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Balloon dilation and electrodestruction for colorectal anastomosis strictures

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ABSTRACT *AIM: to assess results of balloon dilatation (BD) and electric destruction (ED) for strictures of colorectal anastomoses.*

PATIENTS AND METHODS: the prospective cohort study included 69 patients with colorectal anastomotic strictures. Thirty-two of them underwent endoscopic balloon dilatation, 37 — electric destruction of scar tissue using a spherical monopolar electrode.

RESULTS: the recurrence rate of the anastomotic stricture in the BD group was 3 times higher than after ED (OR = 2.9; 95% CI: 0.7-11.1; p = 0.04). The independent factor of stricture recurrence was the extent of stricture > 11 mm (OR = 11.8; 95% CI: 1,57-123,5; p = 0.02).

CONCLUSION: electric destruction and balloon dilatation are effective and safe methods for strictures of colorectal anastomoses. The independent factor recurrence risk of the stricture was the extent of the scar narrowing more than 11 mm long.

KEYWORDS: *colorectal anastomotic stenosis, endoscopic treatment, electrocautery dilation, electrocautery incision, electrocoagulation, balloon dilation*

CONFLICT OF INTEREST: *The authors declare no conflict of interest*

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INTRODUCTION

Postoperative anastomotic stricture is one of the late complications of colorectal resection. The incidence of strictures is 3–30% [1–3]. Their occurrence depends on many factors that can be conditionally divided into two large groups: related to the patient (concomitant inflammatory and vascular colorectal diseases), the second — associated with surgery (the type of anastomosis and related complications) [1,4,5,6]. As a rule, strictures develop within the first 3 months after surgery, and in 5% of patients they cause intestinal disorders [7]. In most cases, cicatricial stricture is detected during routine examination and in some patients, may become an obstacle to closure of preventive stoma.

An endoscopic method is used for strictures, and colorectal resection with stricture is also possible. A variety of endoscopic techniques is represented by mechanical dilation, balloon dilatation, electro- and laser destruction, stenting, endomicrosurgical stricturoplasty. According to the literature, balloon dilatation is the most popular, which is probably explained by its technical simplicity and relative safety [8,9]. The method of electrodestruction of stricture requires the participation of an experienced endoscopist and can be carried out both with the help of an endoscopic knife or loop, and with the help of a ball monopolar electrode [10]. There are publications in the literature about small series of observations where one or another method of endoscopic correction is used. The lack of a clear strategy for the treatment of colorectal anastomosis strictures leaves open

the question of the indications and effectiveness of a particular method of endoscopic correction. In this regard, the problem of choosing the most optimal and safe method of treating cicatricial strictures of colorectal anastomoses remains very relevant. The basis of this study is a comparison of the effectiveness of two methods aimed at eliminating strictures — electrodestruction and balloon dilatation. Risk factors for recurrence of colorectal anastomosis strictures after endoscopic treatment were also analyzed.

PATIENTS AND METHODS

A prospective cohort (September 2014 — December 2021) included 69 patients who had previously undergone colorectal resection, whose postoperative period was complicated by cicatricial strictures of anastomoses. The study did not include patients who had been diagnosed with inflammatory bowel disease or had a recurrence of the tumor in the anastomosis area. The exclusion criterion was the patient's refusal to participate in the study. The primary point of the study was the recurrence rate of anastomosis stricture. In addition to the clinical examination and general clinical tests aimed at cancer recurrence check-up, as well as assessing the severity of concomitant diseases, all patients underwent colonoscopy, which assessed the diameter and extent of stricture, the condition of the colorectal wall in the narrowing area, the severity of scarring. If it was impossible to adequately assess the characteristics of the stricture endoscopically, X-ray examination methods were used: barium enema, proctography, virtual colonoscopy with contrast, pelvic MRI. The target indicator of the diameter of the intestine at the stricture level was 13 mm, since it is this diameter of the lumen of the colorectal anastomosis that allows to subsequently perform colonoscopy using a standard device with an examination of the proximal parts of the bowel. Thirty-two patients underwent endoscopic balloon dilation (BD), and in 37 cases endoscopic electrodestruction (ED) of the stricture was performed. Balloon dilation was carried out under visual control using Boston Scientific universal type cylinders with sizes from 6 to 18 mm.

A spherical monopolar electrode was used to destruct the anastomosis stricture. The recurrence of the stricture of the colorectal anastomosis was considered to be a narrowing of its lumen less than 13 mm in diameter and the impossibility of carrying out a standard colonoscope for the zone of narrowing of the anastomosis during a control endoscopic examination.

There were no significant differences between the groups by gender, age, body mass index (BMI). The majority of patients — 24 (75.0%) of 32 patients in the BD group and 27 (73.0%) of 37 patients in the ED group had previously been operated on for a colorectal cancer ($p = 0.62$). Adjuvant chemotherapy in the history occurred in 8 (25.0%) patients in the BD group and 18 (48.6%) patients in the ED group ($p = 0.04$). Radiation therapy was performed in 3 (9.4%) patients and 1 (2.7%) patient in the BD and ED group, respectively ($p = 0.23$). There were no significant differences in the type of colorectal operation performed between the groups ($p = 0.9$). A stapler anastomosis was formed in all patients in the ED group and 30 (93.75%) patients in the BD group. Most often, in 28 (87.5%) and 31 (83.8%) patients in the BD and ED groups, respectively, the anastomosis was "end-to-end" type. Colorectal anastomosis leakage occurred in history in 7 observations in each of the groups ($p = 0.76$). At the time of detection of the stricture of the bowel anastomosis, 19 (59.4%) patients of the BD group and 22 (59.4%) patients of the ED group were carriers of a preventive stoma ($p = 0.99$) (Table 1).

The median diameter of the stricture before endoscopic treatment in the BD group was 6 (3;11) mm, and in the ED group — 5 (3;8) mm ($p = 0.09$). The extent of scar stricture before treatment was 4.5 (3;6.5) and 4 (3;5) mm in the BD and ED group, respectively, ($p = 0.86$). The median level of the anastomosis stricture location from the anal edge in both groups did not differ significantly ($p = 0.75$). In all patients included in the study, the timing of the anastomosis stricture development was assessed. The median time of stricture detection from the moment of surgery was 6 (3;11) months in the BD group and 7 (3;11) months in the ED group ($p = 0.67$) (Table 1).

The data of the patients included in the study were entered into an Excel database. The statistical analysis was carried out using the Statistica 13

Table 1. *Characteristics of balloon dilation and electrodestruction groups of strictures of colonic anastomoses*

Sign	BD *n* = 32	ED *n* = 37	*p*
Gender, m/f	16/16	20/17	0.74
Me[1] age (quartiles), years	62.5 (50.5;67.5)	61 (53;66)	0.71
Me BMI (quartiles), kg/m^2	25.3 (22.1;28.4)	25.2 (22.3;27.1)	0.07
Comorbidities	25 (78%)	26 (70.2%)	0.46
Adjuvant chemotherapy	8 (25%)	18 (48.6%)	0.04
Radiation therapy	3 (9.3%)	1 (2.7%)	0.23
Diagnosis			0.62
Malignant neoplasm	24 (75%)	27 (72.9%)	
Diverticular disease	4 (12.5%)	5 (13.5%)	
Bowel injury	3 (9.4%)	2 (5.4%)	
Sigmoid volvulus with necrosis	1 (3.1%)	2 (5.4%)	
Hirschsprung's disease	0	1 (2.8%)	
Type of procedure			0.9
Anterior rectal resection	11 (34.4%)	10 (27%)	
Stoma closure	9 (28.1%)	12 (32.4%)	
Low anterior rectal resection	5 (15.6%)	4 (10.8%)	
*Left he*micolectomy	4 (12.5%)	6 (16.2%)	
Sigmoid resection	3 (9.4%)	5 (13.6%)	
Anastomosis			0.12
Hand-sewn	2 (6.25%)	0	
Stapler	30 (93.75%)	37 (100%)	
Type of anastomosis			0.81
"end-to-end"	28 (87.5%)	31 (83.8%)	
"end-to-side"	3 (9.4%)	5 (13.5%)	
"side-to-side"	1 (3.1%)	1 (2.7%)	
Preventive stoma, *n* (%)	19 (59.4%)	22 (59.4%)	0.99
Anastomosis leakage in history, *n* (%)	7 (21.8%)	7 (18.9%)	0.76
Me time of stricture detection (quartiles), months	6 (3;11)	7 (3;11)	0.67
Extent of stricture before treatment (quartiles), (min–max), mm	4.5 (3;6.5), (2–27)	4 (3;5), (3–10)	0.42
Me stricture diameter before treatment (quartiles), (min–max), mm	6 (5;7), (3–9)	5 (3;7), (0–9)	0.09
Me height of stricture location from anal edge (quartiles), cm	12 (8;17)	12 (8;15)	0.75

[1] *Me — median*

program (TIBCO, USA). The Kolmogorov-Smirnov test was used to determine the normality of the distribution, and the Shapiro-Wilk test was used as a test.

Table 2. *Number of endoscopic stricture procedures in groups.*

Number of endoscopic procedures, n	BD group (n = 32)	ED group (n = 37)
1	8 (25.0%)	8 (21.6%)
2	17 (54.0%)	23 (62.2%)
3	4 (12.0%)	6 (16.2%)
4	2 (6.0%)	0
5	1 (3.0%)	0

Table 3. *Result's characteristics*

Sign	БД, n = 32 BD, n = 32	ЭД, n = 37 ED, n = 37	p
Me endoscopic procedures	2.0 (1.5;2.0)	2.0 (2;2)	
Me diameter of anastomosis after endoscopic intervention, mm	14.5 (12;15)	15 (13;15)	0.64
Me diameter of anastomosis during control colonoscopy, mm	15 (5;20)	20 (15;20)	0.13
Undesirable phenomena: Ruptures of mucosa Postcoagulation necrosis	 3 (9.4%) 0	 0 37 (100%)	
Incidence of stricture recurrence	8 (29.6%)	4 (12.5%)	0.1

As a result of statistical processing, the continuous data with a normal distribution were described by the mean and standard deviation, the groups were compared using the Student's *t*-test. The continuous data with nonparametric distribution were described by median and quartiles, groups were compared using the Mann-Whitney criterion. The binary data were compared by the criterion χ^2 with the Yates correction. Statistically significant differences were recognized at $p \leqslant 0.05$. Multiple logistic regression was performed to determine the risk factors affecting the incidence of recurrence of anastomotic strictures. The results are presented by the odds ratio (OR) and 95% coincidence interval (CI).

RESULTS

Dilation of the anastomosis lumen to the target diameter required two procedures of endoscopic stricture correction in the majority of patients in the BD and ED groups — in 17 (54.0%) and 23 (62.2%) cases, respectively (Table 2). There were no complications in both groups after endoscopic procedure, requiring repeated endoscopic or surgical intervention.

Gross ruptures of the mucosa to the muscle layer during BD were noted in 3 (9.4%) of 32 patients, and postcoagulation necrosis in the area of a pre-existing stricture was registered in all patients in the ED group.

In both groups, good early results of the treatment were achieved, namely: it was possible to expand the intestinal lumen in the stricture area to the target diameter in all patients. The median diameter of the anastomosis lumen in the BD and ED groups was 14.5 (12;15) mm and 15 (13;15) mm, respectively ($p = 0.64$), which made it possible to perform a total colonoscopy to the dome of the cecum with a standard adult colonoscope (Table 3).

In the long term after the treatment, 27 (84.4%) of 32 patients in the balloon dilation group and 32 (83.8%) of 37 patients in the electrodestruction group were followed up ($p = 0.15$). The median time of the control colonoscopy in the BD group was 6 (3;7), and in the ED group — 6 (1;7) months. The median diameter of the intestinal lumen in the area of the pre-existing stricture at the time of the control examination was 15 (5;20) mm in

Table 4. *Risk factors of patients with and without relapse of stricture*

Sign	Recurrence is present, n = 12	Recurrence is not present, n = 47	p
Gender, m/f	7/5	23/24	0.6
Me[1] age (quartiles), years	61.5 (57;66)	62 (52;66)	0.9
Me BMI (quartiles), kg/m^2	27 (23.6;33.7)	24.9 (22.2;26.5)	0.09
Comorbidities, n (%)	11 (91.6%)	34 (72.3%)	0.2
Adjuvant chemotherapy, n (%)	3 (25%)	19 (40.4%)	0.3
Radiation therapy, n (%)	0	2 (4.25%)	0.5
Diagnosis			0.2
Malignantneoplasm	10 (83.2%)	34 (72.3%)	
Diverticular disease	1 (8.4%)	7 (14.9%)	
Bowel injury	1 (8.4%)	4 (8.6%)	
Sigmoid volvulus with necrosis	0	1 (2.1%)	
Hirschsprung's disease	0	1 (2.1%)	
Surgery kind			0.1
Anterior rectal resection	4 (33.3%)	14 (29.8%)	
Stoma closure	3 (25%)	15 (32%)	
Low anterior resection	4 (33.3%)	4 (8.5%)	
Left hemicolectomy	0	8 (17%)	
Sigmoid resection	1 (8.4%)	6 (12.7%)	
Anastomosis			0.3
Hand-sewn	1 (8.3%)	1 (2.1%)	
Stapler	11 (91.7%)	4 (97.9%)	
Anastomosis type			0.1
"end-to-end"	11 (91.7%)	41 (87.2%)	
"end-to-side"	0	5 (10.7%)	
"side-to-side"	1 (8.3%)	1 (2.1%)	
Preventive stoma, n (%)	5 (41.6%)	30 (63.8%)	0.2
Anastomosis leakage in history, n (%)	5 (41.6%)	7 (15%)	0.1
Me height of anastomosis location from anal edge, cm	**9 (6.5;12)**	**12 (10;15)**	**0.01**
Me extent of stricture, mm	**5.5 (4;11)**	**4 (3;5)**	**0.01**
Me stricture diameter, mm	5 (3.5;6)	6 (4;7)	0.4
Me diameter of anastomosis after endoscopic treatment, mm	14.5 (13.5;15)	15 (15;17)	0.1
Me diameter of anastomosis during control colonoscopy, mm	4.5 (3.5;7)	20 (16;20)	0.1

the BD group and 20 (15;20) mm in the ED group (p = 0.13) (Table 3).

Recurrence of colorectal anastomosis stricture was diagnosed in 8 (29.6%) of 27 patients in the BD group, and in the ED group almost 3 times less often — in 4 (10.8%) of 32 patients (OR = 2.9; 95% CI: 0.7–11.1; p = 0.04).

The analysis of signs was carried out depending on the fact of recurrence of stricture of colorectal anastomosis. As a result, it was found that only 2 signs in the formed groups — the height of the anastomosis from the level of the anal edge and the extent of the stricture, significantly differed (Table 4).

In the BD group, 6 out of 8 patients with recurrent stricture underwent repeated endoscopic balloon dilation, which allowed them to achieve the target values of the intestinal diameter in the narrowing area. One of the 8 patients with a recurrence of stricture was urgently operated on in another medical institution due to acute intestinal obstruction. Another patient, after detecting a recurrence of the colorectal anastomosis stricture, refused further treatment aimed at its correction, as well as the closure of the preventive stoma.

In the ED group, three out of 4 patients with recurrent stricture underwent repeated electrocoagulation of scar tissues with a positive effect: the intestinal lumen in the stricture area was expanded to the target value. In another case, the reason for refusing to perform repeated endoscopic correction of the stricture was its significant extent,

Table 5. *ROC analysis of numerical predictors*

Predictor	AUC (95% CI)	*p*-value	Sensitivity (95% CI)	Specificity (95% CI)	Critical level
Height of anastomosis	0.73 (0.56–0.89)	0.01	25 (8.9–53)	95.8 (86–99.2)	< 7 cm
Diameter of anastomosis before treatment	0.57 (0.39–0.76)	0.4	91.67 (80.4–96.7)	8.3 (0.42–35.4)	> 1mm
Extent of stricture before treatment	0.73 (0.56–0.9)	0.01	25 (8.9–53.2)	98 (89.1–99.9)	> 11 mm
Diameter of anastomosis after treatment	0.7 (0.5–0.87)	0.02	50 (25.4–74.6)	79 (65.7–88.3)	< 14 mm

Table 6. *Cox-regression analysis of the risk factors of recurrence of colorectal anastomosis stricture*

Factor	Analysis			
	Univariate		Multivariate	
	OR (95% CI)	p	OR (95% CI)	p
Height of stricture location is ⩽ 7 cm / > 7 cm	**5.5 (1.32–21.3)**	**0.04**	2.7 (0.1–33)	0.44
Extent of stricture before treatment ⩾ 11 mm / < 11 mm	**0.04 (0.03–0.34)**	**0.04**	**11.8 (1.57–123.5)**	**0.02**
Diameter of anastomosis after treatment ⩽ 14 mm / > 14 mm	0.26 (0.08–0.93)	0.06		
Anastomosis leakage (yes vs no)	**0.22 (0.05–0.96)**	**0.048**	1.58 (0.17–11.9)	0.6
Diverticular disease (yes vs no)	1.09 (0.29–3.65)	> 0.9		
Radiation therapy (yes vs no)	0.32 (0.08–1.3)	> 0.9		
Type of anastomosis (manual vs hardware)	0.25 (0.01–5.27)	0.38		
Kind of anastomosis (“end-to-end” vs “end-to-side”)	0.6 (0.05–5.06)	> 0.9		
Presence of preventive stoma (yes vs no)	2.5 (0.69–8.64)	0.19		
Treatment method (balloon dilation vs electrodestruction)	0.3 (0.1–1.18)	0.11		

15 mm according to the MRI data. He underwent resection of an intestine section with colorectal anastomosis with stricture, with mobilization of the left flexure and the formation of a new colorectal anastomosis.

We analyzed the risk factors for the recurrence of anastomotic stricture in both groups. Given the small sample size, the analysis included only those signs that, according to the literature, could have the greatest impact [6,11]. For numerical variables, a ROC analysis was performed, according to the results of which critical values were established, characterized by high diagnostic sensitivity in predicting the outcome (Table 5).

The numerical variables were reduced to the binary values and the univariate analysis of predictors was carried out. As a result, it was found that the factors having a statistically significant effect on the recurrence formation were: previous colorectal anastomosis leakage (OR = 0.2; 95% CI:0.05–0.96; p = 0.048), the height of the stricture location less than 7 cm from the anal edge (OR = 5.5; 95% CI: 1.32–21.3; p = 0.04), as well as the initial extent of cicatricial stricture ⩾ 11 mm (OR = 0.04; 95% CI: 0.03–0.34; p = 0.04) (Table 6).

In the multivariate analysis, only the extent of cicatricial stricture exceeding 11 mm turned out to be an independent factor that increases the risk of recurrence of stricture of colorectal anastomosis (OR = 11.8; 95% CI:1.57–123.5; p = 0.02).

The incidence of closure of preventive stomas in the groups after endoscopic treatment of

anastomotic strictures was analyzed. At the time of detection of colorectal anastomosis stricture, preventive stoma was in 19 (70.4%) of 27 and in 22 (68.7%) of 32 followed up patients in the BD and ED groups, respectively ($p = 0.89$). After completion of the treatment, ileostomy was closed in 11 (58%) and 18 (82.0%) cases in the BD and ED groups, respectively ($p = 0.09$).

DISCUSSION

Modern endoscopic technologies can reduce the risk of repeated intestinal resections in the treatment of strictures of colorectal anastomoses. For their correction, there are various endoscopic techniques, of which, along with augmentation, the possibilities of which are limited by the height of the stricture, BD and ED are the most popular [2,4,7,12–17]. The choice of the method of endoscopic treatment often depends on the preferences of the endoscopist. Despite the large number of publications, the proportion of studies based on a significant number of cases is low, and the effectiveness of the above endoscopic methods has not been proven. For the most part, in the literature, the authors give the experience of using any one method of correction of strictures. So, in the study by Kim, P. et al. the balloon dilation method was successfully applied in 42 patients with colorectal anastomosis stricture, all managed to expand the intestinal lumen in the narrowing area to acceptable values. However, when assessing long-term results, the disease recurrence was noted in 9.5% of patients [15]. In another small study by Araujio A. et al., in which 24 patients with strictures of colonic anastomoses participated, the BD method was successfully applied in 92% of patients, and in 8% endoscopic correction of stricture had to be abandoned in favor of the colon resection [20]. At the same time, a recurrence of stricture developed in 4 (18.0%) of 22 patients whose BD was initially successful. The same trend can be traced in our work: the use of endoscopic stricture correction techniques was effective; however, already in 6 months after the use of BD and ED, a recurrence of cicatricial stricture in the anastomosis area was noted in 29.6% and 9.6% of cases, respectively. Repeated use of the techniques allowed 6 patients with recurrence in the BD group and 3 patients with recurrence in the ED group to successfully complete the treatment and avoid bowel resection.

The authors, whose point of view we share, made a conclusion about the comparable effectiveness and safety of the analyzed methods [18]. In our opinion, the BD method implies the possibility of performing multiple dilatations of the stricture and can be applied again in case of recurrence. On the other hand, ED is potentially more traumatic, more operator-dependent technique, but provides a lower recurrence rate, no more than 10%.

An extremely important issue is the selection of patients with strictures of colorectal anastomoses for endoscopic treatment. And here the clinician has the problem of identifying factors that increase the risk of recurrence of stricture in the first place. Correct assessment of a specific situation potentially reduces the likelihood of choosing an inadequate method of stricture correction, and, consequently, the risk of recurrence. In a number of small studies, risk factors for the development of strictures of colorectal anastomoses were analyzed. In some studies, it has been shown that the height of the stricture location below 12 cm from the anal edge, preoperative radiation therapy, and the anastomosis leakage in the history are the factors that statistically significantly increase the likelihood of recurrence [1,6,19]. In our study, the only independent factor that increases the risk of recurrence of the colorectal anastomosis stricture was only its extent exceeding 11 mm, which is usually a consequence of a previous surgical complication — the leakage of colorectal anastomosis, or post-radiation fibrosis.

Thus, based on the results of our study, which evaluated the experience of almost 70 endoscopic interventions aimed at correcting strictures of colorectal anastomoses, it can be recommended as a treatment method to give preference to resection methods in the presence of an extended stricture in the patient.

CONCLUSION

ED and BD are safe and effective methods for treatment of anastomosis strictures. ED in comparison

with BD is the preferred method due to the lower recurrence rate (p = 0.04). An independent risk factor for the recurrence of colorectal anastomosis stricture is the extent of scar stricture exceeding 11 mm.

AUTHORS CONTRIBUTION

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