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Comparison of clinical results of Transanal Endorectal Pull-Through of the colon with and without laparoscopic assistance in children with Hirschsprung's disease

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Introduction. Techniques of Transanal Endorectal Pull-Through (TEPT) with and without laparoscopic assistance have been widely used in pediatric surgery for correction of Hirschsprung's disease (HD) in children with. Many clinics in their studies have noted the positive features of this approach compared to classical methods, but the long-term results after such operations in children are still debated.

Purpose – to study and compare the clinical results of TEPT with and without laparoscopic assistance in children with HD.

Materials and methods. We analyzed the experience of TEPT approach with laparoscopy (n=65 (29.41%)) and without laparoscopic assistance (n=144 (70.59%)) in children for correction of HD. For confirmation diagnosis we used the results of general clinical and special procedures (barium enema, anomanometry, histological, determination of acetylcholinesterase activity).

Results. Overall, among 55 (26.32%) of 209 patients who underwent TEPT, postoperative in long term follow up we found intestinal problems like – moderate stenosis of the colo-anal anastomosis without incontinence 4 (1.91%), constipation 9 (4.31%), partial faecal incontinence 20 (9.57%) and enterocolitis (EC) 22 (10.53%). There was no significant difference in the clinical results of TEPT with laparoscopy and without laparoscopic assistance in our patients. After TEPT without laparoscopic assistance, 6 (4.17%) of 144 patients had constipation, 11 (7.64%) had partial fecal incontinence, and 16 (11.11%) had enterocolitis (EC). And among 65 children after TEPT with laparoscopy, 3 (4.62%) patients were diagnosed with constipation, 9 (13.85%) with partial fecal incontinence and 6 (9.23%) with EC. All children with postoperative intestinal problems were treated conservatively. There was no need for redo surgical interventions in these patients.

Conclusions. The technique of TEPT with laparoscopy and without laparoscopic assistance is a modern method of surgical correction of HD, which has significant technical advantages compared to other existing methods. In 26.32% of children with HD who were operated by the TEPT method, persistent intestinal problems continue in the long term follow-up period.

The research was carried out in accordance with the principles of the Declaration of Helsinki. The research protocol was approved by the Local Ethics Committee of all institutions mentioned in the work. Informed consent of the children's parents was obtained for the research.

No conflict of interests was declared by the authors.

Keywords: Hirschsprung's disease, children, miniinvasive methods, results.

Оригінальні дослідження. Колопроктологія

Порівняння клінічних результатів трансанального ендоректального зведення товстої кишки з лапароскопією та без лапароскопічної асистенції в дітей з хворобою Гіршпрунга

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Вступ. Методики трансанального ендоректального зведення (Transanal Endorectal Pull-Through (TEPT)) з лапароскопією та без лапароскопічної асистенції в дітей з хворобою Гіршпрунга (ХГ) отримали широке використання в дитячій хірургії. Багато клінік у власних дослідженнях відмітили позитивні риси такого підходу лікування ХГ порівняно з класичними методами, але віддалені результати після таких операцій у дітей дискутуються.

Мета – вивчити та порівняти клінічні результати ТЕПТ з лапароскопією та без лапароскопічної асистенції в дітей з ХГ.

Матеріали та методи. Проаналізовано досвід використання ТЕПТ з лапароскопією (n=65 (29,41%)) та без лапароскопічної асистенції (n=144 (70,59%)) у дітей з ХГ. Для встановлення діагнозу використано результати загальноклінічних і спеціальних (іригоскопія, аноманометрія, гістологічні, визначення активності ацетилхолієстерази) методів дослідження.

Результати. У цілому, у 55 (26,32%) із 209 пацієнтів, яким проведено ТЕПТ при ХГ, у віддаленому періоді відмічено післяопераційні проблеми кишечника – помірний стеноз коло-анального анастомозу без затримки відходження калу 4 (1,91%), закрепи 9 (4,31%), часткове нетримання калу 20 (9,57%) та ентероколіт – ЕК 22 (10,53%). Суттєвої різниці в клінічних результатах ТЕПТ з лапароскопією та без лапароскопічної асистенції в пацієнтів не відмічено. Після ТЕПТ без лапароскопічної асистенції в 6 (4,17%) із 144 пацієнтів виявлено закрепи, в 11 (7,64%) – часткове нетримання калу, у 16 (11,11%) – ЕК. Із 65 дітей після ТЕПТ з лапароскопією у 3 (4,62%) пацієнтів діагностовано закрепи, у 9 (13,85%) – часткове нетримання калу, у 6 (9,23%) – ЕК. Усім дітям із післяопераційними проблемами кишечника проведено консервативне лікування. Необхідності в повторних хірургічних втручаннях у цих пацієнтів не було.

Висновки. Методика ТЕПТ з лапароскопією та без лапароскопічної асистенції – сучасний метод хірургічної корекції ХГ, який має значні технічні переваги порівняно з іншими існуючими способами. У 26,32% дітей з ХГ, які прооперовані методом ТЕПТ, у віддаленому періоді продовжуються персистуючі проблеми кишечника.

Дослідження виконані відповідно до принципів Гельсінської декларації. Протокол дослідження ухвалено Локальним етичним комітетом зазначеної в роботі установи. На проведення досліджень отримано інформовану згоду батьків дітей.

Автори заявляють про відсутність конфлікту інтересів.

Ключові слова: хвороба Гіршпрунга, діти, мініінвазивні методи, результати.

Introduction

Transanal Endorectal Pull-Through (TEPT) of the colon with and without laparoscopic assistance are the most common used modern approach for the surgical treatment of Hirschsprung's disease (HD) in children [4,6,25].

Modern trends in the surgical treatment of HD, which were proposed by K. E. Georgeson (1995) and De La Torre (1998) focused on the mini-invasiveness of such interventions [12,18,20]. Various variants of TEPT are described: the classic TEPT technique without laparoscopic assistance; TEPT with laparoscopic assistance; TEPT for removal of the affected rectum with Swenson technique; TEPT with demucosation of the affected rectum with Soave technique and others [11,17,22,23]. Despite the modernity and mini-invasiveness of such interventions, up to 3.5% of early and 36.8% of long-term surgical complications occur in children with HD [9,13,14,19,21]. Clinics around the world use different techniques, but there are few studies comparing TEPT methods with and without laparoscopic assistance in children with HD [7,10,15,16,20].

The purpose of the research – to study and compare the clinical results of TEPT with and without laparoscopic assistance in children with HD.

Materials and methods of the study

We conducted our own analysis of the use of TEPT with and without laparoscopic assistance in children with HD to compare early and long-term results of our clinical outcomes. We treated 209 children with HD between the ages of 1 month to 8 years using a mini-invasive technique. Patients were operated with classic TEPT with demucosation of the affected rectum using the Soave technique with laparoscopy (n=65 (29.41%)) and without laparoscopic assistance (n=144 (70.59%)).

Under the age of 6 months 29 (9.52%) patients were operated, from 6 to 12 months 39 (9.52%), from 1 to 3 years 56 (50.48%), from 3 to 7 years 73 (27.62%) and older than 7 years there were 12 (32.121%) children. The rectal form of HD was diagnosed in 127 (72.38%) patients, rectosigmoidal – in 73 (25.71%) and subtotal – in 9 (1.91%) patients (Table 1).

Table 1

Distribution of patients by age and form of aganglionosis, who were operated on by mini-invasive methods

Form of aganglionosis	Age of Patients					Sum
	0–6 months	6–12 months	1–3 years	3–7 years	>7 years	
Rectal	10 (4.78%)	17 (8.13%)	22 (10.52%)	66 (31.58%)	12 (5.74%)	127 (60.76%)
Recto-sigmoidal	14 (6.70%)	20 (9.57%)	32 (15.31%)	7 (3.35%)	–	73 (34.93%)
Subtotal	5 (2.39%)	2 (0.96%)	2 (0.96%)	–	–	9 (4.31%)
Sum	29 (13.87%)	39 (18.66%)	56 (26.79%)	73 (34.93%)	12 (5.74%)	209 (100%)

Table 2

Distribution of patients by age and form of aganglionosis, who were operated with TEPT method

Form of aganglionosis	Age of Patients					Sum
	0–6 months	6–12 months	1–3 years	3–7 years	>7 years	
Rectal	10 (6.94%)	17 (11.81%)	21 (14.58%)	18 (12.50%)	–	66 (45.83%)
Recto-sigmoidal	14 (9.72%)	20 (13.89%)	29 (20.14%)	7 (4.86%)	–	70 (48.61%)
Subtotal	5 (3.48%)	2 (1.39%)	1 (0.69%)	–	–	8 (5.56%)
Sum	29 (20.14%)	39 (27.08%)	51 (35.42%)	25 (17.36%)	–	144 (100%)

The main positive features of the TEPT method in the surgical treatment of HD in children are: it is mini invasive, its least traumatic compared to other methods, lowers the probability of traumatizing abdominal organs, minimal blood loss, reduces risk of adhesion in the abdominal cavity, decreasing surgical and anesthesia time, a more favorable course of the postoperative period with simplified patient care; reduction of hospital stay, etc.

For the assessment of the expected clinical results of TEPT with laparoscopy and without laparoscopic assistance in children with HD, we studied the influence of the main factors that, in our opinion, could affect the outcomes: the degree of trauma of the surgical intervention, the age of the patients at the time of the operation, the presence of complex accompanying malformations and complications.

The results of general clinical and special (irrigography, anomanometry, morphological) diagnostic procedures were used for confirmation of diagnosis and evaluation of the results of treatment during postoperative monitoring.

The research was carried out in accordance with the principles of the Declaration of Helsinki. The research protocol was approved by the Local Ethics Committee of all institutions mentioned in the work. Informed consent of parents and children was obtained for conducting research.

Results of the study

All our patients were operated by the same surgical team, as single stage operation, without conversion and without intraoperative complications (Tables 2, 3). At first, we performed TEPT without laparoscopy only in children aged 1–2 years, and laparoscopically assisted TEPT – in children from 3 years of age. Later, when we gained the experience with the TEPT technique and analyzed our primary results in the distant period, we started TEPT without laparoscopy in children with a wider age range – from one month to five years of age.

Miniinvasive technical elements of surgical intervention significantly affect the clinical results of TEPT with laparoscopy and without laparoscopic assistance in children with HD.

We consider the relative trauma caused to the anal sphincter during rectal demucosation and further mobilization of the colon is the main disadvantages of the TEPT technique, which, in our opinion, may be the main cause of anal sphincter dysfunction.

The advantages of laparoscopic-assisted TEPT is that overall such an operation provides an opportunity for correct planning and a surgical strategy for correction of HD. The laparoscopic stage provides an opportunity for a thorough revision of the affected colon and detailing the level of the aganglionic zone. Laparoscopic revision allows the mobilization of mesentery without tension. This intervention allows you to mobilize from

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Table 3

Distribution of patients by age and form of aganglionosis, who were operated on by the TEPT method with laparoscopic assistance

Form of aganglionosis	Age of Patients					Sum
	0–6 months	6–12 months	1–3 years	3–7 years	>7 years	
Rectal	–	–	1 (1.54%)	48 (73.84%)	12 (18.46%)	61 (93.84%)
Recto-sigmoidal	–	–	3 (4.62%)	–	–	3 (4.62%)
Subtotal	–	–	1 (1.54%)	–	–	1 (1.54%)
Sum	–	–	5 (7.70%)	48 (73.84%)	12 (18.46%)	65 (100%)

Table 4

Characteristics of complications in the long term follow-up period depending on the type of surgical intervention

Nature of complications	Type of surgical intervention		
	TEPT without laparoscopic assistance (n=144)	TEPT with laparoscopic assistance (n=65)	Sum (n=209)
Moderate stenosis of the colo-anal anastomosis (without constipation)	4 (2.78%)	–	4 (1.91%)
Constipation	6 (4.17%)	3 (4.62%)	9 (4.31%)
Partial fecal incontinence	11 (7.64%)	9 (13.85%)	20 (9.57%)
Enterocolitis	16 (11.11%)	6 (9.23%)	22 (10.53%)
Total	37 (25.69%)	18 (27.69%)	55 (26.32%)

the additional ligaments that hold the colon, which makes it possible to avoid the tension of the colo-anal anastomosis, to control the correct position of the colon, to prevent its twisting, which can cause obstruction. In older patients, the proximal end of the rectum can be dissected laparoscopically, making TEPT faster and safer.

There was no significant difference in the clinical results of transanal endorectal reduction of the colon with laparoscopy and without laparoscopic assistance in our patients. After TEPT without laparoscopic assistance, 6 (4.17%) of 144 patients had constipation, 11 (7.64%) had partial fecal incontinence, and 16 (11.11%) had EC. Out of 65 children after laparoscopic-assisted TEPT, 3 (4.62%) patients were diagnosed with constipation, 9 (13.85%) with partial fecal incontinence, and 6 (9.23%) with EC. All children with postoperative intestinal problems were treated conservatively. There was no need for redo surgical interventions in these patients.

In the early postoperative period, in 2 (0.96%) of 209 children, failure of the colo-anal anastomosis was noted. These children were operated with laparoscopic-assisted TEPT. In one patient, this complication was

eliminated conservatively. In another child, to correct this complication, it was necessary to impose a right-sided protective intestinal stoma followed by conservative treatment. The intestinal stoma was closed after 3 months after complete secondary healing of the defect in the anastomosis.

The long-term results were studied in all patients, depending on the time of the operation – from 1 to 11 years (Table 4).

In 4 (2.78%) children aged 1 to 12 months after TEPT without laparoscopic assistance during the first 2–4 months after the operation, moderate stenosis of the coloanal anastomosis was noted, which was corrected by bougie dilatations without complications. Despite the moderate stenosis of the anastomosis, there were no signs of constipation in these patients.

Overall, in 55 (26.32%) of 209 patients who underwent TEPT for HD, postoperative intestinal problems occurred in the long-term follow-up period – moderate stenosis of the colo-anal anastomosis without constipation 4 (1.91%) cases, constipation 9 (4.31%) cases, partial faecal incontinence 20 (9.57%) cases and enterocolitis (EC) 22 (10.53%) cases.

Discussion

Various clinics in their studies describe the advantage of mini-invasive methods of correction of HD in children [1,25]. There is less and less talk about the duration of the surgical intervention and the time the patients stay in the surgical hospital after the operation. Possible complications in the early and long-term postoperative period, the reasons for their appearance and methods of their elimination are discussed the most. Also important is the experience of one surgical team, high-quality training of the team to perform a new method of surgical intervention, a large number of operated patients, and other things that confirm the reliability of the effectiveness of this or that method of surgical correction [13,15,22].

The clinical results of TEPT with laparoscopy and without laparoscopic assistance in children with HD directly depend on all factors: the degree of trauma of the surgical intervention, the age of the patients at the time of the operation, the presence of complex accompanying malformations and complications [2,5,17,23].

During the first 2–4 months of the postoperative period, newborns and infants are at risk of moderate stenosis of the colo-anal anastomosis [8,14].

The causes of this complication are the consequences of anastomosis of rectal mucus membrane with the certain degree of sclerotic changes in pull through colon [16,18]. Anastomozitis, which develops from the first days after surgery, with the background of long-term EC, subsequently leads to stenosis of the colo-anal anastomosis. Such a stenosis in infancy is quite compensated, it is easy to correct it by bougie dilatations, provided it is detected early. Therefore, such patients must be examined no later than 1 month after discharge from the hospital, and regular follow-up should be carried out depending on the degree of restoration of the necessary elasticity of the anastomotic line. There are no signs of constipation with such stenosis in infancy, since a thinner consistency of fecal masses remains because of EC, which causes their easy passage through the stenotic area.

The causes of constipation after minimally invasive methods of surgical treatment of HD are: uncorrected stenosis of the colo-anal anastomosis in children older than 1 year; too narrow anal canal after the separation of the sero-muscular layer of the rectum, which occupies the entire rectum and above it; high tone of the internal anal sphincter; insufficient resection of the sigmoid colon leaving additional sclerotized loops; excessive injury of anal sphincters and nerve endings around the anal canal, etc [3,8,11,24].

Stenosis of the colo-anal anastomosis in children older than 1 year can be treated with bougie dilatations.

There was no need for surgical correction in our patients with stenosis of the colo-anal anastomosis.

If the anal canal is too narrow, it is necessary during surgery to dissect this sero-muscular pouch sheath along the front or back walls (in boys) or only along its back (for girls) wall. We did so in each individual case. If this is not done, then in the long term follow-up period such patients will develop persistent constipation, which will require long courses of bougie dilatations, and in some cases even repeated surgical intervention.

Since a high tone of the internal anal sphincter is constantly noted during HD, partial intraoperative sphincterotomy was performed in these patients. If this is not performed during the TEPT operation, in the long term follow-up period, long courses of bougie dilatations are also necessary, or the next stage operation – sphincteromyectomy according to Lynn.

Manifestations of constipation due to insufficient resection of the large intestine leaving additional sclerotized loops or excessive injury to the anal sphincters and nerve endings of the anal canal can be eliminated by complex conservative treatment with the involvement of stimulating physiotherapeutic procedures.

In our opinion, there are several reasons for soiling and faecal incontinence after minimally invasive methods of surgical correction of HD (TEPT without laparoscopic assistance and laparoscopically assisted TEPT). The main cause of such a complication is excessive trauma (stretching) of the anal sphincter, the recovery of which can take a different period of time – from several months to several years.

Another cause of soiling and faecal incontinence is excessive stretching of the colon and the formation of the colo-anal anastomosis. This leads to violation of physiological sphincters and anatomical folds of the large intestine. In such situations, moderate ischemia of the pull-through colon occurs, which aggravates EC or is the cause of EC development.

This complication can lead to technical violations of the sero-muscular sheath. The first technical drawback is failure to resect the mucous membrane of the rectum – less than 1.5 cm from the skin-mucosal junction. It is this area that is the most responsible external zone that provides rectal sensitivity.

We also consider full-layer resection of the rectum to be a mistake, and not antegrade formation of the sero-muscular sheath, as the classic TEPT technique suggests. Of course, the full-layer separation of the rectum is technically simpler than the antegrade formation of the sero-muscular sheath. The physiological consequences of this or that technical moment are described in the parallels of the results of the Swenson and Soave

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operation. Thus, the technique of full-layer rectal separation according to Swenson is more traumatic both for the anal sphincter and for the nerve endings of the pelvic floor, due to which the sensitivity of all pelvic organs is significantly disturbed. Whereas, the Soave technique (that is, internal separation of the sero-muscular sheath of the rectum) is considered the most physiological, in terms of trauma to the anal sphincter and nerve endings of the pelvic floor.

An important point when mobilizing the colon is to maintain sufficient blood supply to the area with which the colo-anal anastomosis is planned. Otherwise, the ischemic part of the pull through can be the cause of long-term colitis, or is the cause of failure of the colo-anal anastomosis.

During the laparoscopic mobilization of the colon, with the subsequent transition to the selection of the initial sections of the rectum, a full-layer dissection of this area should not be performed deeply. The TEPT technique itself involves retrograde separation of the mucous membrane of the rectum, up to the transitional fold of the peritoneum. Thus, we will be able to minimally injure the surrounding tissues and nerve endings, which is very important for the further functioning of the pelvic organs.

Late-diagnosed and late-operated patients with HD are always at risk of long-term soiling and fecal incontinence in the long term follow-up period after radical correction of HD by any method, including minimally invasive operations. Already at the preoperative stage, with late-diagnosed aganglionosis, gross cicatricial-sclerotic changes occur in the pelvis around the rectum. We believe that it is more appropriate to perform an open surgical intervention for patients who are diagnosed with HD at a late stage (in advanced cases), or even in stages – a protective intestinal stoma and a radical operation (according to indications). In such patients, the separation of the sero-muscular sheath and the formation of the colo-anal anastomosis is technically easier than with TEPT.

The next reason for soiling and fecal incontinence is a long and progressive EC in the postoperative period. A long-term inflammatory process in the colon causes a violation of the consistency of fecal masses, dyscoordination of peristalsis, pain and reduced sensitivity to defecation.

Violation of the child's psychological and neurological condition distracts from conscious focus on all physiological processes related to the demand for defecation and the controlled process of defecation.

We noted that the recovery of rectal sensitivity, as a cause of soiling and incontinence in the remote postoperative period, occurs in children with age, when they can more consciously control the process of stool accu-

mulation in the formed rectum and feel the consistency of stool masses.

The courses of conservative restorative rehabilitation treatment included a complex of physiotherapeutic procedures, depending on the nature of the complications, probiotics, enzymes, with consultations and appointments of a pediatrician, a gastroenterologist, a neurologist, a psychologist, and others. Such treatment was recommended from 2 to 4 times a year, according to indications.

Thanks to timely detection, determination of the cause and adequate correction of complications in the long term follow-up postoperative period, good functional results were achieved in all children, which improved their quality of life.

But it is worth to consider this surgical approach is not indicated in all cases. Late referral of patients and untimely establishment of the diagnosis leads to the fact that the intestine, which is located above the aganglionic zone, expands to such a extent that the only way out is the imposition of a protective intestinal stoma, for further reduction of the intestine in size and conducting a radical operation as the second stage. It should also be noted that with subtotal and total forms of HD, it is difficult to mobilize the aganglionic part of the colon from a transanal approach, which forces a laparotomy. In connection with the widespread introduction of laparoscopic techniques, it became possible to mobilize the intestine for its further pull-through from transanal access, which can be used with greater success in older children.

Thus, our own analysis of the TEPT with laparoscopy and without laparoscopic assistance in children of various ages with HD allowed us to evaluate the positive or problematic technical features that significantly affect the clinical results of the early and long-term postoperative periods.

Conclusions

The technique of TEPT with laparoscopy and without laparoscopic assistance is a modern method of surgical correction of HD, which has significant technical advantages compared to other existing methods.

In 26.32% of children with HD who were operated by mini-invasive methods, persistent intestinal problems continue in the long term follow-up period.

No conflict of interests was declared by the authors.

References/Література

1. Bjørnland K, Pakarinen MP, Stenström P, Stensrud KJ, Neuvo M, Granström AL et al. (2017). A Nordic multicenter survey of long-term bowel function after transanal endorectal pull-through in 200 patients with rectosigmoid Hirschsprung disease. *J. Pediatr. Surg.* 52: 1458–1464.

2. Byström C, Östlund S, Hoff N, Wester T, Granström AL. (2020). Evaluation of bowel function, urinary tract function, and quality of life after transanal endorectal pull-through surgery for Hirschsprung's Disease. *Eur J Pediatr Surg*. 31 (1): 40–48.
3. Dickie BH, Webb KM, Eradi B, Levitt MA. (2014). The problematic Soave cuff in Hirschsprung disease: manifestations and treatment. *J Pediatr Surg*. 49 (1): 77–80; discussion 80–81.
4. Ergashev BB, Khamroev UA. (2021). Features of clinic, diagnosis and tactics of surgical treatment of Hirschsprung's disease in infants. *Paediatric Surgery. Ukraine*. 1 (70): 32–37. [Эргашев ББ, Хамроев УА. (2021). Особенности диагностики и тактики хирургического лечения болезни Гиршпрунга у грудных детей. *Хірургія дитячого віку*. 1 (70): 32–37].
5. Fang Y, Bai J, Zhang B, Wu D, Lin Y, Liu M. (2020). Laparoscopic Soave procedure for long-segment Hirschsprung's disease single-center experience. *Wideochir Inne Tech Maloinwazyjne*. 15: 234–238.
6. Jiang M, Li CL, Cao GQ, Tang ST. (2019). Laparoscopic redo pull-through for Hirschsprung disease due to innervation disorders. *J Laparoendosc Adv Surg Tech A*. 29: 424–429.
7. Jiao C, Yu D, Li D, Wang G, Feng J. (2018). A long-term follow-up of a new surgery method: laparoscope-assisted heart-shaped anastomosis for Hirschsprung's disease. *J Laparoendosc Adv Surg Tech A*. 28: 471–475.
8. Kapur RP, Smith C, Ambartsumyan L. (2020). Postoperative pull-through obstruction in Hirschsprung disease: etiologies and diagnosis. *Pediatr Dev Pathol*. 23: 40–59.
9. Kawaguchi AL, Guner YS, Sømme S, Quesenberry AC, Arthur LG, Sola JE, Downard CD, Rentea RM, Valusek PA, Smith CA, Slidell MB, Ricca RL, Dasgupta R, Renaud E, Miniati D, McAteer J, Beres AL, Grabowski J, Peter SDS, Gosain A. (2021). Management and outcomes for long-segment Hirschsprung disease: A systematic review from the APSA Outcomes and Evidence Based Practice Committee. *J Pediatr Surg*. 56 (9):1513–1523.
10. Kim AC, Langer JC, Pastor AC, Zhang L, Sloots CEJ, Hamilton NA, et al. (2010). Endorectal pull-through for Hirschsprung's disease—a multicenter, long-term comparison of results: transanal vs transabdominal approach. *J Pediatr Surg*. 45 (6):1213–1220.
11. Li AW, Zhang WT, Li FH, Cui XH, Duan XS. (2006). A new modification of transanal Soave pull-through procedure for Hirschsprung's disease. *Chin Med J (Engl)*. 119 (1):37–42.
12. Negash S, Getachew H, Tamirat D, Mammo TN. (2022). Hirschsprung disease managed with one-stage transanal endorectal pullthrough in a low-resource setting without frozen section. *BMC Surg*. 22 (1): 89.
13. Neuvonen M, Kyrklund K, Taskinen S, Koivusalo A, Rintala RJ, Pakarinen MP. (2017). Lower urinary tract symptoms and sexual functions after endorectal pull-through for Hirschsprung disease: controlled long-term outcomes. *J Pediatr Surg*. 52: 1296–1301.
14. Neuvonen MI, Kyrklund K, Rintala RJ, Pakarinen MP. (2017). Bowel function and quality of life after transanal endorectal pull-through for Hirschsprung disease: controlled outcomes up to adulthood. *Ann Surg*. 265 (3): 622–629.
15. Onishi S, Nakame K, Yamada K, Yamada W, Kawano T, Mukai M, Kaji T, Ieiri S. (2016). Long-term outcome of bowel function for 110 consecutive cases of Hirschsprung's disease: comparison of the abdominal approach with transanal approach more than 30 years in a single institution – is the transanal approach truly beneficial for bowel function? *J. Pediatr. Surg*. 51: 2010–2014.
16. Prytula VP, Kurtash OO, Hussaini SF, Rusak PS. (2022). Comparative characteristics of the results of surgical treatment of Hirschsprung's disease in children depending on the method of surgical correction. *Paediatric Surgery (Ukraine)*. 4: 40–49. [Прийтла ВП, Курташ ОО, Хуссейні СФ, Русак ПС. (2022). Порівняльна характеристика результатів хірургічного лікування хвороби Гіршпрунга в дітей залежно від способу хірургічної корекції. *Хірургія дитячого віку*. 4 (77): 40–49].
17. Scholfield DW, Ram AD. (2016). Laparoscopic Duhamel procedure for Hirschsprung's disease: systematic review and meta analysis. *J Laparoendosc Adv Surg Tech A*. 26: 53–61.
18. Tang ST, Wang GB, Cao GQ, Wang Y, Mao YZ, Li SW, Li S, Yang Y, Yang J, Yang L. (2012). 10 years of experience with laparoscopic-assisted endorectal Soave pull-through procedure for Hirschsprung's disease in China. *J Laparoendosc Adv Surg Tech A*. 22 (3): 280–284.
19. Tannuri AC, Ferreira MA, Mathias AL, Tannuri U. (2017). Long-term results of the Duhamel technique are superior to those of the transanal pullthrough: a study of fecal continence and quality of life. *J Pediatr Surg*. 52: 449–453.
20. Tomuschat C, Zimmer J, Puri P. (2016). Laparoscopic-assisted pull-through operation for Hirschsprung's disease: a systematic review and meta-analysis. *Pediatr Surg Int*. 32: 751–757.
21. Yasui Y, Nishida S, Shironomae T, Satomi M, Kuwahara T, Kohno M. (2017). Surgical approach for fecal incontinence with a patulous anus after transanal pull-through for Hirschsprung disease. *J. Pediatr. Surg*. 52: 1070–1075.
22. Yokota K, Uchida H, Tainaka T, Tanaka Y, Shiota C, Hinoki A, et al. (2018). Single-stage laparoscopic transanal pull-through modified Swenson procedure without leaving a muscular cuff for short- and long-type Hirschsprung disease: a comparative study. *Pediatr Surg Int*. 34 (10):1105–1110.
23. Zhang JS, Li L, Hou WY, Liu SL, Diao M, Zhang J et al. (2014). Transanal rectal mucosectomy and partial internal anal sphincterectomy for Hirschsprung's disease. *J Pediatr Surg*. 49 (5): 831–834.
24. Zheng Z, Jin Z, Gao M, Tang C, Huang L, Gong Y, Liu Y. (2022). Laparoscopic Complete Excision of the Posterior Muscular Cuff: Technique Refinements and Comparison With Stepwise Gradient Muscular Cuff Cutting for Hirschsprung Disease. *Front Pediatr*. Apr 5; 10: 578843. doi: 10.3389/fped.2022.578843. eCollection 2022.PMID: 35450109.
25. Zimmer J, Tomuschat C, Puri P. (2016). Long-term results of transanal pullthrough for Hirschsprung's disease: a meta-analysis. *Pediatr. Surg. Int*. 32: 743–749.

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