

CLINICAL AND ECONOMIC EFFICIENCY OF HARDWARE ILEOVANAL ANASTOMOSIS USING A JOHNSON STAPLE IN SURGICAL TREATMENT OF NON-SPECIFIC ULCERAL COLITIS: A COMPARATIVE ANALYSIS

B.B.Mirzayev, Sh.Kh.Kosimov, D.Kholbekov

Fergana Medical Institute of Public Health

Annotation: The paper presents a comparative study of the clinical and economic effectiveness of hardware ileoanal anastomosis performed with a Johnson circular stapler in the surgical treatment of nonspecific ulcerative colitis (UC). The data of 100 patients included in the period 2015-2024 were analyzed: the main group - 35 patients operated on using a stapler, and the comparative group - 65 patients in whom the anastomosis was formed by hand suture. It was shown that the use of the device significantly reduced the duration of the operation (142 ± 5 versus 175 ± 6 min), decreased the volume of intraoperative blood loss (480 ± 20 versus 610 ± 25 ml) and reduced the incidence of postoperative complications (8.6% versus 26.2%; $p < 0.05$). The average hospital stay decreased to 9.3 ± 0.5 days versus 12.1 ± 0.6 days, and the total cost of treatment per patient decreased by approximately 10–12% (USD $2,950 \pm 100$ versus USD $3,300 \pm 120$). The results indicate that the stapler technique for ileoanal reservoir formation not only improves immediate surgical outcomes, but also provides significant economic benefits by reducing the length of hospital stay and reducing the costs of treating complications. Thus, the Johnson apparatus can be considered as a preferred method for radical interventions in patients with UC.

Key words: nonspecific ulcerative colitis; Johnson apparatus; ileoanal anastomosis; stapler technique; clinical and economic efficiency; postoperative complications; colproctectomy.

Introduction. Non-specific ulcerative colitis (NUC) is a severe chronic inflammatory disease of the colon, in which surgical intervention becomes necessary in approximately 20–30% of patients during the course of the disease [2,3]. The main indications for surgical treatment are the lack of effect from conservative therapy (steroid resistance, inability to discontinue hormones), the development of serious complications (toxic megacolon, perforation, profuse bleeding) or the occurrence of colorectal neoplasia [5,6,8].

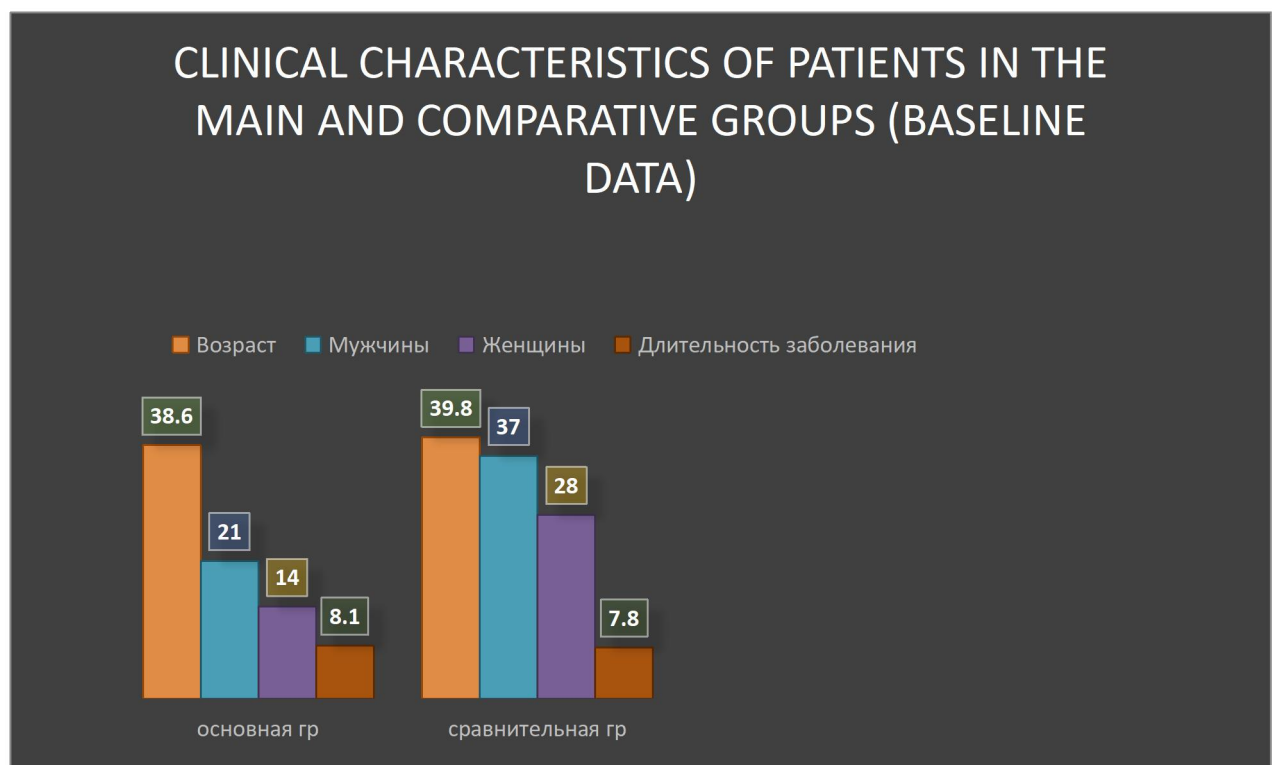
The aim of the study: to evaluate the clinical and economic effectiveness of various methods of surgical treatment of nonspecific ulcerative colitis.

Materials and methods of the study. The results of surgical treatment of patients with a diagnosis of nonspecific ulcerative colitis in the clinical bases of the Fergana Medical Institute of Public Health and in the private clinic "_____ " in Tashkent, in the period 2015-2024 were taken as the material for the study. All patients were operated on with informed consent, the study was carried out in accordance with the Declaration of Helsinki and the ethical principles of medical research involving human subjects (2013). For a comparative assessment of the effectiveness of various surgical techniques, all patients were divided into 2

groups: the main group - 35 patients who used the Johnson stapler (mechanical stapler from Ethicon) during surgery ; the comparative group - 65 patients operated on using the traditional method (manual suturing of the anastomosis).

The average age of patients was about 39 years and did not differ between the groups (Fig . 1). The distribution of patients by gender was also similar: in the main group, the proportion of men was 60%, in the comparative group – 57% ($p>0.05$). The duration of UC before surgery varied from 2 to 15 years (on average, about 8 years in both groups, $p>0.05$). Thus, the groups were homogeneous in age, gender and duration of the disease history.

Diagram 1 Clinical characteristics of patients in the main and comparative groups (initial data)



On admission, most patients presented characteristic complaints reflecting the severe course of ulcerative colitis. More than 90% of patients in both groups had frequent diarrhea (more than 6 times a day) with blood in the stool. Abdominal pain of varying intensity was present in approximately 70–77% of patients. Signs of systemic intoxication (fever >37.5 °C) were observed in every fifth patient, indicating an exacerbation and high activity of the inflammatory process. Objective laboratory data confirmed the severity of the condition: all patients had mild to moderate anemia (mean hemoglobin ~ 110 g/l), increased ESR (~ 30 – 35 mm/h), and decreased serum albumin levels (~ 33 g/l), reflecting chronic inflammation and malnutrition. No statistically significant differences in clinical manifestations and laboratory parameters were found between the groups (Table 2, $p>0.05$).

Table 2. Clinical manifestations of the disease and laboratory parameters in patients with UC (before surgery)

| | Main group | Comparative group | p |
|---|------------|-------------------|-------|
| Stool frequency >6 times/ day , persons (%) | 32 (91.4%) | 58 (89.2%) | >0.05 |
| Presence of blood in stool, persons (%) | 34 (97.1%) | 65 (100%) | >0.05 |
| Abdominal pain, people (%) | 25 (71.4%) | 50 (76.9%) | >0.05 |
| Fever >37.5 °C, people (%) | 8 (22.9%) | 12 (18.5%) | >0.05 |
| Hemoglobin, g/l (M±m) | 109 ± 3 | 112 ± 2 | >0.05 |
| ESR, mm/hour (M±m) | 32 ± 2 | 35 ± 3 | >0.05 |
| Serum albumin, g/l (M±m) | 33.5 ± 0.8 | 32.8 ± 0.6 | >0.05 |

During the examination, a significant proportion of patients had concomitant diseases. In general, ~60% of patients were found to have comorbid conditions, mainly chronic posthemorrhagic anemia due to prolonged blood loss (~30% of patients) and cardiovascular pathology (ischemic heart disease, hypertension - about 15-20%). Less common were concomitant diseases of the endocrine system (diabetes mellitus type 2 ~5%), chronic diseases of the liver and biliary tract, etc. The presence of concomitant pathology required correction of these conditions at the stage of preoperative preparation and consideration when choosing the tactics of anesthesia. In patients with severe cardiovascular insufficiency, anemia and other diseases, treatment was carried out to stabilize the condition before surgery.

Traditional surgical treatment method (manual anastomosis). Surgical intervention was performed on a planned basis through a midline laparotomy approach under general endotracheal anesthesia [3,4]. The standard surgical tactic for total colon damage was colic proctotomy – removal of the entire colon and rectum in order to radically eliminate the source of inflammation [9,10,12]. After mobilization and resection of the colon, proctectomy was performed : the distal rectum was excised subtotally, leaving a small fragment of the rectal wall (anal canal) ~1.5–2 cm long at the level of the dentate line. In the comparative group, the ileoanal anastomosis was formed manually [2,13,14,16]. For this purpose, total mucectomy was preliminarily performed – removal of the mucous membrane of the remaining section of the rectum – in order to prevent persistence of inflammation and the development of neoplasia in the remaining mucosal islets. Then, a J-loop reservoir was formed from the ileum: two loop segments of the small intestine, ~15 cm long, were sutured together side by side (creating a J-shaped small intestinal reservoir with a capacity of ~200–250 ml) [10,11,15]. The end of the formed reservoir (small intestine) was anastomosed to the anal canal with a hand suture. The anastomosis was applied at a distance of approximately 1–2 cm proximal to the pectineal zone line, using interrupted absorbable sutures in a circle. Thus, a restorative proctocolectomy with a manual ileoanal anastomosis was performed. In most cases, a temporary protective ileostomy (double-barreled or loop) was formed on the small intestine to unload the anastomosis , which made it possible to reduce the load of intestinal contents on the anastomotic suture line in the early postoperative period. The created ileostomy was subsequently closed 8–12 weeks after the main operation (outside the scope of this study). With the traditional manual method of

reservoir and anastomosis formation, the operative time was usually longer due to the labor-intensive mucotomy and the application of a large number of sutures [2,3,7,8].

Operation using the Johnson stapler. In the main group, an improved technique for forming an ileoanal anastomosis using a circular stapler was used. The stage of resection of the colon and rectum was performed in the same volume (total colectomy) through a laparotomy approach [19,20,22]. The difference was in the technique of the recovery stage. After removal of the large intestine, the rectal stump was intersected at the level of the upper anal section using a linear stapler, without cutting out the mucosa (mucotomy was not performed). Thus, the intact mucous membrane of the anal canal was preserved over a section of ~2 cm, which technically facilitated and accelerated the stage of forming the anastomosis. A J-shaped reservoir (two-loop) was similarly created from the ileum (ileal reservoir). Next, an ileoanal anastomosis was performed using a circular suturing device (the "Johnson device"). For this purpose, the head (anvil) of the device was immersed in the reservoir dome and fixed, the device itself was inserted through the anus, and the end of the reservoir was placed on the stump of the anal canal [13,23,24]. A single operation of the circular suturing device formed a hermetic "end-to-end" reservoir-anal anastomosis with a double-row stapler suture. After removing the device, the adequacy of the anastomosis was checked (air leak test and inspection of the ring of excised tissue - donuts). If necessary, additional supporting sutures of the serous-muscular layer were applied [4,21,22]. Thus, the anastomosis in the main group was formed using a hardware method, which significantly reduced the time of this stage and eliminated the risk of leaving free areas of the mucosa. In the main group, most patients also had a protective ileostomy formed on the small intestine for temporary unloading of the anastomosis line. Compared with the manual method, the use of a suturing device simplified and accelerated the operation, made it possible to reduce the trauma of the intervention and achieve a reliable hermetic connection of the intestine. According to the literature, an ileoanal anastomosis formed with a suturing device provides no worse, and in some respects even better results compared to a manual suture (improved retention function, fewer septic complications).

In both compared groups, the operations were performed by a team of experienced proctologist surgeons according to a single protocol, the only difference being in the method of reservoir anastomosis formation. The scope of surgical intervention (total proctocolectomy with formation of ileoanal anastomosis and protective ileostomy) and the scope of intraoperative manipulations on other organs (in case of their accidental damage or need for additional measures) did not differ between the groups. All operations were completed without conversions or interoperative transfers to another method.

Research results.

The main results of the clinical and economic analysis of the comparative groups are presented in Table 3. As can be seen from the presented data, the use of the Johnson stapling device significantly reduced the duration of the operation, decreased the volume of intraoperative blood loss and reduced the incidence of postoperative complications compared to the traditional method ($p < 0.05$). The average operation time in the main group was almost 30 min less (≈ 2.4 hours versus 2.9 hours in the control group), which was due to the absence of the mucotomy stage and accelerated anastomosis using a stapler. The volume of blood loss was also lower

when using the device (on average ~ 0.48 l versus 0.61 l; $p < 0.05$), reflecting less tissue trauma and shorter operative time. Intraoperative complications (e.g. accidental injuries to abdominal organs, technical difficulties) were noted in only 2 patients (3.1%) in the group without the device, while not a single intraoperative complication was recorded in the main group; however, this difference is statistically insignificant due to the small number of events ($p > 0.05$).

In the postoperative period, significant differences were obtained in favor of the main method. The overall frequency of postoperative complications in the main group was 8.6%, while in the comparative group it was 26.2% ($p < 0.05$). In particular, in the control group there were cases of ileoanal anastomosis failure (anastomotic leaks were noted in 4 patients, which required drainage of the pelvic abscess or reoperation), while in the group with stapler anastomosis, no suture failure occurred in any patient. In patients without the device, purulent-septic complications were more often observed: suppuration of the postoperative wound (in 6 patients against 1 case in the main group) and urinary tract infection. In the main group, among the postoperative complications, 1 case of intercurrent pneumonia and 2 cases of gastrointestinal tract paresis for more than 3 days were registered, which were stopped conservatively. There were no severe life-threatening complications (fatal outcomes, thromboembolism) in either group. As a result of a more favorable course of the postoperative period, the duration of hospitalization of patients in the main group was significantly shorter: on average ~ 9 days, while in the comparison group ~ 12 days ($p < 0.05$). Rapid restoration of bowel function (the appearance of peristalsis and independent stool on the 2nd day in the main group versus 3 days in the control) and earlier activation of patients made it possible to reduce the postoperative bed-day. The intensity of pain syndrome according to VAS on the first day was slightly lower in patients of the main group (on average 4.5 points versus 5.2 points; $p > 0.05$), which was reflected in the need for analgesics (a lower total volume of narcotic analgesics in the stapler group).

Economic analysis showed that despite the additional costs of a disposable stapler in the main group, the total cost of treating one patient was lower than with the traditional method. This is due to a decrease in the volume of infusion and drug therapy (less blood loss - less transfusions; less pronounced inflammatory reaction - less antibiotic consumption, etc.), and most importantly - a reduction in the length of hospital stay and the absence of costs for treating severe complications. The cost calculation includes direct medical costs: the average cost of surgery (including consumables), postoperative drug treatment and hospital stay. According to our data, the average costs per patient in the main group were \sim USD 2950, while in the comparison group - \sim USD 3300 ($p < 0.05$). In other words, the use of the device allowed us to save ~ 10 -12% of funds per patient.

Table 3. Main results of surgical treatment (clinical and economic indicators) in the compared groups

| Indicator | Main group | Comparative group | p |
|---|--------------|-------------------|-------|
| Operation duration, min (M \pm m) | 142 \pm 5 | 175 \pm 6 | <0.05 |
| Intraoperative blood loss, ml (M \pm m) | 480 \pm 20 | 610 \pm 25 | <0.05 |
| Intraoperative complications, persons (%) | 0 (0%) | 2 (3.1%) | >0.05 |
| Postoperative complications, people (%) | 3 (8.6%) | 17 (26.2%) | <0.05 |

| | | | |
|---|------------|------------|-------|
| Postoperative hospital stay, days (M±m) | 9.3 ± 0.5 | 12.1 ± 0.6 | <0.05 |
| Cost of treatment, USD (M±m) | 2950 ± 100 | 3300 ± 120 | <0.05 |

The average length of hospital stay after surgery did not differ statistically significantly between the groups ($p>0.05$). In Group 1, postoperative hospitalization averaged 10.5 ± 1.2 bed-days, while in Group 2 it was 9.8 ± 1.5 bed-days. The slightly shorter initial hospitalization period in Group 2 can be explained by the fact that after subtotal colectomy with ileostomy there is no anastomosis requiring observation, and some patients were discharged home somewhat earlier in a stable condition and with a functioning stoma. At the same time, in Group 1, despite a more extensive intervention, the hospitalization periods were comparable: due to fewer complications and effective rehabilitation, patients left the hospital within similar periods.

Conclusion. The volume of intraoperative blood loss had no significant intergroup differences. In the main group, the average blood loss was $\sim 380\pm 50$ ml, in the comparison group – $\sim 350\pm 40$ ml ($p>0.05$). In no case was transfusion of blood components required; hemodynamic parameters during the operations remained stable in all patients. Intraoperative complications, such as damage to adjacent organs or uncontrolled bleeding, were not noted in both groups. The reliability of the anastomosis formation in the main group was additionally confirmed by an intraoperative leak test (pneumatic test): in all cases, the suture proved to be competent, no air leakage through the anastomosis was detected. In the traditional treatment group, the adequacy of the manual anastomosis was assessed visually and confirmed by the imposition of an additional row of sutures; in addition, the formed protective stoma served as a preventive measure in case of partial suture failure.

However, the fundamental difference between the two treatment methods is reflected in the total cost of hospital stay. Patients in Group 2 subsequently require re-hospitalization for the second stage of surgical treatment (closure of the protective stoma and formation of the final anastomosis). An additional re-operation implies another postoperative period lasting several days. In total, the total duration of hospital treatment for patients operated on using the traditional two-stage method is significantly longer than for patients in Group 1, who underwent complete surgical treatment in one stage. Thus, one can note the obvious economic effect of the one-stage approach using the Johnson apparatus due to a decrease in the total number of bed days and the elimination of costs for re-hospitalization and surgery, compared with the traditional two-stage treatment of UC.

Conclusions. Thus, the use of the Johnson stapler in the surgical treatment of UC demonstrated higher clinical and economic efficiency compared to the traditional method of manual anastomosis. The results show that mechanical formation of the ileoanal anastomosis allows to reduce the surgical trauma and duration of the intervention, which leads to faster recovery of patients (earlier restoration of bowel function, shorter hospital stay) and a decrease in the number of complications, primarily anastomotic leaks and wound infections. Together, these advantages provide an economic effect in the form of reduced direct treatment costs.

List literature :

1. Abraham C., Cho JH Inflammatory bowel disease // *N. Engl. J. Med.* – 2009. – Vol. 361, No. 21. – P. 2066–2078.
2. Farraye FA, Moss AC, Shaheen NJ, et al. ACG Clinical Guideline: Ulcerative Colitis in Adults // *Am. J. Gastroenterol.* – 2019. – Vol. 114, No. 3. – P. 384–413.
3. Feuerstein JD, Moss AC, Farraye FA Ulcerative colitis: epidemiology, diagnosis, and management // *Mayo Clin. Proc.* – 2019. – Vol. 94, No. 7. – P. 1323–1343.
4. Fujiwara D., Maeda Y., Kajii E. et al. Mucosal healing in clinical practice: how useful is fecal calprotectin ? // *Inflamm. Bowel Dis.* – 2013. – Vol. 19, No. 6. – P. 1437–1444.
5. Gros B., Kaplan GG Ulcerative colitis in adults: a review // *JAMA.* – 2023. – Vol. 330, No. 10. – P. 951–965.
6. Harbord M., Eliakim R., Bettenworth D., et al. Third European evidence-based consensus on diagnosis and management of ulcerative colitis. Part 2: current management // *J. Crohns Colitis.* – 2017. – Vol. 11, No. 7. – P. 769–784.
7. Jess T., Gomborg M., Munkholm P., Sørensen TI Overall and cause-specific mortality in ulcerative colitis: meta-analysis of population-based inception cohort studies // *Am. J. Gastroenterol.* – 2007. – Vol. 102, No. 3. – P. 609–617.
8. Kaser A., Zeissig S., Blumberg RS Inflammatory bowel disease // *Annu. Rev. Immunol.* – 2010. – Vol. 28. – P. 573–621.
9. Kornbluth A., Sachar DB Ulcerative colitis practice guidelines in adults: ACG, ECCO, and World Gastroenterology Organization perspectives // *Mayo Clin. Proc.* – 2010. – Vol. 85, Suppl. – S1–S42.
10. Kornbluth A., Sachar DB Ulcerative colitis practice guidelines in adults: American College of Gastroenterology, 2010 update // *Am. J. Gastroenterol.* – 2010. – Vol. 105, No. 3. – P. 501–523.
11. Lamb CA, Kennedy NA, Raine T., et al. British Society of Gastroenterology consensus guidelines on the management of inflammatory bowel disease in adults // *Gut.* – 2019. – Vol. 68, Suppl. 3. – P. s1–s106.
12. Le Berre C., Honap S., Peyrin-Biroulet L. Ulcerative colitis // *Lancet.* – 2023. – Vol. 402, No. 10401. – P. 571–584.
13. Lyukmayev V. Yu., Shushera VE, Orlova MA et al. Ulcerative colitis (review) // *Gastroenterol. Hepatol. Polymed.* – 2021. – Vol. 18, No. 3. – P. 52–59. (on (Russian language)
14. Narula N., Peerani F., Kushnir V. et al. Fecal microbiota transplant for ulcerative colitis – a systematic review and meta-analysis // *Inflamm. Bowel Dis.* – 2017. – Vol. 23, No. 10. – P. 1702–1709.
15. Panaccione R., Ghosh S., Middleton S., et al. Combination therapy with infliximab and azathioprine is superior to monotherapy with either agent in ulcerative colitis // *Gastroenterology.* – 2014. – Vol. 146, No. 2. – P. 392–400.
16. Porter R.J., Kalla R., Ho G.-T. Ulcerative colitis: Recent advances in the understanding of disease pathogenesis // *F1000Res.* – 2020. – Vol. 9. – Article 294.
17. Pravda J. Evidence-based pathogenesis and treatment of ulcerative colitis: A causal role for colonic epithelial hydrogen peroxide // *World J. Gastroenterol.* – 2022. – Vol. 28, No. 31. – P. 4263–4298.



18. Rafiee P., Singh S., Sandborn W.J., et al. Anti-integrin therapies for inflammatory bowel disease // *Gastroenterology*. – 2013. – Vol. 145, No. 6. – P. 1687–1698.
19. Rubin DT, Ananthakrishnan AN, Siegel CA, et al. ACG Clinical Guideline: Ulcerative Colitis in Adults // *Am. J. Gastroenterol.* – 2019. – Vol. 114, No. 4. – P. 384–413.
20. Rutgeerts P., Sandborn W.J., Feagan BG, et al. Infliximab for induction and maintenance therapy for ulcerative colitis // *N. Engl. J. Med.* – 2005. – Vol. 353, No. 23. – P. 2462–2476.
21. Sandborn W.J., Feagan BG, Rutgeerts P., et al. Adalimumab induces and maintains clinical remission in patients with moderate-to-severe ulcerative colitis // *Gastroenterology*. – 2012. – Vol. 142, No. 2. – P. 257–265.
22. Segal JP, LeBlanc J.-F., Hart AL Ulcerative colitis: an update // *Clin. Med. (Lond.)*. – 2021. – Vol. 21, No. 2. – P. 135–139.
23. Travis SP, Stange EF, Lémann M, et al. European evidence-based consensus on the management of ulcerative colitis: current management // *J. Crohns Colitis*. – 2008. – Vol. 2, No. 1. – P. 24–62.
24. Ungaro R., Mehandru S., Allen PB, et al. Ulcerative colitis // *Lancet*. – 2017. – Vol. 389, No. 10080. – P. 1756–1770.