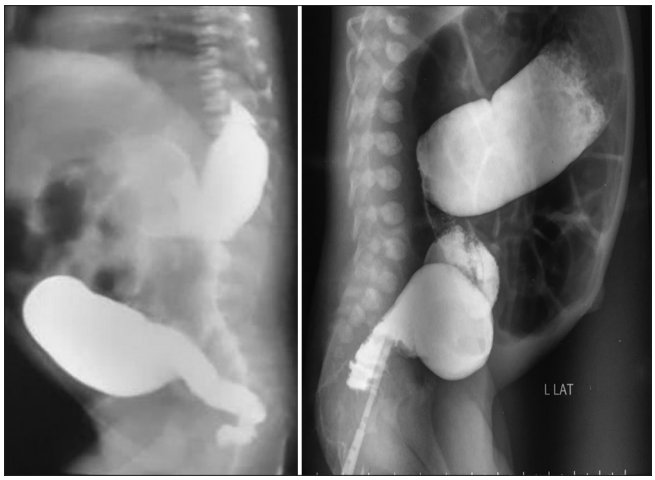


Figure 3: Contrast enema of two neonates with HD. HD: Hirschsprung's disease

passes stools. Once started orally and off IV fluids, he/she is discharged and then followed up in the outpatient department as per a standard follow-up regimen.

This is later objectively compared to the distance of the per-operative finding and the gTZ as per visual assumption by the surgeon and is corroborated with the frozen section transition zone (fTZ) and ultimately the paraffin section (pTZ), which serves as the gold standard.

Statistical analysis

The patient characteristics were reported as numbers and percentages. Corroboration of the rTZ, the gTZ and the fTZ with the pTZ was reported at percentages and their strength of correlation was determined using the Kendall's tau correlation coefficient. The statistical analysis was performed using SPSS version 26 (SPSS, Chicago, Illinois, USA).

Results

Patient characteristics

A total of 47 patients underwent single-stage transanal pull-through. There were 40 males and 7 females (85.1% males) included in the study. There were 8 neonates, 20 infants and 19 children (>12 months of age), ranging from 3 days to 9 years of age at the time of diagnosis. The mean age at diagnosis was 8.7 days (3–20 days) for the neonates, 5.11 months (2–12 months) for the infants and 4.3 years (1.5–9 years) for children. The mean weight at diagnosis was 2.87 kg (2.5–3.3 kg) for the neonates, 5.62 kg (2.7–9.5 kg) in the infants and 14.6 kg (9.2–30 kg) in the children.

The symptomatology of the patients is described in Table 1 and the CE (rTZ) findings are tabulated in Table 2.

Six patients (2 infants and 4 children) with equivocal CE reports underwent FTRB. All 6 had absent ganglion cells reported and underwent a TEPT 6 weeks after the FTRB. In our study, 12.7% of patients had an equivocal report on the CE. More than 50% of patients had the rTZ at the level of rectosigmoid (55.3%).



Figure 4: Intraoperative specimen with areas marked for frozen section

During the surgical procedure, the mean total bowel resected was 10.4 cm (7–16 cm) in the neonates, 22.6 cm (8–33 cm) in infants and 25.3 cm (16–36 cm) in children above 1 year of age.

Surgical, pathological and radiological correlation of the level of transition zone

The rTZ, gTZ and the fTZ were correlated with the pTZ and are described in Table 3.

There was significant correlation between the rTZ and the pTZ ($\tau b = 0.362$, $P = 0.006$). Discordance was present in 14.89% of patients. However, on subgroup analysis, it was noted that this correlation was not significant in infants and children >1 year of age. The gTZ ($\tau b = 0.942$, $P < 0.001$) and the fTZ had excellent correlation with the pTZ ($\tau b = 0.942$, $P < 0.001$).

Subgroup analysis

There were no differences in the rTZ, gTZ, fTZ and pTZ in the neonatal group ($\tau b = 1.0$, $P < 0.0001$).

In the infants, 2 (10%) patients had equivocal studies on the CE. One of these patients had gTZ in the rectosigmoid area and 1 in the distal sigmoid, which was concordant with the fTZ and the pTZ. On Kendal Tau's analysis, there was a positive correlation of rTZ with pTZ ($\tau b = 0.36$. $P = 0.09$); however, it was not statistically significant. The gTZ and the fTZ correlated significantly with the pTZ ($\tau b = 0.85$, $P < 0.0001$). There was discordance of gTZ and fTZ with the pTZ in only one infant. In this patient, the CE and the gross appearance were suggestive of TZ in the rectosigmoid region, which also corroborated with the results of the frozen section biopsy. However, the paraffin section reported an absence of ganglion cells at the level of the pulled-down colon. This patient had difficulty passing stools in the post-operative period. The patient required a diversion colostomy four weeks after the TEPT. Eight months later, he underwent a Modified Duhamel pull through.

In the paediatric age group, there were 4 CEs (21%) that did not show a convincing rTZ. One of these patients had a gTZ in the rectosigmoid area and the remaining three patients had the gTZ in the distal sigmoid area. On Kendall's tau correlation, the rTZ did not correlate with pTZ statistically ($\tau b = 0.138$, $P = 0.50$). However, there was a 100% correlation between the gTZ, the fTZ and the pTZ ($\tau b = 1$, $P < 0.0001$).

Table 1: Symptoms of patients

	Delayed passage of meconium (>48 h) (%)	Failure to thrive (%)	Abdominal distension (%)	Vomiting (%)	Chronic constipation (%)	Laxative use/ enema (%)	Enterocolitis (%)
Neonate	8 (100)	0*	8 (100)	5 (62.5)	0*	1 (12.5)	1 (12.5)
Infant	13 (65)	12 (60)	15 (75)	8 (40)	15 (75)	13 (65)	2 (10)
Children (>1 year)	9 (47.3)	13 (68.4)	18 (94.7)	5 (26.3)	18 (94.7)	18 (94.7)	3 (15.7)

*Chronicity of constipation and failure to thrive cannot be commented upon on neonates as they presented soon after birth

Table 2: Contrast enema findings

	Equivocal (%)	rTZ in rectum (%)	rTZ in recto sigmoid region (%)	rTZ in mid sigmoid (%)	rTZ in proximal sigmoid (%)
Neonate (*n*=8)	0	4 (50)	3 (37.5)	1 (12.5)	0
Infant (*n*=20)	2* (10)	3 (15)	14 (70)	0	1 (10)
Children (*n*=19)	4* (21)	5 (26.3)	9 (47.3)	0	1 (5.2)

*6 patients with equivocal reports underwent full thickness rectal biopsy. All 6 had absent ganglion cells. Equivocal CE was seen in 2 patients in the infantile and 4 in the paediatric age group. All these had strong clinical suspicion of HD and underwent a FTRB. All 6 had "absent ganglion cells" reported and underwent a TEPT 6 weeks after the FTRB. In our study, 7.8% patients had an equivocal report on the CE. rTZ: Radiological transition zone, CE: Contrast enema, HD: Hirschsprung's disease, FTRB: Full-thickness rectal biopsy, TEPT: Transanal endorectal pull-through

Table 3: Correlation of radiological transition zone, gross transition zone, frozen section with the pathological transition zone using Kendall's tau correlation

	rTZ (τb)	rTZ (p)	gTZ (τb)	gTZ (p)	fTZ (τb)	pTZ (p)
Neonates (*n*=8)	1.0	<0.0001	1.0	<0.0001	1.0	<0.0001
Infants (*n*=20)	0.36	0.09	0.86	<0.0001	0.86	<0.0001
Children (*n*=19)	0.138	0.50	1.0	<0.0001	1.0	<0.0001
All (47)	0.362	0.006	0.942	<0.0001	0.942	<0.0001

gTZ: Gross transition zone, fTZ: Frozen section, pTZ: Pathological transition zone, rTZ: Radiological transition zone

Discussion

HD is a neurocristopathy resulting from the failure of craniocaudal migration of ganglion cells through the neural crest at 4–12 weeks of gestation. Consequently, the absence of ganglion cells in the myenteric and submucosal plexuses of variable lengths of distal bowel results in functional bowel obstruction.[11] The diagnosis of HD is based on clinical features and investigations. Clinical features include failure to pass meconium within the first 48 h of life and/or chronic constipation in early infancy or childhood. These patients may be enema/laxative dependent or may present with acute symptoms such as enterocolitis and rarely even perforation peritonitis. Investigations include radiological evaluation, manometric studies and histopathological confirmation.

Plain abdominal X-rays and CE are used in most centres in the world.[12,13] The CE is usually the first radiological investigation to be prescribed when evaluating a child with HD. It is relatively safe and allows good visualisation of the intestinal calibre. The morphological visualisation of the transition zone is not only the most reliable diagnostic indicator of HD but also a valuable aid in planning the strategy for surgical management.[14,15]

Histopathology is the gold standard investigation to confirm the diagnosis of HD.[16] Martucciello *et al*. have laid down diagnostic criteria and guidelines which emphasise rectal biopsy being the major diagnostic criteria.[17] Other authors agree that the rectal biopsy should be used to confirm the diagnosis due to its high sensitivity and specificity when compared to the CE.[18]

Surgical pull-through of the ganglionic segment is the only established treatment for HD. Over the last three decades, single-stage procedures have gained popularity and have been shown to have good functional outcomes, especially in patients with classical HD.[19,20] Therefore, a reliable determination of the length of the aganglionic segment is crucial to selecting patients suitable for single-stage pull-through.

In our protocol, when we encounter a classical rTZ in a well-decompressing child, we take up the patient for a TEPT along with a frozen section. Intraoperative assessment of the length of aganglionic bowel to be resected and the level of colo-anal anastomosis is guided by findings of the pre-operative CE, the gross assessment of the transition zone by the surgeon and corroboration by frozen section biopsy. The histopathology of the permanent sections of resected bowel remains the gold standard investigation. There are a few studies that have looked into the concordance of the rTZ with the pTZ and others that have studied the reliability of frozen section biopsies. However, there are none that compare all three determinants of the level of colo-anal anastomosis, i.e., the

rTZ, the gTZ and the fTZ with the gold standard pTZ. As per the existing literature, the rTZ may be present in 50%–90% of HD cases.[15,18] Rosenfield *et al*. reported that CE has a sensitivity of 62% and a specificity of 100% for diagnosing HD. As the rTZs move, more proximally, the sensitivity increases, however, the specificity drops to as low as 80%. This indicates an increase in the false positives when we move proximally to the rectosigmoid region.[14]

Chen *et al*. reported that the sensitivity and specificity of CE for the presence of rTZ were 86.9% and 92.1%, respectively. They used the Cohen kappa coefficient to study the association between rTZ and pTZ and determined it to be 0.776 ($P < 0.05$). The overall concordance rate of rTZ with pTZ was 84.4%, with 88.5% correlation in the rectosigmoid colon and 44.4% in the descending colon.[21] Similar outcomes were reported by Proctor *et al*. who found 89% of CE showed a reliable rTZ, of which 88% were concordant with the pTZ.[6]

Other authors reported poorer correlation outcomes. Jamieson *et al*. found the concordance between the rTZ and pTZ to be 62.5%, with only 25% concordance in patients with long-segment HD.[22] Haikal *et al*. also noted that CE had low accuracy (50% [95% confidence interval [CI: 0.33–0.67]) to predict intraoperative aganglionosis segment. Twenty-six patients (72.2%) with rTZ at the rectum showed a concordance of only 30.8%, compared to ten subjects (27.8%) with rTZ at the rectosigmoid who had a concordance of 100%.[10]

Our series showed that the CE was 'positive' with an rTZ in 87.2% of patients. We follow the above-mentioned diagnostic algorithm [Figure 1] and have a heavy dependence on an optimally carried out CE. We believe that the CE with a classical transition zone is diagnostic of HD in the rectosigmoid (short segment) disease.[23-25] In our study, we found that although the rTZ corroborated significantly with the pTZ, this correlation did not extend to infants and children in subgroup analysis. All our neonates had a 100% correlation between the rTZ, gTZ, fTZ and pTZ. There was discordance between the rTZ and the gTZ in 15% and 21% of infants and children, respectively. Chen *et al*. reported that the correlation was higher in children older than 3 months (85.3%) than in infants (69%).[21]

Muller *et al*. also used the kappa coefficient to study the concordance of the rTZ and the pTZ in pateints of HD. They found an overall agreement of 58.1% between the rTZ and the pTZ (k = 0.39, 95% CI 0.24 - 0.57). On subgroup analysis, the rTZ was concordant with the pTZ in 42% in the rectal form, 57% in the rectosigmoid form, and 100% in the long segment and the total colonic forms of the disease.[26]

In another study on the accuracy of radiological, intraoperative and histological finding of the transitional zone, the gTZ correlated with rTZ in all 26 patients, while the true ganglionic segment (pTZ) was located up to 10 cm proximally.[27] On the contrary, the gTZ had an excellent correlation with the pTZ in our study.

We found that intraoperative gross assessment and frozen section biopsies have excellent reliability. There was discordance noted in only one patient (0.02%). In 2004, Shayan *et al*. reported a discrepancy between frozen sections and permanent sections in 9 (3%) of their patients. Two of these were false positives and required a second surgery. The remaining were false negatives, resulting in more extensive bowel resection than was required.[28] Maia reported a lower concordance rate, with 89% frozen section biopsies corresponding to the permanent sections.[29]

A reliable CE is the road map for the surgeon, which helps him decide his procedure and the surgical approach. The basic principle for the surgical management of HD entails a meticulous excision of the 'aganglionic segment' followed by the pull-through of the adequately 'ganglionated' bowel to achieve the best results. After the adequate mapping of the rTZ, the TEPT is the procedure of choice in carefully selected patients of HD with rectosigmoid HD.[30,31] In our study, concordance of 85.1% was noted between rTZ and pTZ. There was an excellent correlation between the gTZ, the fTZ and the pTZ in all patients except one (97.8%). Here, the ganglion cells that were >5 cm proximal to the margin were reported on the frozen section. This patient later underwent redo surgery and is doing well. As a general rule, we dissect 5–7 cm proximal to the upper part of the transition zone before sending a biopsy to ascertain the adequate level of aganglionosis, before a colo-anal pull-down is carried out.

Although we found the rTZ to be a useful predictor for surgical planning, the correlation with the pTZ is suboptimal in older children. Frozen section assessment is, therefore, necessary for determining the exact level of ganglionic bowel to be pulled down in patients of HD undergoing TEPT.

Conclusions

Transanal endorectal pull-through is a technically challenging procedure for selected short and classical rectosigmoid segment HD. This procedure has a strong reliance on the CE which is the roadmap for the surgeon and clearly defines the extent of pull-through in a good majority of patients. There is a good correlation between the CE, intraoperative surgical findings and frozen section reports.

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Conflicts of interest

There are no conflicts of interest.

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