Novel Endoscopic Technique in Treating Colon Neoplasms with Improved Clinical Outcomes

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Abstract

Background: Colorectal polyps are a significant concern due to their potential to develop into colorectal cancer (CRC), a leading cause of cancer mortality. While many polyps are benign, a subset is "complex" and challenging to resect endoscopically. Current methods for polyp removal include cold excision, electrocoagulation, endoscopic mucosal resection (EMR), and endoscopic submucosal dissection (ESD), with varying success and complication rates. This study evaluates a new endoscopic excision technique involving a gel injection and diode laser system. Methods: The study included 208 patients with superficial neoplastic lesions of the colon, divided into a comparison group (112 patients, 170 polyps) and a main group (96 patients, 152 polyps). The comparison group underwent conventional excision techniques, while the main group received the new gel injection and diode laser excision method. Outcomes measured included complete resection rates, complication rates, recurrence rates, and hospital stay duration. Results: The main group showed a higher complete resection rate (70.4% vs. 57.1%, p=0.014) and lower recurrence rates (5.0% vs. 24.2%, p<0.001) compared to the comparison group. Clinically significant bleeding during and after procedures was also reduced in the main group (0% intraoperative, 0.7% postoperative) compared to the comparison group (4.7%intraoperative, 2.4% postoperative, p=0.012). The average hospital stay was shorter in the main group (3.4±1.0 days) compared to the comparison group (4.0±1.2 days, p<0.05). Conclusion: The new endoscopic excision technique using gel injection and diode laser significantly improves the complete resection rate, reduces complications and recurrence rates, and shortens hospital stay for patients with superficial colonic neoplastic lesions. This method offers a promising alternative for the endoscopic treatment of complex colorectal polyps.

Keywords: Colon polyps, endoscopic resection, laser excision, recurrence, complications

Significance | This study demonstrated a novel endoscopic method enhancing polyp removal efficacy, reducing complications, and lowering recurrence rates significantly.

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Introduction

One of the most frequent localizations of polypoid formations of the mucous membrane is the colon, which is of particular importance in terms of the risk of colorectal cancer. Among the most common variants are hyperplastic polyps, adenomas, and dentate formations (Sullivan et al., 2022). The prevalence of hyperplastic polyps in colonoscopic examinations usually ranges from 10% to 15%, but in certain population groups, it can reach 30% (Schramm et al., 2018). A meta-analysis of screening colonoscopic examinations at the age of ≥50 years showed that the overall prevalence of adenoma is approximately 24%, and the frequency of detection of advanced forms of polyps (size ≥10 mm, villous adenomas, and high-degree dysplasia) was about 4.5% (Kolb et al.,

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2021). The prevalence of traditional dentate colon adenomas (average size about 15 mm) is less than 1% during screening colonoscopy (Bettington et al., 2017). At the same time, colorectal cancer remains the second leading cause of cancer mortality worldwide, with a lifetime risk of developing from about 4% to 5% (Sung et al., 2021). Colorectal cancer screening and removal of precancerous colon adenomas lead to a reduction in morbidity and mortality by about 50% (Atkin et al., 2017). Most colorectal polyps are small, benign formations; however, in 10-15% of cases, polyps are classified as "complex," meaning they are technically difficult for endoscopic resection due to their size (> 20 mm), morphology, or localization (Ngamruengphong et al., 2016; Mann et al., 2021).

Most of the recommendations are aimed at removing polypoid formations larger than 5 mm (Evans et al., 2015). A biopsy cannot completely exclude dysplasia and malignancy; therefore, after complete removal of the formation, a thorough pathoanatomical study with morphological verification and assessment of the quality of resection should be carried out (Qin & Xu, 2020). The detection of precancerous colon polyps is a global problem, since the risk of developing colorectal cancer during life remains from about 4% to 5% (Surveillance, Epidemiology, and End Results Program [SEER], 2021). Treatment methods for polypoid formations include clipping, cold excision, electrocoagulation, endoscopic mucosal resection (EMR), endoscopic submucosal dissection (ESD), etc. (Choi et al., 2012). The probability of complete removal of polyps depends on their size and the method of excision; in particular, with a diameter of 6-20 mm, this figure reaches 81.6% with cold removal and 94.1-95.5% with cold or thermal resection (Jiang et al., 2023). According to other data, the frequency of single block resections ranges from 44.5% to 63% for EMR and from 87.9% to 96% for ESD (Yilmaz & Gorgun, 2023). Endoscopic submucosal dissection has a higher level of complete resection than other options, but at the same time, the risk of bleeding and perforation increases (Kim et al., 2012).

Proper diagnosis and reduction of the risk of these interventions are of key importance in the endoscopic treatment of superficial formations of the gastrointestinal tract (Yacoub et al., 2022; Akilov et al., 2023). The removal of such formations is associated with a considerable risk of complications and should be performed by specially trained endoscopists (Pimentel-Nunes et al., 2019). Among the main complications that develop both during the intervention and in the early period, bleeding and perforation are distinguished (Pattarajierapan et al., 2023). The frequency of early postmanipulation bleeding ranges from 0% to 6.3%, and perforations from 0% to 6% (Yanai et al., 2021). Conducting an intervention in the colorectal area is technically more difficult than in the upper gastrointestinal tract, which is reflected in a higher probability of complications and recurrence of polyps (Tanaka et al., 2020; Ataullaevich et al., 2023). The recurrence rate of polyps can reach 32.1% (Li et al., 2016; Zhu et al., 2009). Even after complete resection by endoscopic resection or dissection, recurrences occur in 2.4-12.2% of patients due to incomplete removal (Zhong & Xu, 2002; Kim et al., 2012). Local recurrence after polyp resection occurs in 3% of cases with single block removal and in 20% with fragmentary resections (Belderbos et al., 2014). There is still insufficient research to assess the advantages and disadvantages of various methods of removing polyps (Kang et al., 2018). The issue of improving the effectiveness of endoscopic treatment of polypoid formations requires further study (Qin & Xu, 2020). This applies both to the correct choice of endoscopic methods and methods of removing formations (Pattarajierapan et al., 2023).

2 Materials and methods

2.1 *Study Design*

The material for the analysis of clinical studies involved evaluating the treatment results for patients with superficial neoplastic lesions of the colon. This included two distinct groups: the comparison group, comprising 112 patients with 170 formations removed, and the main group, comprising 96 patients with 152 formations removed. In the comparison group, 75 patients had single formations, 22 had two formations, 12 had three formations, and 3 had more than three formations. The main group had 60 patients with single formations, 21 with two formations, 13 with three formations, and 2 with more than three formations. The average size of the formations was 1.8 cm in the comparison group and 1.9 cm in the main group.

2.2 Types of Formations Removed

In the comparison group, 42 polypoid formations of type 0-Is and 125 non-polypoid slightly raised surface formations (type 0-IIa) were removed. The main group had 39 type 0-Is formations and 109 type 0-IIa formations removed. After introducing the submucosal dissection method, 3 LST-type formations (laterally spreading formations) were removed in the comparison group, while 4 were removed in the main group.

2.3 Endoscopic Interventions

The comparison group employed various endoscopic techniques: cold removal with biopsy forceps (16 formations), cold removal with a loop (34), thermal removal by electroexcision (58), EMR (43 cases), and ESD (19 cases). In contrast, the main group utilized a new endoscopic excision method, which included thermal removal by laser excision (72 cases), EMR (48 cases), and ESD (32 cases).

2.4 Technical Aspects and Advantages

The new method involved introducing a gel prepared from Hemoben powder and 20 ml of methylene blue solution into

the submucosal layer at the base of the polyp, forming a roller. The polyp was then excised along with surrounding healthy mucosal tissue to the submucosal layer using a diode laser from the Gbox system. In cases without high-energy laser equipment, the gel can be used with standard cold or thermal excision methods. The advantages of this method include complete and stable hemostasis, prevention of damage to the musculoserous layer of the stomach, and radical removal of the polyp regardless of its pedicle shape. Additionally, the high-energy laser used has less penetrating power compared to electrocoagulation and infrared lasers, enhancing both safety and efficacy.

3. Results and discussion

In the comparison group, the proportion of excisions in a single block was 57.1% (with 97 out of 170 polyps), respectively, 73 (42.9%) polyps were removed from fragments. In the main group, taking into account the implementation of the new excision technique, this indicator was 70.4% - in a single block (with 107 out of 152 polyps) and 45 (29.6%) – fragmentally. With polyps up to 1 cm in the comparison group, 29 were removed in a single block, in the main group in 29 cases. With formations of more than 1 cm in 52.7% and 66.1% of cases.

When performing excisions, there were no signs of bleeding in 71 (41.8%) cases in the comparison group and in 108 (71.1%) interventions in the main group. Clinically significant manifestations of hemorrhagic syndrome during manipulation were in 4.7% of cases in the comparison group and none in the main group. In the early period after endoscopic excision, delayed bleeding after removal of polyps developed in 4 (2.4%) cases in the comparison group and only in 1 (0.7%) case in the main group.

Of the 112 patients in the comparison group, in addition to delayed bleeding, 1 (0.9%) case of postpolypectomy electrocoagulation syndrome was also noted. There were 107 (95.5%) patients in the comparison group and 95 (99.0%) in the main group without any complications.

In the comparison group, morphological verification was not possible in 39 cases in the material sent for histological examination; in the main group, the proportion of morphologically unidentified variants of polyps was only 7.9%. Hyperplastic character was identified in 36.6% of cases in the comparison group and 32.9% in the main group. The adenomatous type and dentate formations most dangerous from the point of view of malignancy were identified in 48.9% and 14.5% of cases in the comparison group and 50.7% and 16.4% in the main group.

In contrast to the removed formations from the mucosa of the upper gastrointestinal tract, morphological examination of preparations from the colon revealed a different degree of dysplasia in 51.1% of cases in the comparison group and 56.4% in the main group. Malignancy was detected in 3 cases in the comparison group and 4 in the main group. Surgical treatment with established malignancy was performed in only 2 patients (right-sided hemicolonectomy), the remaining patients refrained from surgery and were observed in dynamics.

After removal of formations from the colon mucosa in the main group, 64 drugs were evaluated for the quality of resection. During morphological analysis of the edges of the resected formations, the polyp tissue was verified in 20.3% of cases, which corresponded to R1 resection, and in 79.7% of cases, the pathological tissue was not determined along the edge of resection (R0 resection). With polyps up to 2.0 cm, resection of R0 was determined in 91.7% of cases, R1-resection in 8.3%. With polyps over 2.0 cm, resection of R0 was determined less frequently and amounted to 76.9%.

The reduction in the duration of the hospital period after removal of tumors in the colon in patients in the main group cannot be recognized only as a result of the introduction of a new method. It is also of objective importance to increase the experience of performing such manipulations, to expand the indications for simultaneous removal of several formations at once. In general, according to this indicator, after the introduction of the new technique, the hospital period after the intervention significantly decreased. Thus, 37 (33%) patients in the comparison group and 60 (62.5%) in the main group were discharged within 3 days. 64 (57.1%) and 34 (35.4%) patients were discharged within 4-5 days, respectively, 11 (9.8%) and 2 (2.1%) spent more than 5 days in the department ($\chi 2=19.574$; df=2; $p<0,001$).

The average bed day after endoscopic colon surgery was 4.0±1.2 days in the comparison group and 3.4±1.0 days in the main group ($t=4.23$; $p<0.05$).

Long-term results were observed in 91 patients in the comparison group and 80 in the main group. In the comparison group, no relapses were noted in 69 (75.8%) patients during the control study, however, in 22 (24.2%) cases, recurrences of the development of superficial neoplasms were verified. In the main group, relapse was detected in only 4 (5.0%) patients.

In polyps up to 1 cm in the comparison group, relapse was determined at 3.8%, and there was no recurrence in the main group. In 1-2 cm polyps, the recurrence rate was 7.7% versus 0% (Table 1). In polyps over 2.0 cm, this value reached 20.4% in the comparison group, whereas in the main group it was only 4.5%.

Also, in the comparison group of excisations of polyps in a single block, the recurrence rate was 7.5%. In the main group of 90 formations removed by a single block, relapse was in 1 (1.1%) case. Fragmented deletion increased these figures to 24.6% and 7.0%.

Summarizing all the results of treatment, the following can be noted. In our study, we attributed the results to good ones, which excluded the development of immediate complications after manipulation and recurrence of polyps formation. The results were

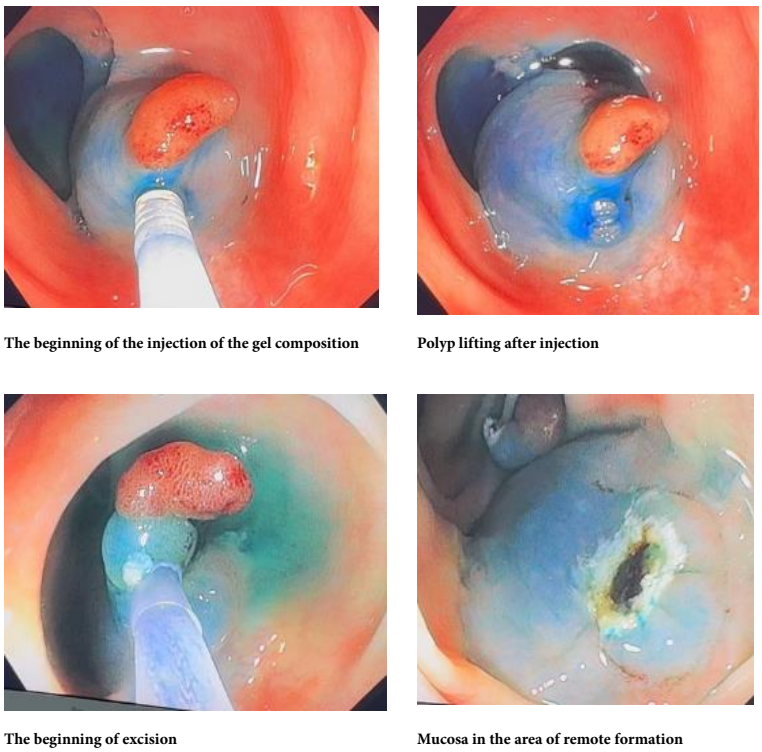

Figure 1. The stages of performing the removal of the sigmoid colon polyp

Table 1. Recurrence of neoplasm development depending on the initial size of the formations (from the number of formations)

Polyp size	Comparison Group			The main group			χ^2 (df=1)	
	n	Recurrent	%	n	Recurrent	%	Recurrent	p
Up to 1 cm	26	1	3,8%	21	0	0,0%	0,825	0,364
1,0-2,0 cm	26	2	7,7%	24	0	0,0%	1,923	0,166
>2,0 cm	93	19	20,4%	88	4	4,5%	10,285	0,002
Total	145	22	15,2%	133	4	3,0%	12,109	<0,001
Without recurrent	145	123	84,8%	133	129	97,0%		

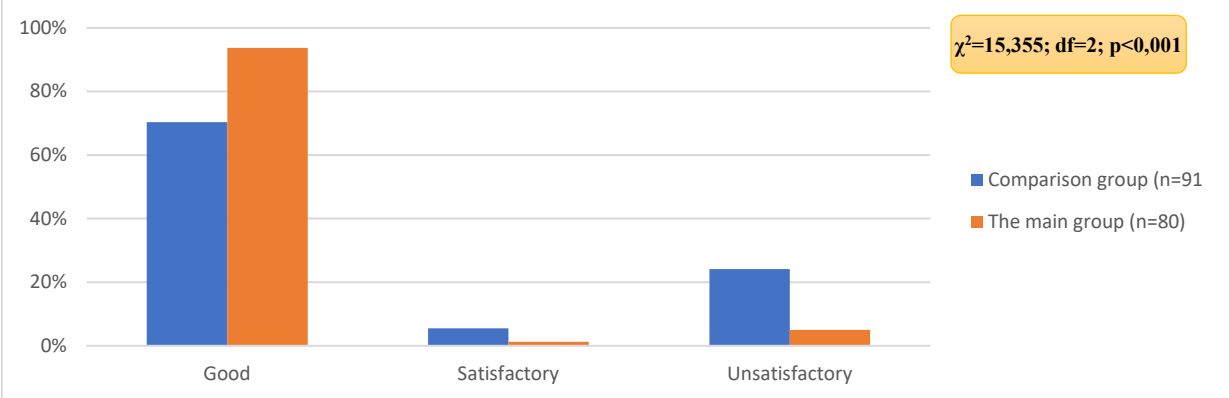

Figure 2. The overall result of endoscopic treatment, taking into account the patients traced in the near and long term

considered satisfactory if there were no recurrence of pathology, but there were any clinically significant complications resolved conservatively (postpolypectomy electrocoagulation syndrome) or repeated endoscopic intervention (delayed bleeding) (grade 2-3a according to Clavien-Dindo). The results were considered unsatisfactory when relapses of neoplasm formation were noted in the long-term period (Fig. 2). Taking into account all patients initially included in the study, the proportion of good results in the main group increased from 57.1% (64 patients in the comparison group) to 78.1% (75 patients in the main group), satisfactory results were obtained in 4.5% (5) and 1.0% (1), unsatisfactory – 19.6% (22) and 4.2% (4) of patients, respectively, in another 18.8% (21) and 16.7% (16) of cases, the result was not evaluated due to the failure of patients to attend a control examination (-2=15.536; df=3; p=0.002).

If we consider the cohort of patients only followed in the long–term period, the proportion of good results in the comparison group was 70.3% (in 64 of 91 patients), satisfactory – 5.5% (5) and unsatisfactory - 24.2% (22). In the main group, the results corresponded to good in 93.8% (in 75 out of 80 patients) of cases, satisfactory in 1.3% (1) and unsatisfactory in 4 (5.0%) cases (χ2=15,355; df=2; p<0,001).

4. **Conclusion**

Endoscopic removal of superficial polypoid and non-polypoid neoplasms of the colon mucosa according to the developed technique allowed to increase the probability of excision in a single block from 57.1% to 70.4% (p=0.014), significantly reduce the risk of hemorrhagic manifestations requiring additional manipulations both during the intervention (from 4.7% to 0%) and delayed bleeding in the next the period (from 2.4% to 0.7%) (p=0.012), as well as the overall overall complication rate from 4.5% to 1.0%, while the duration of the hospital period after the intervention decreased from 4.0±1.2 to 3.4±1.0 days (p<0.05).

The risk of recurrence after removal of superficial tumors from the colon depends on factors such as size, method of removal and localization, while the proposed technique allowed to reduce this indicator across the entire sample from 24.2% to 5.0% (p<0.001), when removed in a single block - from 7.5% to 1.1% (p=0.037), fragmented excision from 24.6% to 7.0% (p=0.019), the size of formations up to 1 cm from 3.8% to 0%, 1-2 cm – from 7.7% to 0%, more than 2 cm – from 20.4% to 4.5% (p=0.002), in turn, when the formations are removed In the right half of the colon, the recurrence rate of pathology decreased from 23.7% to 5.3% (p=0.005) and in the left part from 9.3% to 1.3% of cases (p=0.027).

Author contributions

I.S.I. conceptualized the study, designed the methodology, and prepared the original draft. D.D.A handled data curation, performed formal analysis, and contributed to the review and editing of the manuscript. Y.S.K.was responsible for investigation, acquiring resources, and creating visualizations. Y.F.R. supervised the project, managed administrative tasks, and secured funding. S.D.S contributed to project administration and provided critical insights. All authors have read and approved the final manuscript.

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Competing financial interests

The authors have no conflict of interest.

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