COLONIC STOMA CREATION AS THE FIRST STAGE OF SURGICAL CORRECTION OF TOTAL COLONIC AGANGLIONOSIS IN CHILDREN

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ФОРМУВАННЯ КИШКОВОЇ СТОМИ ЯК ПЕРШІЙ ЕТАП ХІРУРГІЧНОЇ КОРЕКЦІЇ ТОТАЛЬНОГО АГАНГЛІОЗУ КИШЕЧНИКА В ДІТЕЙ

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Abstract. The use of a staged approach in surgical treatment of total colonic aganglionosis is controversial. The creation of a protective colonic stoma as the first stage of surgical correction of total colonic aganglionosis rather than one-stage correction has become an alternative in treatment of such patients. This approach contributes to better survival, reduces the incidence of ileoanal anastomotic failure and improves functional outcomes.

The objective of the research was to study and evaluate the need for colonic stoma creation as the first stage of surgical correction of total colonic aganglionosis in children.

Materials and Methods. The analysis of surgical treatment of 41 children with total colonic aganglionosis over the period 1980-2020 was conducted. Protective colonic stoma was created in all the patients, namely 36 children with isolated colonic aganglionosis and 5 children with the involvement of the entire colon and a segment of the small bowel.

Results. Twenty-four (58.54%) patients were diagnosed and underwent the first stage of treatment in National Specialized Children's Hospital "Okhmatdyt". There were 17 (41.46%) patients who were transferred from other clinics after being diagnosed with a pathology and undergoing colonic stoma creation. During staged treatment of children with total colonic aganglionosis, a single-barrel ileostomy (n=10, 24.40%), a double-barrel ileostomy (n=5, 12.19%), or a loop colonic ileostomy (n=26, 63.41%) were created. The periods between creating the protective colonic stoma and performing radical surgery ranged from 4 to 14 months. The colonic stomas were closed 2-4 months after radical surgery. The third stage of surgical correction of total colonic aganglionosis in children was carried out after the state of the neorectum formed and ileoanal anastomosis was assessed for readiness of inclusion in the passage. There were no complications after protective stoma closure. Within the first 3 months, the frequency of bowel movement ranged from 10 to 15 times a day, and, in a year, it was 2-4 times a day. All the children survived. Functional outcomes of treatment were found to be good. Bowel function was satisfactory. The X-ray images demonstrated the rectal reservoir of sufficient size with pronounced colonization.

Conclusions. Surgical correction of total colonic aganglionosis in children involves the three-stage approach consisting in the creation of the protective small bowel stoma (the first stage), radical surgery, namely colectomy with reconstructive plastic formation of functionally advantageous reservoir version of the neorectum (the second stage) and ileostomy closure after adaptation of the small bowel reservoir (the third stage). The creation of the protective small bowel stoma as the first stage of surgical correction of total colonic aganglionosis in children is emergency surgery. The creation of the loop small bowel stoma at 12 cm above aganglionosis level is the most rational type of the first stage of correcting total colonic aganglionosis in children.

Keywords: Total Colonic Aganglionosis; Treatment; Colectomy; Outcomes; Children.

Резюме. Вступ. Дискутабельним моментом при хірургічному лікуванні тотального агангліозу кишечника в дітей є використання поетапного підходу. Використання захисної кишкової стоми як першого етапу хірургічної корекції тотального агангліозу кишечника стало альтернативою в лікуванні таких пацієнтів, на відміну від одноетапної корекції. Цей підхід сприяє кращому виживанню, зниженню неспроможності ілеоанального анастомозу та покращенню функціональних результатів.

Мета: вивчити та оцінити необхідність формування кишкової стоми як першого етапу хірургічної корекції тотального агангліозу кишечника в дітей.

Матеріал і методи дослідження. Проведено аналіз хірургічного лікування в 41 дитини з тотальною формою агангліозу за період від 1980 до початку 2020 року. Захисні кишкові стоми сформовані в усіх пацієнтів: при ізольованому ураженні агангліозом товстої кишки (n=36) та при ураженні всієї товстої та фрагмента тонкої кишок (n=5).

Результати. У клініці дитячої хірургії Національної спеціалізованої дитячої лікарні «ОХМАТДИТ» встановлено діагноз та виконано перший етап лікування в 24 (58,54%) пацієнтів. З інших лікувальних закладів після встановлення діагнозу та формування кишкових стом було переведено 17 (41,46%) дітей. При етапному лікуванні дітей з тотальним агангліозом було виведено кінцеві одностовбурові (n=10 (24,40%)), кінцеві двостовбурові (n=5 (12,19%)) або петлеві (n=26 (63,41%)) кишкові ілеостоми. Період між накладанням захисної кишкової стоми та радикальною операцією коливався від 4-х до 14-ти місяців. Закриття кишкових стом виконували через 2-4 місяці після радикальної операції. Третій етап хірургічної корекції тотального агангліозу в дітей проводили після оцінки стану готовності сформованого «неоректуму» та ілео-анального анастомозу для включення в пасаж.

У післяопераційному періоді після закриття кишкових стом жодних ускладнень не було. Перші 3 місяці частота стільця становила 10-15 разів, а після 1 року - 2-4 рази на добу. Усі діти вижили. Функціональні результати лікування в них добрі. Функція кишечника задовільна. При рентгенограмах – сформована пряма кишка з достатнім резервуарним об'ємом і вираженою колонізацією.

Висновки. Хірургічна корекція тотального агангліозу кишечника в дітей передбачає трьохетапний підхід: накладання захисної тонкокишкової стоми (1-й етап); радикальна операція – колектомія з реконструктивно-пластичним формуванням функціонально вигідного резервуарного варіанта «неоректуму» (2-й етап) та закриття ілеостоми після адаптації сформованого тонкокишкового резервуару (3-й етап). Формування захисної тонкокишкової стоми як першого етапу хірургічної корекції тотального агангліозу кишечника в дітей відбувається в ургентному порядку. Петлева тонкокишкова стома на висоті до 12 см від рівня агангліозу при тотальному ураженні товстої кишки є найбільш раціональним видом першого етапу хірургічної корекції цієї патології в дітей.

Ключові слова: тотальний агангліоз, лікування, колектомія, результати, діти.

Problem Statement and Analysis of the Recent Research

Total colonic aganglionosis is a rare form of Hirschsprung's disease (HD) that affects 1 in every 50,000 newborns [4, 7]. This form of aganglionosis accounts for 2-13% of all HD cases. Total colonic aganglionosis involves the entire colon and may extend up to 50 cm proximal to the ileocecal valve. Total colonic and small bowel aganglionosis is rarer form involving long segments of the small bowel (exceeding up to 50 cm) [6, 14]. In colonic aganglionosis involving the small bowel, non-specific dilatation of small bowel loops is often observed. However, a characteristic transition zone can be difficult to identify [5], that complicates surgery, including the need to re-site a previously created stoma [11, 13].

There were described the cases of patients with colon aganglionosis involving the small bowel when serial biopsies were performed in the aganglionic small bowel. However, over the first year of life, repeated biopsies in previously aganglionic small bowel identified mature ganglion cells. Such information suggested the possibility of ganglion maturation in the small bowel wall even after birth and encouraged surgeons to consider more conservative surgical approach [2, 15].

Thus, there are various forms of total colonic aganglionosis, namely isolated aganglionosis involving the large bowel only and total colonic aganglionosis involving the small bowel. In each case, changes of different nature and structure occur in the overlying sections of the small bowel. This results in the search for a differential approach to surgical treatment of total colonic aganglionosis considering the rational staged approach [1, 2, 12].

One of the disputable matters in surgical treatment of total colonic aganglionosis is the use of the staged approach. There have been described the cases of simultaneous one-stage colon resection and ileoanal anastomosis [3, 8, 17]. However, they often resulted in anastomotic failure and various septic states that, in turn, caused lethality. The use of the protective colonic stoma as the first stage of surgical correction of total colonic aganglionosis has become an alternative in treatment of such patients [9, 16]. This approach contributed to better survival, reduced the incidence of ileoanal anastomotic failure and improved functional outcomes. Such patients are further studied and observed to develop the most advantageous approach to safe and guaranteed treatment of children with total colonic aganglionosis [5, 10, 18].

The objective of the research was to study and evaluate the need for colonic stoma creation as the first stage of surgical correction of total colonic aganglionosis in children.

Materials and Methods

The analysis of surgical treatment of 1,187 children with different forms of colonic aganglionosis aged from birth to 18 years over the period 1980-2020 was conducted (Table 1). Total colonic aganglionosis was diagnosed in 41 (3.45%) cases. Isolated colonic aganglionosis was detected in 36 (87.80%) out of 41 patients; the involvement of the entire colon and a segment of the small bowel was diagnosed in 5 (12.20%) children.

To make diagnosis and evaluate treatment outcomes during postoperative monitoring, the results of clinical examinations (careful anamnesis,

physical examination, blood and urine tests, electrocardiogram, abdominal ultrasound) and special methods of investigation (irrigography, irrigoscopy, contrast radiography of the digestive tract, sigmoidoscopy, colonoscopy, anorectal manometry, histological study, determination of acetylcholinesterase activity) were used.

The studies were carried out in accordance with the Declaration of Helsinki. The study protocol was adopted by the Local Ethics Committees of all the institutions indicated in the research. All the parents gave their consent for their children to participate in the study.

All the children with total colonic aganglionosis required the removal of the affected bowel section, namely the entire colon, and, if necessary, a segment of aganglionic small bowel. After total colectomy, there were used different variants of optimal reconstructive surgery with the creation of functionally advantageous bowel reservoir. However, the first stage of surgical treatment of this pathology included the creation of the protective colonic stoma.

Results and Discussion

Protective colonic stoma creation in children at the stages of surgical correction of total colonic aganglionosis remains a controversial issue. The selection of proper stoma site, type, and technique for its creation in certain pathology is even more challenging task.

The main goal of diverting the protective colonic stoma at the stages of surgical correction of total colonic aganglionosis in children is to restore structural changes in the supragenetic portions of the bowel and to create favourable conditions for healing functionally advantageous bowel reservoir (neorectum) and ileoanal anastomosis. The one-stage approach is dangerous in such patients, as after surgery they often develop anastomotic failure and various septic states that, in turn, cause lethality.

To solve these problems during reconstructive plastic surgeries in children with total colonic aganglionosis who required colectomy, we used the three-stage approach consisted in the creation of the protective small bowel stoma (the first stage), radical surgery, namely colectomy with reconstructive plastic formation of functionally advantageous neorectal reservoir (the second stage) and ileostomy closure after adaptation of the small bowel reservoir (the third stage).

In all the patients, the protective colonic stoma was created after the midline incision that allowed us to carry out surgical revision of the bowel and abdominal organs to detect and evaluate intestinal changes and the presence of concomitant maldevelopment.

Protective colonic stomas were created in all the patients,

Table 1. Distribution of patient according to age and aganglionosis form

Form of aganglionosis	Age					Total	
	0-6 months	6-12 months	1-3 years	3-7 years	>7 years		
Rectal	39	61	74	95	117	386	32.52%
Rectosigmoid	98	94	187	143	76	598	50.38%
Subtotal	102	48	7	2	3	162	13.65%
Total	41	-	-	-	-	41	3.45%
Total	280	203	268	240	196	1187	100%
	23.58%	17.10%	22.58%	20.22%	16.52%		

Table 2. Patient's age during protective colonic stoma creation

Form of aganglionosis	Age (days)				Total
	1	2	3	4	
Isolated colonic aganglionosis	11	11	9	5	36 (87.80%)
Involvement of the entire colon and small bowel segment	4	1	-	-	5 (12.20%)
Total	15 (36.58%)	12 (29.26%)	9 (21.96%)	5 (12.20%)	41 100%

namely 36 children with isolated colonic aganglionosis and 5 children with the involvement of the entire colon and small bowel segment. The signs of acute or subacute low bowel obstruction with a rapid increase in symptoms were the main clinical signs in children with total colonic aganglionosis. Therefore, colonic stomas were diverted within the 1st-4th days of life (Table 2). Most children (n=27, 65.84%) were operated on within the 1st-2nd days of life.

Twenty-four (58.54%) patients were diagnosed and underwent the first stage of treatment in National Specialized Children's Hospital "Okhmatdyt". There were 17 (41.46%) patients who were transferred from other clinics after being diagnosed with pathology and undergoing colonic stoma creation (Table 3).

The main indications for creating the protective colonic stoma in total colonic aganglionosis included small bowel perforation (n=1), acute (n=31) and subacute (n=9) course of low bowel obstruction.

During staged treatment of children with total colonic aganglionosis, the single-barrel ileostomy, the double-barrel ileostomy, or the loop colonic ileostomy were created (Table 4). They were formed above the transition zone.

We preferred the creation of the loop and single-barrel protective colonic stoma. There was no case of creating the double-barrel colonic ileostomy (Table 5-7).

The site and type of the protective colonic ileostomy depended on the form of aganglionosis (the extent of aganglionosis), the dilatation degree of the overlying sections of the small bowel, and the presence of necrotic changes (in case of perforation).

In isolated colonic aganglionosis (n=36), anatomic changes above the ileocecal valve manifested themselves as dilatation of various extension degree and small bowel hypertrophy. In the involvement of the entire colon and small bowel segment (n=5), the aganglionic segments ranged from 5 to 16 cm, therefore, the site of colonic stoma creation depended on the

length of aganglionosis in the small bowel, dilatation and hypertrophy of the overlying sections. In these patients, stoma creation was followed by more difficulties due to understanding that the higher the small bowel stoma is, the more difficult is to take care of such children in the postoperative period. The site of colonic stoma creation provided the restoration of the passage through the bowels, as well as the creation of conditions for reconstructive plastic surgeries being of great

importance as they aim to eliminate colectomy effects by forming functionally advantageous small bowel reservoir (neorectum). While creating the ileostomy, the small bowel segment of sufficient length (stump) had to be left below the diverted stoma to allow creating favorable conditions for forming functionally advantageous small bowel reservoir, its safe transrectal pull-through followed by ileoanal anastomosis at the next stage.

In our opinion, if such conditions are not fulfilled, the next stage depends on whether the small bowel segment is left, or whether the left segment is of sufficient length for reconstructive surgery (the second stage).

If, while creating the ileostomy in total colonic aganglionosis, the small bowel stump was not left, then, on the one hand, all the favorable conditions for forming functionally advantageous small bowel reservoir, transrectal pull-through procedure followed by ileoanal anastomosis are created. In such case, however, repeated diversion of the protective small bowel stoma during radical surgery is required.

If, while creating the ileostomy in total colonic aganglionosis, there was left the small bowel stump of insufficient length for forming the small bowel reservoir, transrectal pull-through procedure followed by ileoanal anastomosis, then, at the second stage of reconstructive surgery, it is necessary to remove the ileostomy, to form the neorectum from the bowel stump left and the small bowel segment above the ileostomy and to re-site the protective stoma.

Having analyzed the experience in using the safest variants of functionally advantageous small bowel reservoir (neorectum) to correct colostomy effects in children with total colonic aganglionosis, we have found that, when creating the protective colonic stoma in such patients, it is advisable to leave a 10-12-cm small bowel stump below the diverted stoma.

In our opinion, such a length of the ileostomy is safe for postoperative management of patients. In the interoperation period (8-14 months), the bowel above the ileostomy and the

Table 3. Distribution of patients depending on aganglionosis form

Form of aganglionosis	Number of children diagnosed with pathology		Total
	in other clinics	in our clinic	
Isolated colonic aganglionosis	15	21	36 (87.80%)
Involvement of the entire colon and small bowel segment	2	3	5 (12.20%)
Total	17 (41.46%)	24 (58.54%)	41 100%

Table 4. Distribution of patients according to the technique of protective colonic stoma creation

Form of aganglionosis	Type of protective colonic ileostomy			Total
	Loop stoma	Single-barrel stoma	Double-barrel stoma	
Isolated colonic aganglionosis	23	9	4	36 (87.80%)
Involvement of the entire colon and small bowel segment	3	1	1	5 (12.20%)
Total	26 (63.41%)	10 (24.40%)	5 (12.19%)	41 100%

Table 5. Characteristics of protective colonic stoma created in different clinics

Type of protective colonic stoma	Number of children diagnosed with pathology		Total
	in other clinics	in our clinic	
Loop stoma	6	20	26 (63.41%)
Single-barrel stoma	6	4	10 (24.40%)
Double-barrel stoma	5	-	5 (12.19%)
Total	17 (41.46%)	24 (58.54%)	41 100%

stump left continue to grow. Therefore, such a length of the stump left considering its growth in the interoperation period is sufficient for forming the neorectum. Thus, the creation of the loop small bowel stoma at 12 cm above aganglionosis level is the most rational type of the first stage of correcting total colonic aganglionosis in children.

The period between creating the protective colonic stoma and performing radical surgery ranged from 4 to 14 months, depended on the nature of pathology, the presence of concomitant congenital abnormalities and severe complications, and allowed eliminating changes in the bowel and stabilizing the patients' general condition (Table 8).

The option for restoring the bowel patency after total colectomy was being selected with searching for, improving, developing, and implementing the optimal methods of forming functionally advantageous small bowel reservoir (neorectum).

During treatment of the patients, we have used different options of surgical restoration of functionally advantageous reservoir (neorectum) after colostomy towards the most advanced and effective, namely:

- intrarectal ileal pull-through procedure followed by ileorectal anastomosis (n=1);
- creation of entero-entero anastomosis with the end-to-side invagination valve (n=4);
- formation of a J reservoir from double-layer ileo-transplant (n=1);
- formation of the side-to-side reservoir from double-layer ileo-ileal transplant (n=28);
- formation of the side-to-side reservoir from double-layer ileo-colonic transplant (n=7).

The colonic stomas were closed 2-4 months after radical surgery. The third stage of surgical correction of total colonic aganglionosis in children was carried out after the state of the neorectum formed and ileoanal anastomosis were assessed for readiness of inclusion in the passage.

There were no complications in the postoperative period.

Table 7. Characteristics of protective colonic stoma created in "Okhmatdyt" depending on aganglionosis form

Form of aganglionosis	Type of protective colonic ileostomy			Total
	Loop ileostomy	Single-barrel ileostomy	Double-barrel ileostomy	
Isolated colonic aganglionosis	17	4	-	21
Involvement of the entire colon and small bowel segment	3	-	-	3
Total	20	4	-	24

Table 6. Characteristics of protective colonic stoma created in other clinics depending on aganglionosis form

Form of aganglionosis	Type of protective colonic ileostomy			Total
	Loop ileostomy	Single-barrel ileostomy	Double-barrel ileostomy	
Isolated colonic aganglionosis	6	5	4	15
Involvement of the entire colon and small bowel segment	-	1	1	2
Total	6	6	5	17

Within the first 3 months after protective stoma closure, the frequency of bowel movement ranged from 10 to 15 times a day, and, in a year, it was 2-4 times a day. All the children survived. In the remote period, bowel function was satisfactory in all the patients who underwent the formation of the most functionally advantageous reservoir in the distal colon through the creation of the side-to-side double-layer ileo-colonic transplant and ileo-ileal transplant. On the irrigogram, the rectal reservoir was of sufficient size with pronounced colonization and overlying sections of the diverted bowel.

Conclusions

1. The creation of the protective small bowel stoma as the first stage of surgical correction of total colonic aganglionosis in children is emergency surgery.
2. The creation of the loop small bowel stoma at 12 cm above aganglionosis level is the most rational type of the first stage of correcting total colonic aganglionosis in children.
3. The period between creating the protective colonic stoma and performing radical surgery ranged from 4 to 14 months, depended on the nature of pathology, the presence of concomitant congenital abnormalities and severe complications, and allowed eliminating changes in the bowel and stabilizing the patients' general condition.

Financial Support

This research received no specific grant from any funding agency, commercial or not-for-profit sectors.

Conflict of Interest

None.

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Table 8. Periods between creating the protective colonic stoma and performing radical surgery

Form of aganglionosis	Interoperation time			Total
	4-8 months	8-12 months	12-14 months	
Isolated colonic aganglionosis	3	10	23	36 (87.80%)
Involvement of the entire colon and small bowel segment	-	1	4	5 (12.20%)
Total	3 (7.32%)	11 (26.83%)	27 (65.85%)	41 100%

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Received: 07.05.2020

Revised: 08.07.2020

Accepted: 23.10.2020