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# Opportunities for Prevention of Complications in Intestinal Stoma Surgery

Vitaliy S. Groshilin[1]*, Vladimir D. Kuznetsov[1], Dmitry V. Kuznetsov[2], Akop A. Pogosyan[3]

[1] *Rostov State Medical University, Rostov-on-Don, Russian Federation*
[2] *Central District Hospital in the Neklinovsky district, Pokrovskoye village, Neklinovsky district, Rostov region, Russian Federation*
[3] *City Clinical Hospital No. 6, Rostov-on-Don, Russian Federation*

**Aim:** to reduce the number of paracolostomy complications and improve the quality stoma patients' life by justifying the use of a comprehensive approach to the end colostomy, including preoperative marking, taking into account the variants of the structure of the muscular-aponeurotic frame of the anterior abdominal wall, as well as the individual features of vascularity and topography of the intestine section undergoing ostomy surgery.
**Materials and methods.** To confirm the effectiveness of the proposed algorithm, an analysis of 52 clinical observations in patients who underwent surgeries with the formation of an end colostomy was carried out, which made up two clinical groups. In group 1 ($n$ = 25) the developed therapeutic and diagnostic algorithm was applied, which included a rational choice of the colostomy localization site, taking into account individual features of the anterior abdominal wall structure, the quality of vascularity of the ostomy intestine, the terminal portion of its mesentery, the length and topography of the end section. Group 2 of patients ($n$ = 27) underwent ostomy creation surgery using traditional techniques, without considering individual features.
**Results.** The obtained results indicate the possibility of reducing the number of early (group 1 — 16 %, group 2 — 40.7 %; $p < 0.05$) and late (group 1 — 8 %, group 2 — 29.6 %; $p < 0.05$) paracolostomy complications, decreasing the number of repeated surgical interventions (three cases of re-creation of the stoma in the early postoperative period in group 2 and no indication for repeated interventions in group 1) and improving the quality of life in stoma patients through the application of the developed personalized algorithm. The assessment of the psychological (group 1 — 33.24, group 2 — 53.41) and physical (group 1 — 32.46, group 2 — 54.78) components of health based on the results of the SF-36 survey confirmed the advantages of the proposed tactics and therapeutic and diagnostic algorithm in group 1. The average number of hospital-stay days was also less in patients of clinical group 1 — 12.1 ± 3.4 days vs. 16 ± 4.7 in group 2.
**Conclusions.** The use of patient-centered complex approach to determining the place and method of formation of an end colostomy, which includes taking into account the individual structure of the muscular-aponeurotic frame of the anterior abdominal wall, and the peculiarities of vascularity and topography of the intestine section undergoing ostomy surgery, is accompanied by a low number of early and late paracolostomy complications.
**Keywords:** end colostomy, intestinal stoma complications, paracolostomy hernias, preoperative markings on the anterior abdominal wall
**Conflict of interest:** the authors declare no conflict of interest.

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## Возможности профилактики осложнений в хирургии кишечных стом

В.С. Грошилин[1]*, В.Д. Кузнецов[1], Д.В. Кузнецов[2], А.А. Погосян[3]

[1] *ФГБОУ ВО «Ростовский государственный медицинский университет» Министерства здравоохранения Российской Федерации, Ростов-на-Дону, Российская Федерация*
[2] *ГБУ РО «Центральная районная больница» в Неклиновском районе, с. Покровское, Неклиновский р-н, Ростовская область, Российская Федерация*
[3] *ГБУ РО «Городская больница № 6», Ростов-на-Дону, Российская Федерация*

**Цель исследования:** снизить количество параколостомических осложнений и улучшить качество жизни стомированных больных за счет обоснования применения комплексного подхода к наложению одноствольной колостомы, включающего дооперационную разметку, учет вариантов строения мышечно-апоневротического каркаса передней брюшной стенки, а также индивидуальных характеристик васкуляризации и топографии участка кишки, подлежащего стомированию.
**Материалы и методы.** В целях подтверждения эффективности предложенного алгоритма проведен анализ 52 клинических наблюдений пациентов, перенесших операции, сопровождающиеся формированием одно-

ствольной концевой колостомы, составивших две клинические группы. В первой группе (25 пациентов) был применен разработанный лечебно-диагностический алгоритм, включавший рациональный выбор места локализации колостомы, учет индивидуальных характеристик строения передней брюшной стенки, качества васкуляризации стомируемой кишки, терминального отдела ее брыжейки, длины и топографии концевого участка. Во второй группе (27 пациентов) выполнялось стомирование с использованием традиционных приемов, без учета особенностей.

**Результаты.** Полученные результаты свидетельствуют о возможности снижения количества ранних (I группа — 16 %, II группа — 40,7 %; $p < 0,05$) и поздних (I группа — 8 %, II группа — 29,6 %; $p < 0,05$) парастомальных осложнений, уменьшения числа повторных оперативных вмешательств (3 случая рестомирования в раннем послеоперационном периоде во II группе и отсутствие показаний для повторных вмешательств в I группе) за счет применения разработанного персонифицированного алгоритма. Стандартизированная оценка психологического (I группа — 33,24, II группа — 53,41) и физического (I группа — 32,46, II группа — 54,78) компонента здоровья по результатам опросника SF-36 подтвердила преимущества предложенной тактики и лечебно-диагностического алгоритма в I группе. Средний койко-день также был меньшим у пациентов первой клинической группы — 12,1 ± 3,4 койко-дня (против 16 ± 4,7 во II группе).

**Выводы.** Применение пациентоориентированного комплексного подхода к определению места и способа наложения одноствольной колостомы, включающего учет индивидуального строения мышечно-апоневротического каркаса передней брюшной стенки, а также особенностей васкуляризации и топографии участка кишки, подлежащего стомированию, сопровождается низким числом ранних и поздних параколостомических осложнений.

**Ключевые слова:** одноствольная колостома, осложнения кишечных стом, параколостомические грыжи, предоперационная маркировка передней брюшной стенки

**Конфликт интересов:** авторы заявляют об отсутствии конфликта интересов.

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## Introduction

The number of operations performed for surgical pathology of the colon and resulting in the necessary formation of the end colostomy does not tend to decrease, both in emergency and elective cases. The proportion of postoperative complications with terminal stomas, regardless of the original diagnosis, reaches alarming levels, ranging from 13 to 40 % [1].

Paracolostomy complications including paracolostomy hernias, prolapse, pinching of the stoma site of the intestine, stoma retraction, bleeding and necrosis, followed by the forming of stricture of the terminal area of the colostomy are a significant reason of disability, reducing social functions and a deterioration of patient's quality of live [2, 3].

The development of complications in most cases is associated either with technical and tactical errors during the formation of the colostomy, including the irrational choice of its location, or with the lack of clear criteria for choosing the technique of applying the colostomy without preoperative marking of the anterior abdominal wall [4]. Preoperative marking of the stoma area according to clinical recommendations should be performed for every patient undergoing stoma [5].

However, the choice of location is often based only on the data of physical examination and the individual preferences of the surgeon without consideration of the individual characteristics of patients, which leads to an increased risk of peristomal complications. It is especially important to determine the location of the colostomy, objectify the criteria for choosing the stoma formation technology and justify the use of certain techniques (mobilization of the intestine, formation of a "tunnel" in the anterior abdominal wall and carrying out the area of the stoma in it). It is especially important when applying stomas in patients with a high probability of complications, which include patients with a high body mass index, and patients who had several surgeries on abdominal organs earlier [7, 8].

### Aim of the study

To reduce the number of paracolostomy complications and improve the quality of life in stoma patients by justifying the use of a comprehensive approach to the end colostomy, including preoperative marking, taking into account the variants of the structure of the muscular-aponeurotic skeleton of the anterior abdominal wall, as well as the individual features of vascularity and topography of the intestine section undergoing ostomy surgery.

## Materials and methods

An analysis of 52 clinical observations of patients after surgery accompanied by the formation of an end colostomy was conducted at the surgical center of clinic of Rostov State Medical University. Surgeries were performed for colon cancer ($n$ = 19), intestinal obstruction ($n$ = 12), complicated inflammatory bowel diseases ($n$ = 14), consequences of abdominal injuries with damages of colon and its mesentery ($n$ = 7).

Complete blood count, urine test, coagulogram, biochemical blood parameters, blood type, and Rh factor were determined for all patients in the preoperative phase. The leukocyte index of intoxication was calculated using the formula of Ya.Ya. Kalf-Kalif [9].

The design of the prospective study included examining the results in two comparable groups of clinical observations. In group 1 (the main group consisted of 25 patients), a developed therapeutic and diagnostic algorithm was applied, which included a rational choice of the colostomy location, individual structure features of anterior abdominal wall, the quality of vascularization of bowel and terminal part of its mesentery, the length and topography of the terminal section.

To take into account the individual characteristics of anatomical structure of the anterior abdominal wall (determining the location and thickness of the rectus abdominis muscles and feeding arteries, such as *aa. epigastrica superior, epigastrica inferior* and *thoracica interna* and their feeding branches), ultrasonography of the layered structure of the anterior abdominal wall was performed in patients of group 1 in order to obtain reliable indicators and assess individual differences (Fig. 1).

Based on ultrasonography of soft tissues with evaluation of structure and vascularization of the muscular-aponeurotic frame of the anterior abdominal wall, preoperative marking of the colostomy location was performed. The marking was performed with permanent marker in various positions of the patient (standing, sitting, lying), considering the anthropometric data and individual characteristics of the patient (postoperative scars, skin and fat folds, a patient's preferences in wearing a belt) and, certainly, in direct visual access of the intended place of stoma for patients themselves.

Group 2 (control group) consisted of 27 patients who underwent colostomy using traditional techniques, without considering the individual structural features of the anterior abdominal wall or evaluating the options for position and vascularization of the intestine.

Ostomy for all patients included in the study was performed retroperitoneally, while a stoma channel was created between the parietal membrane of the peritoneum and the muscular-aponeurotic layer of the anterior abdominal wall. The skin area at the stoma site was excised circularly, according to the diameter of the intestinal stoma-to-be area. The following separation of subcutaneous tissue was carried out both acutely and bluntly, followed by dissection of the rectus abdominis aponeurosis and further separation of the muscle fibers along the course to create a retroperitoneal canal.

Postoperative follow-up was performed daily during the patient's stay in the hospital, followed by monitoring visits for outpatient examination 1, 3, 6 and 12 months after the colostomy.

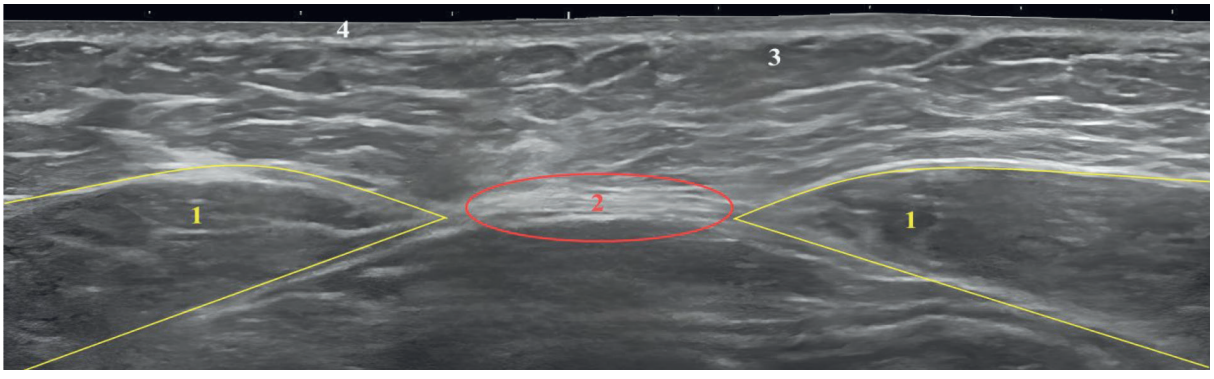


***Figure 1.*** Structure of the anterior abdominal wall at ultrasonography: 1 — anterior rectus abdominis muscles, 2 — linea alba, 3 — subcutaneous adipose tissue, 4 — skin

***Рисунок 1.*** Строение передней брюшной стенки по ультрасонографии: 1 — передние прямые мышцы живота, 2 — белая линия, 3 — подкожная жировая клетчатка, 4 — кожа

The control examination after 3 and 12 months included, among other things, an objective examination and colonoscopy, ultrasonography of the abdominal organs and soft tissues of the anterior abdominal wall. In addition, before hospitalization and 6 months after surgery, the quality of patients' life was assessed using the standardized Russified SF-36 questionnaire. This questionnaire was chosen as the most objective non-specific way to assess a patient's quality of life. It includes 36 items grouped into eight basic scales: physical functioning, role-playing, bodily pain, general health, vitality, social functioning, emotional state and mental health. The indicators of each scale are interpreted in the following way: the higher the value of the indicator (from 0 to 100) is, the better is the result on the selected scale.

The work was done with consideration of ethical standards and rules of medical research. Permission was received from the local independent Ethics Committee of the Rostov State Medical University (Protocol No. 14/23 dated September 14, 2023).

Statistical processing of the clinical trial results was done using Microsoft Office Excel 2016 (Microsoft Corp., USA) and an adapted package of the IBM SPSS computer program version "Statistic 25.0" (StatSoft Inc., USA). The treatment results were evaluated on quantitative and qualitative grounds.

## Results

Despite the observance fundamental principles of colostomy formation and evaluation of the viability of the intestinal stoma in both groups, parastomal complications could not be avoided. The results obtained in the postoperative period are presented in Table 1. The development of early paracolostomy complications was notes in 14 cases, 10 of them — in patients of the control group who were applied traditional methods with no individual justification of the applied colostomy techniques and no marking of the anterior abdominal wall. The presented results confirm the possibility of effectively reducing the number of parastomal complications and influencing the course of the postoperative period due to individual justification of the choice of technique and location of the stoma.

Focal necrosis of intestinal walls because of ischemia was detected in 1 (4 %) patient in group 1 and in 3 (11.1 %) patients in group 2 (Fig. 2). In group 1, ischemia of the intestinal section was associated with injury of marginal vessel feeding the intestinal segment. Over one-week period, demarcation of the necrotic area with leveling the threat of suture eruption and stoma retraction was achieved. In 3 patients of group 2 the lack of colostomy perfusion was associated, in addition to the initial ischemia, with compression of the intestine in the "tunnel" in the tissues of the anterior abdominal wall due to an irrational choice of colostomy localization, made without consideration of the individual anatomical features of the structure of the muscular-aponeurotic frame of the anterior abdominal wall.

Stoma retraction occurred in 2 (7.4 %) patients in group 2 and was associated with the tension of the stoma segment of the intestine (due to errors in estimating the required length of the extraperitoneal canal), the thickness of the anterior abdominal wall and increased intra-abdominal pressure. It should be noted that in both cases the patients' body mass index was more than 30 kg/m$^2$, that is why it can be supposed that due to the pronounced subcutaneous fat layer, there was a lack of length the excretory intestine, and as a result, axial tension of the stoma, which led to its retraction [10].

Suture abscess line with its eruption developed in 3 (12 %) patients of group 1, in 4 (14.8 %) patients of group 2.

Re-creation of the stoma due to the development of complications in the early postoperative period was required in 3 (11.1 %) patients of the control group, in the main group operations to "transfer" the previously applied end stoma (with the development of complications) were avoided.

***Table 1.*** Early postoperative complications
***Таблица 1.*** Ранние послеоперационные осложнения

| **Complication** ***Осложнение*** | **Group 1 / *I группа* ($n$ = 25)** | **Group 2 / *II группа* ($n$ = 27)** |
|---|---|---|
| Necrosis of the stoma / *Некроз стомы* | 1 (4 %) | 3 (11.1 %) |
| Bleeding / *Кровотечение* | – | 1 (3.7 %) |
| Retraction of the stoma / *Ретракция стомы* | – | 2 (7.4 %) |
| Suppuration along the suture line / *Нагноение по линии швов* | 3 (12 %) | 4 (14.8 %) |
| Parastomal abscess / *Парастомальный абсцесс* | – | 2 (7.4 %) |
| Total / *Всего* ($p < 0.05$) | 4 (16 %) | 12 (40.7 %) |

***Figure 2.*** Consequences of cutting out sutures and inversion of the stoma section of the intestine (due to excessive tension and retraction) with suppuration and focal necrosis of the skin and subcutaneous tissue in patients of group 2

***Рисунок 2.*** Последствия прорезывания швов и вворачивания стомированного участка кишки (вследствие чрезмерного натяжения и ретракции) с нагноением и очаговым некрозом кожи и подкожной клетчатки у пациентов II группы

In terms of the total frequency of early complications, the groups significantly differ statistically ($p < 0.05$) with a higher number of complications in group 2 (44.4 % vs. 16 % in group 1). Taking into account the small sample size, the results should be interpreted with caution, but the identified differences in complication rates deserve attention and further study.

Late paracolostomy complications during the 1-year outpatient follow-up period developed in 10 patients (Table 2), of which in 7 cases conventional methods were used without an individual approach to choosing the location and method of stoma formation (group 2).

Cicatricial strictures up to stenosis of the stoma at the skin level were recorded in 2 (7.4 %) patients of group 2, in observations when, in addition to the cutting out of sutures, in the postoperative period there were local purulent-inflammatory complications in the suture area with subsequent healing by secondary intention and scarring of soft tissues, as well as impaired evacuation from the intestine.

The prolapse of the stoma area was noted in three cases: 1 (4 %) patient in group 1 and 2 (7.4 %) patients in group 2, which was regarded as a consequence of increased intra-abdominal pressure with "weakness" of the aponeurotic edges of the incision of the anterior abdominal wall. The study also describes the variable topographic, anatomical and functional features of the muscular, fascial and aponeurotic structures of various areas of the anterior abdominal wall, as well as their ability to maintain increased intra-abdominal pressure during exercise. Excessive loads on the abdominal and pelvic floor muscles (especially during rapid weightlifting) in the daily life of stoma patients can be regarded as the most important predisposing factor of development of late complications, mainly parastomal hernias.

***Table 2.*** Late postoperative complications
***Таблица 2.*** Отсроченные послеоперационные осложнения

| **Complication** ***Осложнение*** | **Group 1 / *I группа* ($n = 25$)** | **Group 2 / *II группа* ($n = 27$)** |
|---|---|---|
| Stricture / *Стриктура* | – | 2 (7.4 %) |
| Evagination / *Эвагинация* | 1 (4 %) | 1 (3.7 %) |
| Parastomal hernia / *Параколостомическая грыжа* | 1 (4 %) | 3 (11.1 %) |
| Parastomal fistulas / *Парастомальные свищи* | – | 2 (7.4 %) |
| Total / *Всего* ($p < 0.05$) | 2 (8 %) | 8 (29.6 %) |

In the first year after surgery, paracolostomy hernias developed in 3 (11.1 %) patients of group 2 aged 55 to 70 years and in 1 (4 %) patient of group 1 in the age group over 70 years, which was associated with age-related degenerative and dystrophic processes and hypotension in the tissues of the anterior abdominal wall. Performing ultrasonography of the anterior abdominal wall at the preoperative phase revealed the structural features of its muscular-aponeurotic frame that are significant for colostomy, such as the thickness and width of the rectus abdominis muscles, defects of the patient's anterior abdominal wall, the maximal and minimal thickness of the subcutaneous fat layer, and its mobility relative to the muscles of the anterior abdominal wall when the patient's body position changes. Based on the results of the physical examination and ultrasonography, the final preoperative marking of the intestinal stoma was applied with a permanent marker on the surface of the patient's anterior abdominal wall.

For the total number of late complications, statistically significant results were reliably higher ($p < 0.05$) in group 2 (29.6 %) compared with group 1 (8 %). Due to the small sample, an additional study in larger groups of patients is required for statistical analysis.

Routine characteristics such as a rise in body temperature on day 5 after surgery and later, as well as a stable leukocyte left shift for 3 days and more, proved to be particularly important and reliably significant predictors of the development of infiltrative-inflammatory and suppurative complications (Fig. 3). Deviations in the complete blood count were associated with normalization of the leukocyte index of intoxication, reflecting the quantitative growth of neutrophils in relation to other cells of the leukocyte formula. This technique made it possible to objectify the severity of the patients' condition and to assess the course of inflammatory, purulent and purulent-destructive processes. Summary indicators of the leukocyte formula are shown in Table 3.

In group 1 of clinical observations on day 5 after surgery, a decrease in the level of leukocytes was noted, the elimination of a leukocyte left shift in more than 80 % of cases, and a decrease in the average values of the leukocyte index of intoxication in this group to 1.6 (i.e., to the normal level).

A general assessment of the dynamics of the complete blood count in group 2 also clearly shows a tendency towards a steady normalization of indicators. However, it can be stated that in this group it is slower and deviations of the average values from the norm indicate a greater variability in the values of the leukocyte index of intoxication on day 5, which was 2.1, which may be both a sign of a detected pronounced inflammatory reaction and a manifestation of already developed purulent-septic changes with tissue destruction of the peristomal area and even the stoma site (suture abscess, focal necrosis of the intestinal wall).

The SF-36 questionnaire assessment of the quality of stoma patients' life confirmed the advantages of proposed tactics and therapeutic and diagnostic algorithm in group 1 and allowed us to obtain a comprehensive multifactorial palette of levels of mental, physical and emotional well-being of patients, which is especially important for supporting the social status of stoma patients. The

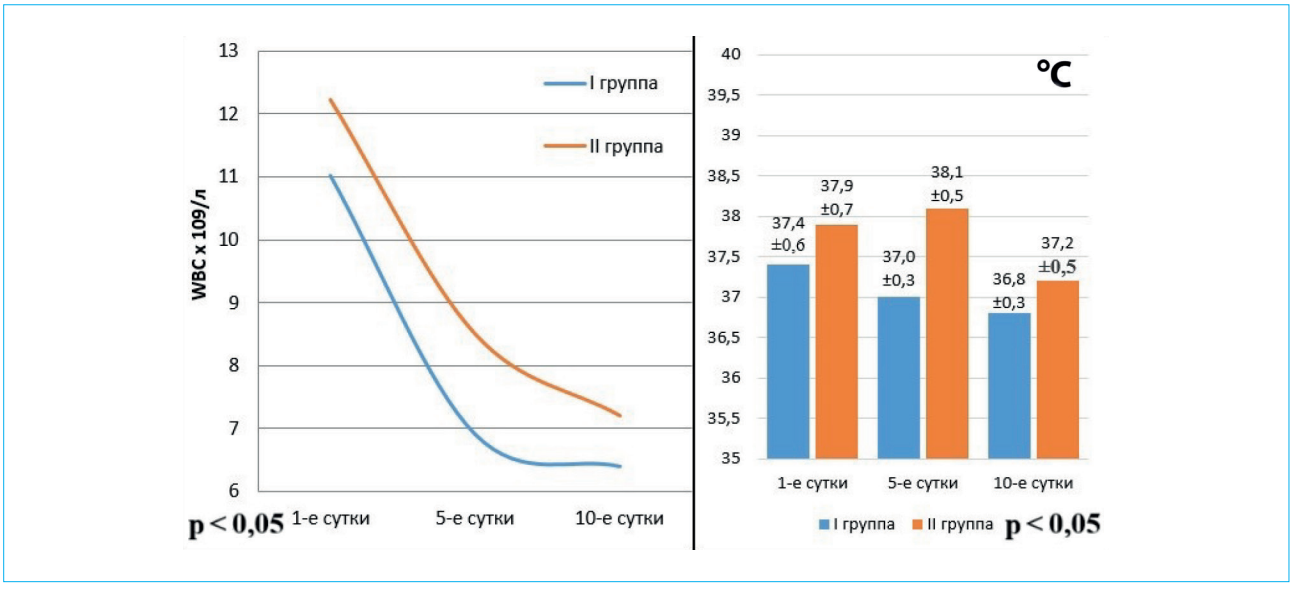


***Figure 3.*** Dynamics of postoperative leukocytosis and temperature reaction in the postoperative period

***Рисунок 3.*** Динамика послеоперационного лейкоцитоза и температурной реакции в послеоперационный период

***Table 3.*** Dynamics of changes in the results of the leukocyte formula
***Таблица 3.*** Динамика изменения результатов лейкоцитарной формулы

| Parameter *Показатель* | Time after surgery / *Сроки после оперативного вмешательства* | | | | | |
|---|---|---|---|---|---|---|
| | Day 1 / *1-е сутки* | | | Day 5 / *5-е сутки* | | |
| | Group 1 *I группа* | Group 2 *II группа* | *p* | Group 1 *I группа* | Group 2 *II группа* | *p* |
| WBC, $\times 10^9$/L *Лейкоциты, $\times 10^9$/л* | 11.02 | 12.23 | < 0.05 | 6.91 | 8.5 | < 0.05 |
| Of these / *Из них:* | | | | | | |
| Band, % *Палочкоядерные, %* | 10.1 | 11.7 | < 0.05 | 4.2 | 6.2 | < 0.05 |
| Segmented, % *Сегментоядерные, %* | 57.12 | 56.97 | < 0.05 | 61.1 | 59.74 | < 0.05 |
| Basophils, % *Базофилы, %* | 0.48 | 0.4 | < 0.05 | 0.41 | 0.49 | <0.05 |
| Eosinophils, % *Эозинофилы, %* | 1.81 | 1.78 | < 0.05 | 1.41 | 1.52 | < 0.05 |
| Lymphocytes, % *Лимфоциты, %* | 17.84 | 16.54 | < 0.05 | 22.31 | 18.76 | < 0.05 |
| Monocytes, % *Моноциты, %* | 10.72 | 9.46 | < 0.05 | 10.06 | 9.57 | < 0.05 |
| Leukocyte intoxication index *Лейкоцитарный индекс интоксикации* | 2.1 | 2.7 | < 0.05 | 1.6 | 2.2 | < 0.05 |

patient-oriented approach in the application of colostomy made it possible to achieve higher quality of life parameters in patients of group 1. This is clearly demonstrated in the diagram (Fig. 4).

The algorithm used in the main group for examining patients at the preoperative phase combined with the justification of rational techniques for colostomy made it possible to achieve shorter hospital treatment periods compared with the control group. In group 1 the average length of a patient's hospital-stay was 12.1 ± 3.4 days, in group 2 — 16 ± 4.7 days. These indicators are due to a significant percentage of cases with complications in the postoperative period, which led to longer inpatient treatment. Thus, with the development of complications in 16 % of patients in group 1, days of hospital-stay averaged 14.8 ± 2.8, and in group 2 — 20.7 ± 3.3 bed-days.

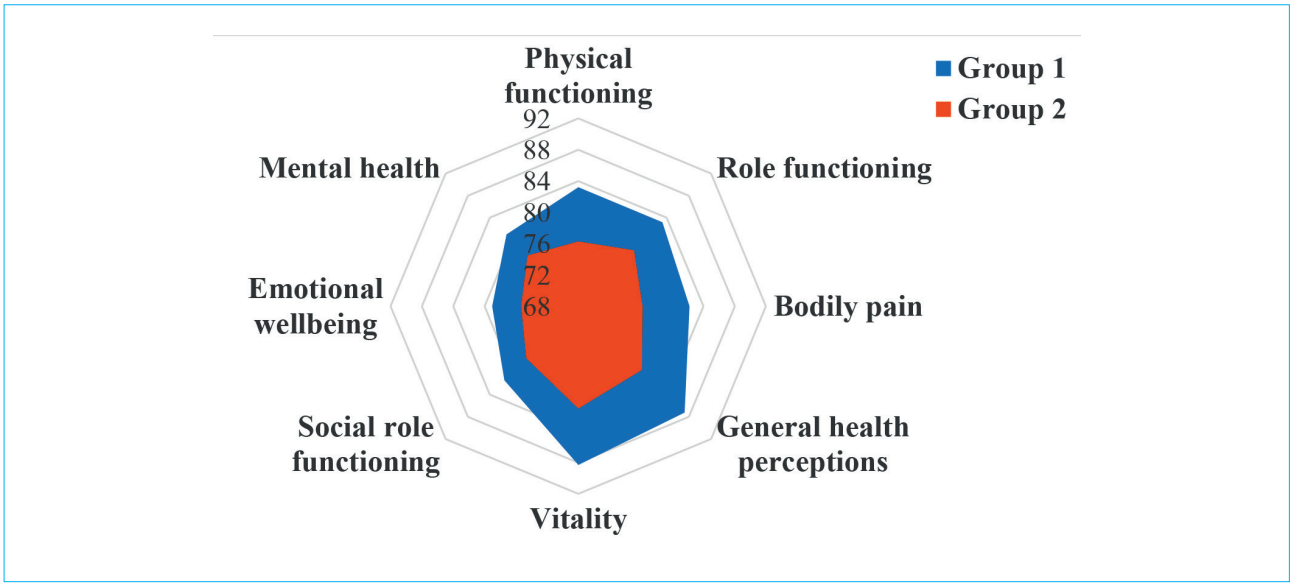


***Figure 4.*** Postoperative assessment of quality of life according to the SF-36 scale ($p < 0.05$)

***Рисунок 4.*** ДПослеоперационная оценка качества жизни по шкале SF-36 ($p < 0,05$)

## Conclusions

The use of a patient-centered, complex approach to determining the location and method of forming an end colostomy, taking into account the individual characteristics of the muscle-aponeurotic structure of the anterior abdominal wall, as well as the vascularity and topography of the intestinal section undergoing ostomy surgery, has been shown to be associated with a low incidence of early and late paracolostomy complications. This approach has the potential to reduce the number of paracolostomal complications, and further research is needed to confirm its effectiveness.

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## Information about the authors


**Vitalii S. Groshilin*** – Dr. Sci. (Med.), Professor, Head of the Department of Surgical Diseases No. 2, Rostov State Medical University.
Contact information: groshilin@yandex.ru;
344022, Rostov-on-Don, Nakhichevansky lane, 29.
ORCID: https://orcid.org/0000-0001-9927-8798

**Vladimir D. Kuztetsov** – Surgeon, Rostov State Medical University.
Contact information: groshilin@yandex.ru;
344022, Rostov-on-Don, Nakhichevansky lane, 29.
ORCID: https://orcid.org/0000-0003-0292-4357


## Сведения об авторах


**Грошилин Виталий Сергеевич*** – доктор медицинских наук, профессор, заведующий кафедрой хирургических болезней № 2, ФГБОУ ВО «Ростовский государственный медицинский университет» Министерства здравоохранения Российской Федерации.
Контактная информация: groshilin@yandex.ru;
344022, г. Ростов-на-Дону, пер. Нахичеванский, 29.
ORCID: https://orcid.org/0000-0001-9927-8798

**Кузнецов Владимир Дмитриевич** – врач-хирург, ФГБОУ ВО «Ростовский государственный медицинский университет» Министерства здравоохранения Российской Федерации.
Контактная информация: dv_kuz@mail.ru;
344022, г. Ростов-на-Дону, пер. Нахичеванский, 29.
ORCID: https://orcid.org/0000-0003-0292-4357

* Corresponding author / Автор, ответственный за переписку

**Dmitry V. Kuznetsov** — Chief Physician, Central District Hospital in the Neklinovsky district.
Contact information: dv02021972@mail.ru;
346830, Rostov region, Pokrovskoe village, Parkovy lane, 27.
ORCID: https://orcid.org/0009-0007-3060-1674

**Akop A. Pogosyan** — Head of the Surgical Department, City Clinical Hospital No. 6.
Contact information: a.a.pogosyan@yandex.ru;
344025, Rostov-on-Don, Saryana str., 85/38.
ORCID: https://orcid.org/0000-0002-2648-7203

**Кузнецов Дмитрий Владимирович** — главный врач, ГБУ РО «Центральная районная больница» в Неклиновском районе.
Контактная информация: dv02021972@mail.ru;
346830, Ростовская обл., с. Покровское, пер. Парковый, 27.
ORCID: https://orcid.org/0009-0007-3060-1674

**Погосян Акоп Александрович** — заведующий хирургическим отделением, ГБУ РО «Городская больница № 6».
Контактная информация: a.a.pogosyan@yandex.ru;
344025, Ростов-на-Дону, ул. Сарьяна, 85/38.
ORCID: https://orcid.org/0000-0002-2648-7203

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