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Research Article



## Intestinal anastomoses in children: The draft decision of the Russian Symposium of Children surgeons (April 2023)

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### Abstract

The Symposium of Pediatric Surgeons of Russia, "Intestinal Anastomoses in Children," was conducted in Volgograd on April 26, 2023, with around 180 doctors in attendance. Thirty papers were presented and discussed, and 41 articles were published in the proceedings of the symposium. According to the results of a systemic analysis of a questionnaire poll of major pediatric surgeons in 75 regions of Russia, 4,558 surgeries on intestinal anastomosis formation were performed in 2021–2022, including 1,735 operations in newborn children (36%); their share in general pediatric surgery was less than 0.6%, and it was more than 18.6% in neonatal surgeons. The number of intestinal anastomoses formed during laparoscopic procedures increased (4.4%). Pediatric surgeons equally often used double-row nodal intestinal sutures (33.3%), single-row continuous sutures (34.6%), and different types of sutures (33.3%). A T-shaped anastomosis was performed in cases of necrotizing enterocolitis where there was a significant difference in the diameters of the intestine's inflow and outflow channels. The clip-and-drop technique was used to treat neonates with multifocal necroses. Interintestinal anastomoses were favored over enterostomies in numerous segmental resections. For duodenal obstruction, duodeno-duodenal, and duodeno-jejunal anastomoses were performed. In children with Crohn's disease and choledochal cysts, most specialists prefer operations with stapling devices. Creating a magnetic interintestinal anastomosis lowers the risk of postoperative complications and facilitates the postoperative period. Clinical observations after laparoscopic surgeries accounted for a significant proportion of complications (66%). Anastomosis failure was three times more common in planned small intestinal in older children than in emergency surgeries (1.2 and 0.4%, respectively).

The modern stage of development of intestinal anastomosis formation techniques in children is characterized by good results, the expansion of indications for intestinal anastomosis in conditions of compromised colon or peritonitis, and the introduction of laparoscopic techniques and mechanical stapling devices with slightly poorer results.

**Keywords:** abdominal surgery; anastomosis failure; children; complications; interintestinal magnetic anastomosis; intestinal anastomoses; laparoscopy; necrotizing enterocolitis; newborns.

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Научная статья

## Кишечные анастомозы у детей. Проект решения Российского симпозиума детских хирургов, апрель 2023 г.

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### Аннотация

26 апреля 2023 г. в Волгограде состоялся симпозиум детских хирургов России «Кишечные анастомозы у детей», в котором приняли участие свыше 180 специалистов. Были заслушаны и обсуждены 30 докладов, в материалах симпозиума опубликована 41 статья. По результатам системного анализа анкетирования главных детских хирургов 75 регионов России всего в 2021–2022 гг. выполнено 4558 операций по формированию кишечных анастомозов, включая 1735 — у новорожденных (36 %), доля этих операций в общей практике детской хирургии составила не более 0,6 %, а у неонатальных хирургов — свыше 18,6 %. Отмечена тенденция к увеличению числа создания кишечных анастомозов при лапароскопических операциях (4,4 %). Одинаково часто детские хирурги использовали двухрядный узловый кишечный шов (33,3 %), однорядный непрерывный (34,6 %) и другие типы швов (33,3 %). При некротизирующем энтероколите в случаях выраженного несоответствия диаметров приводящего и отводящего отделов кишечника выполняли Т-образный анастомоз. Технологию clip-and-drop применяли для лечения новорожденных с мультифокальными некрозами кишечной трубки. При множественных сегментарных резекциях предпочтительно наложение межкишечных анастомозов вместо энтеростомий. При непроходимости двенадцатиперстной кишки выполняли дуодено-дуоденальный и дуодено-еюнальный анастомозы. У детей с болезнью Крона и кистами холедоха большинство специалистов отдадут предпочтение операциям с применением сшивающих аппаратов. Создание магнитного межкишечного анастомоза позволяет снизить риск послеоперационных осложнений и облегчает течение послеоперационного периода. При операциях на двенадцатиперстной кишке в структуре осложнений значительную долю составили клинические наблюдения после лапароскопических операций (66 %). При плановых операциях на тонкой кишке у старших детей частота несостоятельности анастомоза зафиксирована в 3 раза больше, чем при экстренных (1,2 и 0,4 % соответственно).

Современный этап развития технологий формирования кишечных анастомозов у детей характеризуется хорошими результатами, расширением показаний к кишечному анастомозированию в условиях компрометированной кишки или перитонита, а также внедрением лапароскопических методик и механических сшивающих аппаратов с несколькими худшими результатами.

**Ключевые слова:** абдоминальная хирургия; кишечные анастомозы; осложнения; несостоятельность анастомоза; лапароскопия; межкишечный магнитный анастомоз; некротизирующий энтероколит; новорожденные; дети.

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## 儿童的肠吻合术。俄罗斯小儿外科医生研讨会决定草案，2023年4月

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### 简评

2023年4月26日在伏尔加格勒举行了俄罗斯小儿外科医生研讨会。本次研讨会的主题是“儿童的肠吻合术”。超过180名专家参加了此次研讨会。研讨会上提交并讨论了30多份报告。在该研讨会的会议记录中发表了41篇文章。对俄罗斯75个地区的首席小儿外科医生的问卷调查进行的系统分析显示了，2021–2022年共进行了4558例肠吻合术。其中1735例手术（36%）是对新生儿进行的。这些手术在儿童外科学的一般实践中的比例不超过0.6%。对于新生儿外科医生来说，这些手术比例超过18.6%。腹腔镜手术中创建的肠吻合术的数量趋于增加（4.4%）。小儿外科医生使用双排间断肠缝合（33.3%）、单纯连续缝合（34.6%）和不同类型的缝合（33.3%）的频率相同。在坏死性小肠结肠炎的病例中，在流入和流出的肠道直径明显不一致的情况下，进行了T型吻合。在治疗新生儿肠管多灶性坏死时，采用了clip-and-drop技术。在多节段切除术的情况下，首选肠间吻合术而不是肠造口术。在十二指肠梗阻的情况下，进行了十二指肠十二指肠侧侧吻合术和十二指肠空肠吻合术。对于患有克罗恩病和胆总管囊肿的儿童来说，大多数专家宁愿用订书机进行手术。进行肠间磁吻合术促进减少术后并发症的风险，并有利于术后的恢复。在十二指肠手术中，腹腔镜手术后的临床观察占并发症的很大比例（66%）。对于大龄儿童来说，对小肠进行的择期手术中吻合术失败的发生率比紧急手术中的高2倍（分别为1.2%和0.4%）。

对儿童进行肠吻合术的现代技术显示出良好的效果。新技术扩大了医生觉得最好哦对患有受损肠道或腹膜炎的病人进行肠吻合术的数量。现阶段技术发展的另一个特点是腹腔镜技术和医用机械订书机的引入，但效果稍差。

**关键词：**腹部外科；肠吻合术；并发症；吻合术失败；腹腔镜检查；肠间磁吻合术；坏死性小肠炎；新生儿；儿童。

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## INTRODUCTION

On April 26, 2023, the “Intestinal Anastomoses in Children” symposium of pediatric surgeons in Russia was held in Volgograd. The significance of this topic stems from the fact that numerous complex and unresolved issues remain in this challenging section of abdominal surgery. These issues are associated with the active introduction of laparoscopic surgery into medical practice, the necessity of prevention of intestinal anastomosis (IA) failure, and the choice of appropriate methods and techniques of their formation. The symposium’s agenda included a presentation of the results of the symposium, with 30 reports being delivered and a total of 41 articles published in the “Proceedings of the Symposium” [1]. More than 180 specialists participated in the symposium.

In preparation for the symposium, the Chief Pediatric Surgeon of the Russian Ministry of Health developed questionnaires containing inquiries about surgeries performed with IA formation. These questionnaires were then sent to the chief specialists of 75 subjects of the Russian Federation. A systematic analysis was conducted on the received questionnaires, which included data from 4,558 operations performed between 2021 and 2022. The issues of intestinal anastomosing technique in open and laparoscopic surgeries, peculiarities of its performance in various diseases, and pathologic conditions of abdominal cavity organs in children of different ages were considered. The analysis of complications encountered in various types of IA was performed.

After hearing and discussion of the reports, the draft decision of the symposium was adopted. Below is its text for familiarization of a wide range of specialists with further adjustment for inclusion in the federal clinical recommendations.

## DEFINITION

IA formation is a surgical technique used to restore the integrity of the intestine, which has been compromised by the removal of a part of it, allowing the passage of contents through the digestive tract. It can be considered as an independent operation, as well as part of any intervention on the abdominal cavity organs. Anastomosis between two parts of the digestive tract is one of the most common operations in pediatric abdominal surgery. According to the analysis of the questionnaire survey of chief pediatric surgeons of Russia in 2023, the share of operations of IA formation in the practice of pediatric surgeons was no more than 0.6%, while in the practice of neonatal surgeons reported over 18.6%.

## TYPES OF INTESTINAL ANASTOMOSES USED IN PEDIATRIC PRACTICE

There are various types of IA, including end-to-end, side-to-side, side-to-side, end-to-side, and side-to-side

anastomoses. Among these, end-to-end anastomoses are the most commonly performed in pediatric practice.

The formation of intestinal anastomoses can be achieved using both manual techniques and stapling devices. It has been observed that there is an increase the number of CAs formed during laparoscopic surgeries (about 4.4% in the period 2022–2023). The choice of a specific variant of IA formation depends on the specific clinical situation, the expertise of the operating surgeon, and the availability of appropriate equipment.

The results obtained from a systematic analysis of data from the chief pediatric surgeons of 75 constituent entities of the Russian Federation, which includes the Donetsk People’s Republic and the Lugansk People’s Republic, in 2021–2022, revealed that pediatric surgeons almost equally often employed double-row knotted intestinal sutures (33.3%), single-row continuous sutures (34.6%), and other types of sutures (33.3%). The single-row knotted suture (10.6%) or their “original” suture type (5.3%) were less frequently preferred. A total of 4,558 IA operations were analyzed, including 1,735 in neonates (36%).

## INTESTINAL ANASTOMOSES IN NECROTIZING ENTEROCOLITIS AND MESENTERIC THROMBOSIS

The standard surgical treatment for children diagnosed with necrotizing enterocolitis consists of resection of the altered intestinal area with the formation of intestinal stomas and subsequent formation of IA. During the first stage of surgical treatment, the affected intestinal area is resected, and with various types of stomas are removed, including double ileostomy, terminal ileostomy, colostomy, and jejunostomy. Subsequently, IA formation is performed: end-to-end anastomosis of the ileum, end of the ileum to the side of the large intestine, and T-anastomosis in case of a marked mismatch between the diameters of the leading and diverting parts of the intestine. The terms of anastomosis formation vary from 2.5 weeks to 4 months. Patients with T-shaped anastomosis undergo closure of the unloading stoma within 3–6 months.

In cases of peritonitis in newborns with necrotizing enterocolitis, it is possible to form small intestinal anastomoses. However, this approach is associated with a high risk of anastomosis failure in the early postoperative period. The final decision is made according to the specific clinical situation.

The clip-and-drop technique is used to treat neonates with multifocal necrosis of the intestinal tube. The first step in surgical treatment involves resection of obviously necrotic parts of the intestine. Potentially viable intestinal fragments are sutured tightly at both ends and immersed in the abdominal cavity. After stabilization of the patient’s condition in 72–120 h, a second operation is performed. This involves assessing the viability of the remaining intestinal fragments, resecting segments that are subjected to

further necrosis, and applying interintestinal anastomoses. Segmental resection of necrotized intestine without removing intestinal stomas followed by delayed formation of interintestinal anastomoses may be the strategy of choice for surgical treatment of multifocal necrosis of the intestinal tube, allowing for maximum preservation of the remaining length of the intestine and achieving a good postoperative result.

## DUODENAL AND SMALL INTESTINAL OBSTRUCTION

The cause of congenital duodenal obstruction can be attributed to malformations affecting the intestine itself (atresia, membrane, or stenosis) as well as abnormalities involving the organs and vessels surrounding the duodenum (ring-shaped pancreas, preadrenal portal vein, or peritoneal tracts compressing the duodenum). Depending on the specific clinical situation, different types of anastomoses are used, namely, duodeno-duodenal and duodeno-jejunal. The Kimura method of diamond-shaped duodeno-duodenoanastomosis has gained significant popularity and is successfully performed using laparoscopic techniques.

At the same time, the introduction of laparoscopic technique of anastomosis formation requires appropriate training. According to the analysis of 2021–2022, as a result of duodenal obstruction treatment in 453 newborns, the majority recovered without complications (10 children died [2.2%] due to progression of combined pathology), anastomosis failure occurred in 9 (1.9%), and repeated anastomosis reconstructions were required in 13 patients (2.9%). Laparoscopic duodenal anastomoses were performed in 87 children (19.2%). In these patients, anastomosis failure occurred three times more often (6.8%), as well as the need for repeated anastomosis reconstructions (8%), and mortality increased to 4.6%.

The most common cause of congenital small intestinal obstruction is atresia. The preferred surgical procedure for this condition involves resection of the atresized part of the small intestine with direct or T-shaped anastomosis in case of a marked discrepancy between the diameters of the leading and diverting parts of the intestine. The greatest difficulties arise with multiple atresia of the small intestine. However, it is possible to form multiple anastomoses between non-atresized parts of the intestine.

## HIRSCHSPRUNG'S DISEASE AND NEUROMUSCULAR DYSPLASIA OF THE COLON

The aim of surgery in Hirschsprung's disease is to remove the aganglionic segment of the intestine. The scope of surgery is determined by the extent of this segment and can vary from rectal resection to total colectomy with the formation of colorectal and even ileorectal anastomosis. Along with classical operations for Hirschsprung's disease, such as

Soave, Duhamel, and Swenson operations, techniques of forming anastomoses with the rectum using stapling devices have recently been increasingly used.

## CROHN'S DISEASE

Crohn's disease (CD) is characterized by transmural lesions of the intestinal wall. In children, the aggressive course of the disease is often complicated by the development of intestinal strictures, fistulas, and infiltrates, requiring surgical treatment. While there is no single standard of anastomosis formation in children with CD, most specialists prefer hardware variants.

Depending on the level and extent of the lesion, various resections of the ileum and colon can be performed. The operations can be performed in one stage, involving resection of the affected part of the intestine with the primary formation of interintestinal anastomosis. Alternatively, a two-stage operation may be performed. In the first stage, a primary ileostomy is created to disconnect the colon. In the second stage, under the ileostomy cover, the colonic stricture is resected, and a circular anastomosis is performed using both manual technique of anastomosis creation and the use of stapling devices for this purpose. The ileostomy is removed once the disease is in remission.

## CREATION OF INTERINTESTINAL ANASTOMOSES DURING ROUX-LOOP FORMATION IN CHILDREN WITH CHOLEDOCHAL CYSTS

The radical operation in children with choledochal cysts involves the excision of cystically altered extrahepatic bile ducts, cholecystectomy, and the formation of hepaticojejunostomy with a disconnected loop along the small intestine. The variants of interintestinal anastomosis are different. Each of them has its own technical peculiarities and can be accompanied by the development of specific complications. After the stage of radical excision of the choledochal cyst, it is necessary to provide bile outflow by forming two anastomoses. The jejunum is crossed at a distance of 20–25 cm from the ligament of Treitz, and its distal loop is passed behind the colon into the subhepatic space, forming hepaticojejunostomy end-to-end or end-to-side single-row suture. Then, the loop is disconnected according to Roux's method by forming an end-to-side IA with a single-row suture between the driving loop of jejunum and the disconnected one at a distance of 30–40 cm from the hepaticojejunostomy.

Extracorporeal or intracorporeal application of stapling devices can be the optimal option of interintestinal anastomosis in the formation of Roux loop during minimally invasive surgeries in children with choledochal cysts, which is accompanied by the least number of postoperative complications and allows to reduce the time of surgical intervention.

## INTESTINAL ANASTOMOSES IN RECONSTRUCTIVE UROLOGY

The creation of an artificial bladder is a reconstructive operation that involves forming a low-pressure reservoir with sufficient capacity from a section of intestine. This procedure is accompanied by an interintestinal anastomosis to restore the continuity of the intestinal tract, uretero-intestinal anastomoses, and the creation of a percutaneous dry stoma for self-catheterization. Intestinal urinary derivation in pediatrics is used for adequate surgical correction in those patients with bladder exstrophy, cloaca, cloaca exstrophy, and epispadias, who have marked pathological changes in the lower urinary tract.

Typically, surgeries to create a heterotopic bladder follow the Mainz Pouch I technique, which involves forming a heterotopic bladder from the small intestine and creating a continent appendicostomy. Additional procedures may include the formation of continent efferent stomas using the modified Monti procedure and augmentation colocolostomy with the formation of a continent efferent stoma, also following the modified Monti procedure.

## MULTIPLE INTESTINAL ANASTOMOSES

In rare cases of intestinal pathology, segmental resection of different parts of the intestine is required and, accordingly, the simultaneous formation of more than two interintestinal anastomoses. Such situations often occur in patients who are at risk of developing postresection short bowel syndrome and chronic intestinal insufficiency. When performing surgical interventions in such patients, the following principles should be followed: precision technique in the application of interintestinal anastomoses; the most economical resection of the intestine during stoma isolation; the use of techniques for shoeing the driving section in case of a marked difference in the diameter of the compared intestinal sections; and preservation of any viable part of the intestine with a reasonable avoidance of enterostomies in favor of interintestinal anastomoses in patients with multiple intestinal stomas.

The preservation of intestinal length is the leading objective in this category of patients, and one-stage placement of more than two interintestinal anastomoses is not associated with a higher incidence of surgical complications. According to an analysis of the work of pediatric surgeons in Russia in 2021–2022, out of 310 newborns with primary anastomoses in conditions of segmental discongruence, the need for multiple small intestinal anastomoses arose in 77 patients (7.6% of all small intestinal anastomoses in newborns and 24% of patients with primary anastomoses).

## INTERINTESTINAL MAGNETIC ANASTOMOSES

Interintestinal magnetic anastomosis in a double-barrel intestinal stoma is an alternative to surgical excision of the stoma and the formation of an IA to restore

the passage of intestinal chyme in the disconnected intestinal section. This technique is commonly used in neonatal patients who have undergone necrotizing enterocolitis, necrosis of the intestine at midgut ingestion. In older children, the formation of magnetic anastomoses is performed in case of intestinal obstruction, injuries of small, large, and rectum. On the 4th–7th day, a pair of permanent magnets is placed in the fistula holes. As the necrosis of the compressed intestinal tissue is necrotic, a lateral union in the form of interintestinal magnetic anastomosis is formed. The appearance of independent stools and a decrease in stoma discharge is an indicator of a functioning stoma. When closing a double-barrel stoma in 2–4 months, the integrity of the intestinal tube is restored with the preservation of the created interintestinal magnetic anastomosis, which allows to sharply reduce the risk of intestinal suture failure and start enteral nutrition early after surgery.

The two-stage surgical treatment method for patients operated for acute abdominal pathology with resection of the intestinal segment and creation of a magnetic interintestinal anastomosis allows to significantly reduce the risk of postoperative complications, facilitates the course of the postoperative period, and helps to avoid the development of dysbacteriosis in the disconnected intestine. In addition, reconstructive surgery is performed against the background of somatic well-being in the most favorable terms.

## COMPLICATIONS IN THE FORMATION OF INTESTINAL ANASTOMOSES IN CHILDREN

IA failure is a major complication with severe and even fatal consequences. Nevertheless, such factors as suture row and interrupted suture do not affect the incidence of failure. The incidence of this complication is significantly higher during emergency interventions, in case of severe adhesions in the abdominal cavity, peritonitis, as well as when performing one-stage colorectal anastomosis. The incidence of failure is significantly higher in patients with concomitant congenital pathology.

According to the data of the chief pediatric surgeons of the Russian Federation regions, in 2021–2022, the failure of duodenal anastomoses in newborns amounted to 1.9%, repeated reconstructions were required in 2.9%. Lethality was 2.2%. IA formation in conditions of peritonitis, with compromised duodenum or disruption of its blood supply increased anastomosis failure up to 27.2%, the need for repeated reconstruction — up to 9%. Clinical observations of laparoscopic operations (66% of all duodenal anastomosis failures) accounted for a significant share in the structure of complications.

Lethality in the subgroup of 1,012 newborns with IA formation at the level of small intestine amounted to 3.75%. In 40% of cases, it occurred after stoma closure surgery,

while in 31% of cases, it occurred after operations against the background of peritonitis or intestinal circulatory disorders. Repeated reconstruction of small intestinal anastomoses in newborns was required in 41 children (4%), with every second case occurring after stoma closure operations. Failure of small intestine anastomoses in newborns was detected in 2% of cases. In primary anastomosis formation (233), including multiple anastomoses (77), the failure rate was 2.1%. After stoma closure, the failure rate was 1.7%, and during operations in conditions of peritonitis or circulatory disorders of the intestinal wall, the failure rate was 2.9%.

The formation of small intestinal IA was performed in 2,097 older children. Analysis of planned operations on the small intestine in older children (closure of stomas, fistulas, including magnetic devices [594 patients, 28.3%]) showed that anastomosis failure occurred in 1.2% of cases, repeated reconstructions in 1.5% of cases, and the lethality rate was 1.3%.

At the same time, emergency intestinal resections were performed in 908 patients (43.2%) in cases of intestinal obstruction, intestinal perforations, trauma, inflammatory diseases, where frequent problems included peritonitis, intestinal viability, and adequacy of blood supply. The treatment results were better—anastomosis failure occurred in 0.4% of observations, repeated reconstructions in 1.3%, and a lethality rate of 0.3%.

When anastomoses were formed at the level of the colon, failure occurred in 2.2% of both newborns and older children. Indications for repeated reconstruction of anastomoses occurred in 0.74%–1.7% of cases. Eighty-five older children (13.4%) underwent emergency surgery for various perforations of the colon, complications of inflammatory and infectious diseases of the colon. In this subgroup, there were no anastomosis failures or fatal outcomes, and only two children (2.4%) required repeated reconstruction.

Out of 4,558 operations of IA formation (including 1,735 in newborns) in the period 2021–2022 in Russia, anastomosis failure was registered in 1.65% of

observations, repeated reconstructions in 2.8%, with lethality rate of 1.52%.

## CONCLUSION

Thus, the current stage of development of techniques for IA formation is characterized by good results, expansion of indications for IA in conditions of compromised intestine or peritonitis, and introduction of laparoscopic techniques and mechanical stapling devices with somewhat worse results.

## ADDITIONAL INFORMATION

**Messages to readers.** You can send your comments and suggestions on the project to the Secretary of the Russian Association of Pediatric Surgeons Oleg S. Gorbachev at: raps@telemednet.ru

**Authors' contribution.** Thereby, all authors made a substantial contribution to the conception of the study, acquisition, analysis, interpretation of data for the work, drafting and revising the article, final approval of the version to be published and agree to be accountable for all aspects of the study.

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**Обращение к читателям.** Свои замечания и предложения по проекту решения можно направлять секретарю Российской ассоциации детских хирургов Олегу Сергеевичу Горбачеву по адресу: raps@telemednet.ru

**Вклад авторов.** Все авторы внесли существенный вклад в разработку концепции, проведение исследования и подготовку статьи, прочли и одобрили финальную версию перед публикацией.

**Источник финансирования.** Авторы заявляют об отсутствии внешнего финансирования при проведении исследования.

**Конфликт интересов.** Авторы декларируют отсутствие явных и потенциальных конфликтов интересов, связанных с публикацией настоящей статьи.

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