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Endoscopic Full-Thickness Resection Biopsy Using Ovesco Diagnostic FTRD® as a Tool to Diagnose Hirschsprung's Disease in Children: A Case Series

Ronaldo A. González García[a] Miriam Riedel[a] Adrian P. Regensburger[a] Aline Rückel[a] Alexander Schnell[a] Marion Appel[a] Jan Thomas Schaefer[a] Carol-Immanuel Geppert[b] Joachim Woelfle[a] André Hoerning[a]

[a]Department of Pediatric and Adolescent Medicine, Universitätsklinikum Erlangen, Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU), Erlangen, Germany; [b]Institute of Pathology, Universitätsklinikum Erlangen, Friedrich-Alexander-Universtität Erlangen-Nürnberg (FAU), Erlangen, Germany

Keywords
Endoscopic full-thickness resection · Pediatric endoscopy · Diagnostic quality analysis

Abstract

Introduction: Hirschsprung's disease is a congenital anomaly affecting intestinal motility. Its main characteristic is the absence of ganglion cells in the distal colon, which results in chronic constipation. To date, confirmatory biopsies in the pediatric population have been obtained through suction biopsies or open surgical procedures. Therapeutic endoscopic full-thickness resection (EFTR) has been successfully used in adult endoscopy to treat various diseases of the lower gastrointestinal tract. This procedure has been shown to be safe and effective. ***Methods:*** A single-center retrospective case series study from May 2024 to September 2025, including 13 pediatric patients aged 3.5–14.4 years (median 9.5 years) with therapy-refractory constipation, who underwent an EFTR biopsy using Ovesco diagnostic FTRD® as part of the diagnostic workup for Hirschsprung's disease. EFTR was performed in the distal rectum, 2 cm above the linea dentata, to exclude an ultrashort variant of Hirschsprung's disease. ***Results:*** All EFTR procedures were successful, and only 1 patient had non-hemodynamically relevant rectal bleeding during the 1-year follow-up. All biopsies fulfilled the requirements to validate or exclude Hirschsprung's disease, showing an excellent success rate of full-thickness resection (100%). ***Conclusions:*** This is the first case series of EFTR using the Ovesco diagnostic FTRD® technique in pediatric patients for the diagnosis of Hirschsprung's disease. EFTR is a safe, time-saving, and successful method that can be used to diagnose Hirschsprung's disease in pediatric patients starting from 3 years of age.

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Introduction

Bowel motility disorders result from neuromuscular dysfunction of the small and/or large bowel, including the rectum. The motility of the intestine (small and large) is regulated by the interplay of smooth muscle cells, interstitial Cajal cells, and the enteric nervous system cells [1, 2].

The main entities of bowel motility disorders in the pediatric population are pediatric intestinal pseudoobstruction, acute colonic pseudoobstruction, idiopathic megacolon/-rectum, slow transit constipation, and Hirschsprung's disease. All the above-mentioned disorders have chronic constipation in common, and it is difficult to differentiate one from another.

The role of histopathology is essential in the differentiation of these conditions. To diagnose or exclude

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Correspondence to:
André Hoerning, andre.hoerning@uk-erlangen.de

most of these diseases, a full-thickness intestinal wall biopsy is needed. It is required that all layers of the intestinal wall are visible in the histopathological section, must have a 3-mm diameter and with a mucosal tissue proportion of at least one-third of the sample. This type of biopsy provides the complete neuromuscular structures of the intestinal wall, thus enabling (immune) histological investigation of the colon, small intestine, or stomach [3, 4].

Hirschsprung's disease is a congenital developmental motility disorder, characterized by the absence of ganglion cells in the myenteric and submucosal plexuses of the intestine, depending on its extension. This results in functional intestinal obstruction and motility problems. Hirschsprung's disease can present itself as a neonatal distal obstruction, enterocolitis or chronic, therapy-resistant constipation in case of an ultrashort variant. It has an incidence of 1:5,000, with males being more affected than females by a ratio of 4:1 [5]. Hirschsprung's disease develops during the first fetal trimester. Ganglion cells stem from the neural crest cells. The vagal neural crest cells begin migrating retrocaudally along the whole colon around week 5 of gestation, reaching the hindgut by week 7. The sacral neural crest cells start migrating around week 7–12 of gestation, beginning at the caudal end and contributing to the distal hindgut. In Hirschsprung's disease, these cells fail to migrate to the distal colon, especially the rectosigmoid region, explaining the lack of ganglion cells in this condition [6]. Hirschsprung's disease is classified into 4 types: short Hirschsprung (75–80%), long Hirschsprung (10%), total colonic aganglionosis (5%), and ultrashort Hirschsprung (5–10%) [7, 8].

If Hirschsprung's disease is clinically suspected, imaging studies should be performed, and contrast enema is the radiologic test of choice [2, 9]. The gold standard for diagnosing Hirschsprung's disease is the histopathological confirmation of the absence of enteric ganglion cells using a full-thickness biopsy of the distal rectum [5, 10]. The most frequently used surgical methods to date are suction and incisional rectal biopsies [9].

Endoscopic full-thickness resection (EFTR) has been successfully used in adult gastroenterology to remove epithelial and subepithelial benign or neoplastic lesions [11, 12]. This method represents the least invasive procedure for performing resections or biopsies [3]. In this paper, we present the results of a retrospective single-center case series, in which 13 pediatric patients underwent an EFTR with FTRD® for acquiring full-thickness intestinal wall biopsies of the rectum for the diagnosis of Hirschsprung's disease.

Biopsy Methods in Hirschsprung's Disease

Rectal biopsies taken through an open surgical procedure represent an established method for gaining appropriate biopsies. The success of this method is more than proven; however, it involves surgery, risks from general anesthesia, and preparation of the operating room to obtain the biopsies. Thus, other techniques are becoming more common, such as suction biopsy, as they provide a less invasive procedure.

Acetylcholinesterase histochemistry and hematoxyin and eosin (H&E) staining are the most widely used histopathological methods. H&E is sufficient to exclude Hirschsprung's disease if any number of ganglion cells can be spotted. In the case of infants and neonates, H&E has certain limitations because of the age-dependent small and immature appearance of these ganglion cells. In case of a challenging diagnosis, an additional staining with calretinin or microtubule-associated protein-2 should therefore be performed [13]. These markers stain ganglion cells in the submucosal plexus, but do not stain an aganglionic bowel, allowing the pathologists to rule out Hirschsprung's disease [14–16].

Suction biopsies do not require general anesthesia, and the procedure is performed relatively quickly. This is of particular interest, especially in neonates or infants. As the patients grow older, the thickness of the rectal mucosa increases, making this approach less successful in the subset of older children [17]. Three biopsies should be taken 3 cm above the linea dentata. Each biopsy should have a 3-mm diameter, and one-third of the tissue should contain mucosa. Suction biopsy is currently the method of choice for diagnosing Hirschsprung's disease in neonates and infants [18].

Both surgical full-thickness resection biopsies and suction biopsies are comparable in terms of safety, with very low complication rates. Surgical biopsies have a complication rate starting at 2%, while suction biopsies have a rate starting at 0.65%. Common adverse events include persistent rectal bleeding, perforation, fecal incontinence, persistent rectal pain, and sepsis [19].

The main difference between surgery and suction biopsy, in addition to the time required to perform the procedures and the risks of anesthesia, is the validity of the biopsies obtained. Surgical biopsies are conclusive in 97% of cases, while suction biopsies are conclusive in only 60% of cases. This explains the recommendation of the European Reference Network of Clinical Experts (ERNICA) in its 2020 Guidelines to take 2–3 suction biopsies, as these are usually small, with the risk of leading to inconclusive results [1, 4].

EFTR with the FTRD® System has been gaining ground in adult gastroenterology as a method for removing polyps, mucosal and submucosal lesions, and neoplasms [20–22]. The FTRD device involves the use of a special cap manufactured by Ovesco. This technique has multiple advantages over conventional methods. Using FTRD, the tissue to be resected can be endoscopically marked before starting the procedure, thus ensuring that only the desired tissue is resected.

This technique has the valuable advantage of allowing a biopsy to be obtained while the biopsy site is clipped and cauterized for securement in a single procedure. This provides increased safety, as a clip is placed and the biopsy site is cauterized.

In addition, this procedure can be performed under sedation, with no requirement for general anesthesia. This approach not only streamlines planning but also significantly reduces procedure time, a benefit that extends to both the general population and, most notably, pediatric patients.

A systematic review of studies performed on adult patients with colorectal cancer who underwent an EFTR to resect lesions showed a low rate of overall adverse events (11.8%). Among these were pain close to the linea dentata (0.1%), bleeding (6.2%), perforation (2.5%), and inflammation/infection (1.3%). It is worth noting that the patients reported in the above study were adult patients with gastrointestinal disease and multiple comorbidities. It is also relevant that endoscopic resection was used for therapeutic rather than diagnostic purposes [23].

There have been cases in which full-thickness intestinal biopsies were performed in combination with laparoscopic surgery for taking multiple small bowel and colonic biopsies in children with obstructive symptoms after a pull-through operation due to Hirschsprung's disease [24]. There are several papers, that report adult patients who underwent an EFTR under mild sedation for diagnostic purposes of complex gastrointestinal motility disorders. The histologic diagnoses ranged from aganglionosis to eosinophilic leiomyositis. The thickness of the biopsies was adequate for histopathological examination and diagnosis [25–27].

Methods

We performed a retrospective single-center study from May 2024 to September 2025, including 13 pediatric patients aged 3.5–14.4 years (median 9.5 years) with therapy-refractory constipation who underwent an EFTR as a part of the diagnostic examination for Hirschsprung's disease.

The biopsies were taken employing a dedicated full-thickness resection device (Ovesco, diagnostic FTRD®) representing a modified OTS clip with an integrated electrosurgical snare enabling a one-step EFTR. Within this procedure, the colonic wall is gently gripped with a dedicated grasping device and retracted into the cap until sufficient tissue has been mobilized. The target tissue does not have to be suctioned (Fig. 1). After this step, the clip is deployed by turning the handwheel of the device. Clip deployment is confirmed when the white circle of the cap shown in Figure 1 is no longer detectable. If the white circle is still visible, the clip has not been completely deployed, and another turn on the handwheel is needed. Once the clip has been successfully deployed, the integrated snare needs to be closed, followed by a subsequent electrothermic resection of the grasped tissue using an Erbe Endocut Vio 200 System (Effect 5, Cut max.180 Watts, Coag max. 20 Watts; Fig. 2). The EFTR procedure is depicted in Figure 3.



Fig. 1. Grasping the rectal mucosa wall 2 cm above the linea dentata into the OTSC device cap.

Biopsies were taken 2 cm above the linea dentata, as there is a physiologic aganglionic zone 2 cm under the linea dentata and keeping this in mind is important to avoid false-positive results [8]. The biopsies were evaluated by our Pathology Department using a H&E staining, as well as a microtubule-associated protein-2 staining (Fig. 4–6).

Results

Thirteen children aged between 3.5 and 14.4 years (median 9.5 years) underwent an EFTR biopsy under sedation as a part of the diagnostic examination for Hirschsprung's disease. The median procedure time was 13.8 min (range: 8.5–20 min), without being influenced by the age of the patients. The median hospital stay for our patients was 2 days. The patients occasionally needed pain medications, but all the patients were discharged pain-free. The median size of the taken biopsies was 18.3 × 14.8 × 3.7 mm (range: 13–22 × 13–21 × 1–8 mm). This size is comparable to the size of samples obtained by open surgical biopsy, making EFTR a representative and less invasive method [4]. The technical success rate and full-thickness resection rate were 100%. The pathology

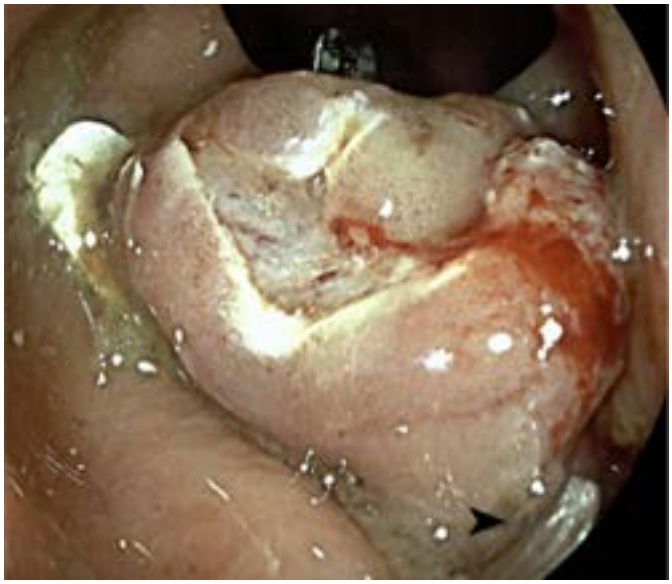


Fig. 2. Post-resection control showing no adverse events. The clip has been successfully applied and is highlighted with an arrow.

report confirmed that all collected biopsies were conclusive. None of our patients had Hirschsprung's disease. After the procedure, we continued the therapy with Macrogol to improve stool consistency and avoid pain or bleeding from the lesion. During a 6-month follow-up after the procedure, we reported 1 patient with non-hemodynamically relevant persistent rectal bleeding. At control rectoscopy, we observed slight bleeding at the site where the biopsy was taken. The site was cauterized using an electrocautery, and the bleeding ceased.

Discussion

We report the first use of the EFTR technique to diagnose Hirschsprung's disease in the pediatric population. Even though none of the patients, in whom we performed the EFTR, had Hirschsprung's disease, the technique showed the feasibility of diagnosing Hirschsprung's disease.

This technique signifies a substantial advancement in the field of diagnosing Hirschsprung's disease. However, it should be noted that a limitation in its application has been identified. The EFTRD diagnostic cap, developed by OVESCO, has a diameter of 19.5 mm, which limits its usefulness in very young patients. The youngest patient documented in our study was 3.5 years of age. The procedure was performed by means of slight dilation of the anus with a 19-mm dilator, after which the EFTRD was inserted. The biopsy was taken without encountering any complications. It is evident that this procedure can be successfully performed on young children; however, it would be challenging to carry out the procedure on children under 3 years of age.

Presently, the gold standard for diagnosing Hirschsprung's disease is histopathological demonstration of aganglionosis in a rectal biopsy. The biopsy is prepared to detect acetylcholinesterase and calretinin, among other special stains. However, recent advancements in diagnostic methods are aimed at enhancing accuracy, reducing invasiveness, and expediting diagnosis.

The integration of artificial intelligence within the medical field is a rapidly evolving area of research and practice. Recent studies have sought to automate image analysis, including histopathological sections and contrast-enhanced colon enemas. However, to reach this goal, the acquisition of substantial, reliable, and reproducible data is imperative, the quality of histopathological sections and images is of utmost importance, and the costs and investment in infrastructure are substantial. However, it does not supplant the supervision of a pathologist [28–30].

Additionally, there are studies that aim to enhance imaging of the enteric nervous system and the microstructure of the colonic wall. The objective of these studies is to improve the localization of the transition zone, thereby delimiting the resection area. However, the images are predominantly ex vivo images and the implementation of this technique in vivo or intraoperatively remains encumbered by several technical challenges, including ethical and regulatory approvals, financial constraints, and the necessity of specialized equipment [31].

Genetic testing is an increasingly important tool in the medical field, and Hirschsprung's disease is no exception to this rule. Research is currently being conducted to identify the mutations associated with Hirschsprung's disease. This approach has the potential to facilitate early diagnosis and inform treatment decisions in familial cases. However, it should be noted that genetic variants only account for a proportion of cases, as many mutations are sporadic and cannot always predict the phenotype of the disease (extent, severity). It is important to note that the cost of these tests is considerable, and that genetic counselling is an essential component of the process [32, 33].

Efforts are being made to standardize the number of biopsies that should be taken and to establish protocols, including a digital workflow for scanning slides and integrating software tools into diagnostic pathology. The implementation of this measure necessitates its dissemination in a greater number of centers. However, ensuring the reproducibility of conditions in all centers presents a significant challenge. The implementation of quality control and regulatory controls is imperative, which, in turn, necessitates substantial expenditures and the establishment of specialized infrastructure [29, 33].

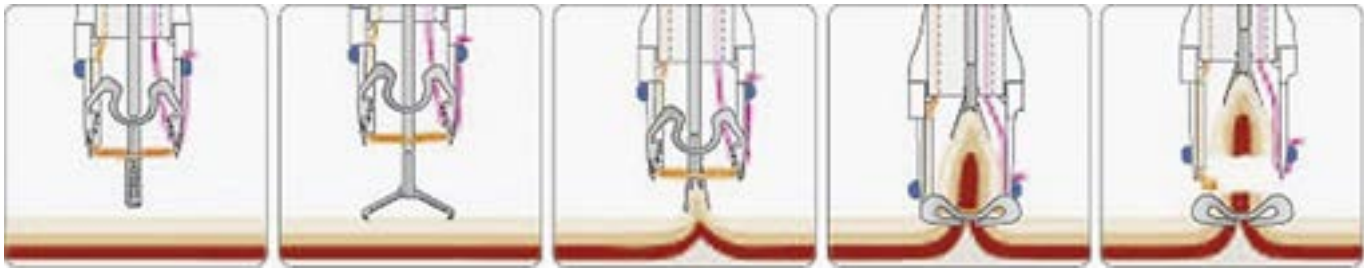


Fig. 3. FTRD® procedure illustration. (1) Marking of the target area for the biopsies before mounting the FTRD system. (2) Grasping the rectal mucosa wall with the FTRD grasper. (3) Retrieval of the rectal mucosal tissue within cap and fixation. (4) Confirmation whether the target tissue is completely mobilized into the FTRD cap. The clip is released by turning the handwheel. (5) The snare is closed and an electrocauterization of the target tissue is performed. Removal of the resected sample. Control of resection site. Image shared with authorization from Ovesco Endoscopy AG.

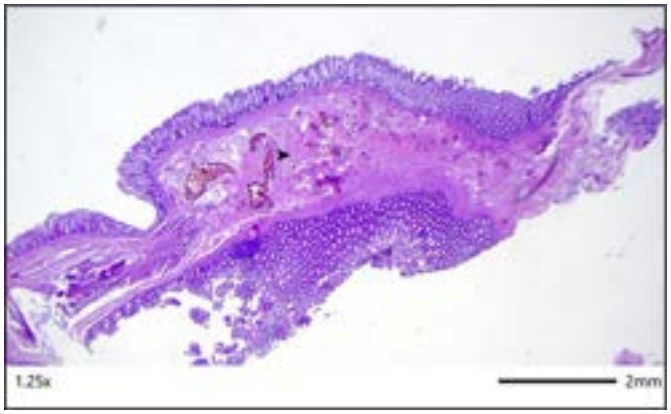


Fig. 4. Our biopsies fulfilled the histopathological requirements to exclude or confirm Hirschsprung's disease. H&E staining showing all wall layers and at least one-third of the submucosa. The arrow indicates the submucosa.

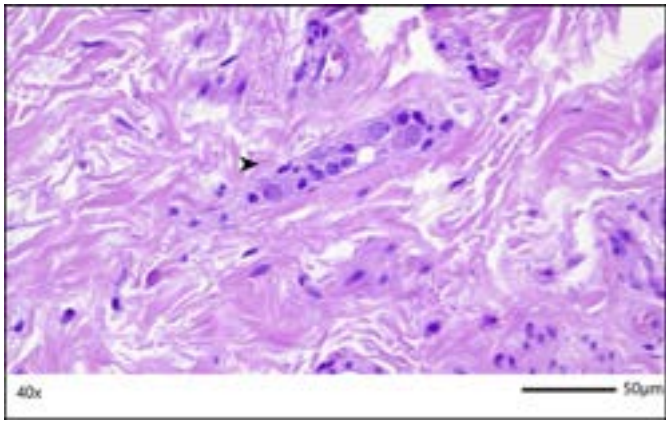


Fig. 5. The biopsies fulfilled the histopathological requirements to exclude or confirm Hirschsprung's disease. H&E staining from our patient showing ganglion cells marked by an arrow.

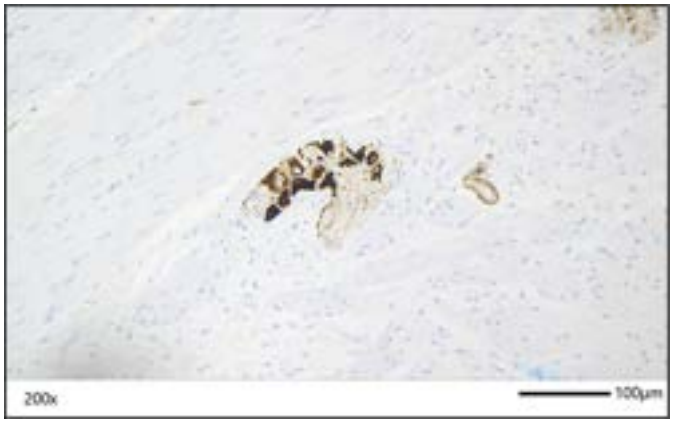


Fig. 6. MAP-2 staining showing multiple ganglion cells (brown color).

Despite the numerous endeavors aimed at developing enhanced diagnostic instruments for Hirschsprung's disease, it is imperative to acknowledge that all the aforementioned proposals are still preliminary and in the first stages of development and require further investigation and studies to attain clinical significance for the broader population. The importance of techniques such as the one presented in our study lies in their ability to meet current standards while offering a more efficient and patient-friendly alternative, particularly for pediatric patients.

In summary, EFTR represents a time-saving, uncomplicated (no need for general anesthesia or an operating room, less staff needed), safe procedure that fulfills the specifications for diagnosing Hirschsprung's disease in the pediatric population. An essential requirement is the training of the team to perform a procedure without adverse events and to obtain conclusive biopsies.

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Statement of Ethics

The study was conducted in accordance with the Declaration of Helsinki and was reviewed and approved by the Ethics Committee of the Medical Faculty of the Friedrich-Alexander-Universität Erlangen-Nürnberg (No. 25-100-Br) on April 4, 2025, with the need for written informed consent waived.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

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Author Contributions

R.A.G.G. and A.H.: conceptualization, data curation, formal analysis, investigation and endoscopy, methodology, validation, and writing – original draft, review, and editing. C.I.G.: conceptualization, validation, and writing, histopathological examination and pictures, review and editing. M.R., J.T.S., A.P.R., A.S., M.A., A.R., and J.W.: review and editing. Figures were provided by A.H. and R.A.G.G.

Data Availability Statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

References

1 Kyrklund K, Sloots CEJ, de Blaauw I, Bjørnland K, Rolle U, Cavalieri D, et al. ERNICA guidelines for the management of rectosigmoid Hirschsprung's disease. Orphanet J Rare Dis. 2020;15(1):164. https://doi.org/10.1186/s13023-020-01362-3

2 Furness JB. The enteric nervous system and neurogastroenterology. Nat Rev Gastroenterol Hepatol. 2012;9:286–94. https://doi.org/10.1038/nrgastro.2012.32

3 Friedmacher F, Puri P. Rectal suction biopsy for the diagnosis of Hirschsprung's disease: a systematic review of diagnostic accuracy and complications. Pediatr Surg Int. 2015;31(9):821–30. https://doi.org/10.1007/s00383-015-3742-8

4 Vervloet G, De Backer A, Heyman S, Leyman P, Van Cauwenberge S, Vanderlinden K, et al. Rectal biopsy for Hirschsprung's disease: a multicentre study involving biopsy technique, pathology and complications. Children. 2023;10(9):1488. https://doi.org/10.3390/children10091488

5 Ambartsumyan L, Smith C, Kapur RP. Diagnosis of hirschsprung disease. Pediatr Dev Pathol. 2020;23(1):8–22. https://doi.org/10.1177/1093526619892351

6 Nagy N, Goldstein AM. Enteric nervous system development: a crest cell's journey from neural tube to colon. Semin Cell Dev Biol. 2017;66:94–106. https://doi.org/10.1016/j.semcdb.2017.01.006

7 Neuvonen MI, Kyrklund K, Lindahl HG, Koivusalo AI, Rintala RJ, Pakarinen MP. A population-based, complete follow-up of 146 consecutive patients after transanal mucosectomy for Hirschsprung disease. J Pediatr Surg. 2015;50(10):1653–8. https://doi.org/10.1016/j.jpedsurg.2015.02.006

8 Comes GT, Ortolan EVP, de Medeiros Moreira MM, de Oliveira Junior WE, Angelini MC, El Dib R, et al. Rectal biopsy technique for the diagnosis of Hirschsprung disease in children: a systematic review and meta-analysis. J Pediatr Gastroenterol Nutr. 2021;72(4):494–500. https://doi.org/10.1097/MPG.0000000000003041

9 Langer JC. Hirschsprung disease. Curr Opin Pediatr. 2013;25(3):368–74. https://doi.org/10.1097/MOP.0b013e328360c2a0

10 Rajan E, Wong Kee Song LM. Endoscopic full thickness resection. Gastroenterology. 2018;154(7):1925–37.e2. https://doi.org/10.1053/j.gastro.2018.02.020

11 Jain D, Mahmood E, Desai A, Singhal S. Endoscopic full thickness resection for gastric tumors originating from muscularis propria. World J Gastrointest Endosc. 2016;8(14):489–95. https://doi.org/10.4253/wjge.v8.i14.489

12 Agustina K, Margiani NN, Anandasari PPY, Mahastuti NM. Constipation that needs attention: late Hirschsprung disease. Intisari Sains Medis. 2021;12(1):64–7. https://doi.org/10.15562/ism.v12i1.845

13 Knowles CH, De Giorgio R, Kapur RP, Bruder E, Farrugia G, Geboes K, et al. The London classification of gastrointestinal neuromuscular pathology: report on behalf of the gastro 2009 international working group. Gut. 2010;59:882–7. https://doi.org/10.1136/gut.2009.200444

14 Yang WI, Oh JT. Calretinin and microtubule-associated protein-2 (MAP-2) immunohistochemistry in the diagnosis of Hirschsprung's disease. J Pediatr Surg. 2013;48(10):2112–7. https://doi.org/10.1016/j.jpedsurg.2013.02.067

15 Schäppi MG, Staiano A, Milla PJ, Smith VV, Dias JA, Heuschkel R, et al. A practical guide for the diagnosis of primary enteric nervous system disorders. J Pediatr Gastroenterol Nutr. 2013;57(5):677–86. https://doi.org/10.1097/MPG.0b013e3182a8bb50

16 Jeong H, Jung HR, Hwang I, Kwon SY, Choe M, Kang YN, et al. Diagnostic accuracy of combined acetylcholinesterase histochemistry and calretinin immunohistochemistry of rectal biopsy specimens in Hirschsprung's disease. Int J Surg Pathol. 2018;26(6):507–13. https://doi.org/10.1177/1066896918761235

17 Nice. Constipation in children and young people- 4. Clinical Investigation; 2010. Available from: https://www.nice.org.uk/guidance/cg99 (accessed on 7 August. 2024).

18 Gonzalo DH, Plesec T. Hirschsprung disease and use of calretinin in inadequate rectal suction biopsies. Arch Pathol Lab Med. 2013;137(8):1099–102. https://doi.org/10.5858/arpa.2012-0220-OA

19 Green N, Smith CA, Bradford MC, Ambartsumyan L, Kapur RP. Rectal suction biopsy versus incisional rectal biopsy in the diagnosis of Hirschsprung disease. Pediatr Surg Int. 2022;38(12):1989–96. https://doi.org/10.1007/s00383-022-05246-4

20 Zwager LW, Mueller J, Stritzke B, Montazeri NSM, Caca K, Dekker E, et al. Adverse events of endoscopic full-thickness resection: results from the German and Dutch nationwide colorectal FTRD registry. Gastrointest Endosc. 2023;97(4):780–9.e4. https://doi.org/10.1016/j.gie.2022.11.005

21 Meier B, Stritzke B, Kuellmer A, Zervoulakos P, Huebner GH, Repp M, et al. Efficacy and safety of endoscopic full-thickness resection in the colorectum: results from the German colonic FTRD registry. Am J Gastroenterol. 2020;115(12):1998–2006. https://doi.org/10.14309/ajg.0000000000000795

22 Schmidt A, Beyna T, Schumacher B, Meining A, Richter-Schrag HJ, Messmann H, et al. Colonoscopic full-thickness resection using an over-the-scope device: a prospective multicentre study in various indications. Gut. 2018;67(7):1280–9. https://doi.org/10.1136/gutjnl-2016-313677

23 Wannhoff A, Meier B, Caca K. Systematic review and meta-analysis on effectiveness and safety of the full-thickness resection device (FTRD) in the colon. Z Gastroenterol. 2022;60(5):741–52. https://doi.org/10.1055/a-1310-4320

24 Mazziotti MV, Langer JC. Laparoscopic full-thickness intestinal biopsies in children. J Pediatr Gastroenterol Nutr. 2001;33(1):54–7. https://doi.org/10.1097/00005176-200107000-00009

25 Martínez-Alcalá A, Martínez-Alcalá García F, Mönkemüller K, Neumann H, Martínez-Alcalá F. Endoscopic full-thickness resection for diagnosis of Hirschsprung's disease. Endoscopy. 2018;50(10):E281–3. https://doi.org/10.1055/a-0642-9017

26 Backes Y, Kappelle WFW, Berk L, Koch AD, Groen JN, de Vos Tot Nederveen Cappel WH, et al. Colorectal endoscopic full-thickness resection using a novel, flat-base over-the scope clip: a prospective study. Endoscopy. 2017;49(11):1092–7. https://doi.org/10.1055/s-0043-114730
27 Valli PV, Pohl D, Fried M, Caduff R, Bauerfeind P. Diagnostic use of endoscopic full-thickness wall resection (eFTR)—a novel minimally invasive technique for colonic tissue sampling in patients with severe gastrointestinal motility disorders. Neurogastroenterol Motil. 2018;30(1):e13153. https://doi.org/10.1111/nmo.13153
28 Akay MA, Tatar OC, Metin S, Tatar E, Varlıklı O, Yıldız GE. Development and clinical assessment of a novel AI-based diagnostic model for Hirschsprung's disease. Updates Surg. 2025. https://doi.org/10.1007/s13304-025-02284-0
29 Braun Y, Friedmacher F, Theilen TM, Fiegel HC, Weber K, Harter PN, et al. Diagnosis of Hirschsprung disease by analyzing acetylcholinesterase staining using artificial intelligence. J Pediatr Gastroenterol Nutr. 2024;79(3):729–37. https://doi.org/10.1002/jpn3.12339
30 Duci M, Magoni A, Santoro L, Dei Tos AP, Gamba P, Uccheddu F, et al. Enhancing diagnosis of Hirschsprung's disease using deep learning from histological sections of post pull-through specimens: preliminary results. Pediatr Surg Int. 2023;40(1):12. https://doi.org/10.1007/s00383-023-05590-z
31 Pan W, Goldstein AM, Hotta R. Opportunities for novel diagnostic and cell-based therapies for Hirschsprung disease. J Pediatr Surg. 2022;57(9):61–8. https://doi.org/10.1016/j.jpedsurg.2021.10.049
32 Li S, Zhang Y, Li K, Liu Y, Chi S, Wang Y, et al. Update on the pathogenesis of the Hirschsprung-Associated enterocolitis. Int J Mol Sci. 2023;24(5):4602. https://doi.org/10.3390/ijms24054602
33 Amaral FTS, Costa LLS. Atualizações sobre a abordagem diagnóstica da Doença de Hirschsprung: uma revisão de literatura. Res Soc Dev. 2024;13(12):e88131247684. https://doi.org/10.33448/rsd-v13i12.47684