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A Study on Modified Endoscopic Mucosal Resection in Rectal Neuroendocrine Tumors

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Abstract: *Objective:* To explore the clinical feasibility and safety of modified endoscopic mucosal resection for rectal neuroendocrine tumors (R-NETs). *Methods:* Seventy cases of R-NETs treated with endoscopic mucosal resection in our hospital between April 2022 and March 2024 were selected and divided into the control group and the observation group using the mean score method, each with 35 cases. In the control group, traditional endoscopic mucosal resection (EMR) was performed, and in the observation group, modified EMR (endoscopic mucosal resection with ligation apparatus [EMR-L]) was performed. The operation time, hospitalization time, operation cost, and related complication rate of the two groups of patients were compared. *Results:* The operation time (20.36 ± 1.46 min) and hospital stay (3.37 ± 0.51 d) of patients in the observation group were shorter than those of the control group (31.44 ± 2.65 min and 4.73 ± 0.49 d). The cost of the operation in the observation group (7,695.85 ± 1,521.42 yuan) was lower than that of the control group (8,418.62 ± 1219.30 yuan), and the difference was statistically significant ($P < 0.05$). The total incidence of postoperative related complications in the observation group was observed to be 11.42%, which was significantly lower than that of 31.42% in the control group, and the difference was statistically significant ($P < 0.05$). *Conclusion:* The application of modified EMR in R-NETs is remarkable, which can not only effectively shorten the operation time and hospital stay, but also further reduce the risk of related complications, and indirectly save a large amount of hospital costs; thus, it is recommended to be promoted and applied clinically.

Keywords: Rectal neuroendocrine tumor; Endoscopic mucosal resection; Endoscopic mucosal resection by ligature method

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1. Introduction

Rectal neuroendocrine tumors (R-NETs) are a relatively rare group of tumors originating from the endocrine cells of the intestinal mucosa, and their detection rate has shown a significant upward trend in recent years with the popularity of screening colonoscopy [1]. According to the latest data from epidemiological studies, R-NETs account for more than 20% of all neuroendocrine tumors in the gastrointestinal tract, and most of them are G1-grade tumors with a diameter of < 10 mm [2]. Despite the relatively inert biological behavior of these tumors, lymph node

metastasis may still occur in about 3–10% of cases, making early diagnosis and standardized treatment crucial [3]. Clinical treatment of R-NETs often adopts traditional endoscopic mucosal resection (EMR), but as tumors mostly originate in the submucosa, the complete resection rate of EMR is only 60–80%; coupled with the hard texture of R-NETs, the use of EMR resection is prone to cause specimen fragmentation, which affects the pathological assessment; therefore, more optimal endoscopic resection techniques must be continuously explored [4]. In recent years, modified endoscopic mucosal resection (m-EMR) has significantly improved the therapeutic efficacy of R-NETs through technological innovations, and the most representative surgical protocols include mucosa resection by hyaline cap aspiration (EMR-C) and endoscopic mucosal resection with ligation apparatus (EMR-L), as well as endoscopic submucosal dissection (ESD), among others [5]. These modified procedures have increased the complete resection rate to more than 90% by improving lesion elevation, increasing resection depth, and reducing thermal damage, while maintaining the advantages of easy EMR operation [6]. The aim of this study was to systematically evaluate the value of modified EMR (EMR-L) in the treatment of R-NETs, by comparing and analyzing key indicators such as surgical indexes and the incidence of postoperative complications between the two groups in order to provide an evidence-based basis for clinical practice.

2. Information and methodology

2.1. General information

Seventy cases of R-NETs treated with EMR in our hospital between April 2022 and March 2024 were selected and divided into the control group and the observation group using the mean score method, each with 35 cases. In the control group, there were 19 males and 16 females, with the age range of 32–68 years old, a mean of 48.62 ± 9.31 years old; the diameter of tumor was 5–15 mm (mean 8.2 ± 2.1 mm); the distribution of the tumor location: 22 cases were 5–10 cm away from the anal verge, and 13 cases were 10–15 cm away from the anal verge. In the observation group, there were 20 males and 15 females, with an age range of 30–65 years old, a mean of 47.8 ± 8.9 years old; the tumor diameter was 5–16 mm (mean 8.3 ± 1.9 mm); the distribution of tumor location: 5–10 cm from the anal verge in 20 cases, 10–15 cm in 15 cases. The differences between the two groups of patients in terms of age, gender, and tumor size and location were not statistically significant ($P > 0.05$) and were comparable. The study was approved by the Ethics Committee of the hospital, and all patients signed an informed consent form before surgery.

2.2. Methodology

All patients received preoperative bowel cleansing preparations, fasted for 8 hours, and the procedure was performed independently by a physician with more than 10 years of experience in endoscopic operations at our institution.

2.2.1. Control group

Conventional EMR was performed in the control group. The patient was placed in the left lateral position, and after the location of the lesion was clarified by routine colonoscopy, the lesion was fully raised by submucosal injection of saline + epinephrine mixture (1:10,000) at the edge of the lesion; a high-frequency electric coil was applied to the base of the raised lesion, and electrocoagulation was performed to resect the lesion after adjusting the appropriate tension. Electrocoagulation was used to stop the hemorrhage, and metal clips were used to close the lesion if necessary. Postoperative specimens were sent for pathological examination to evaluate the cutting edge.

2.2.2. Observation group

Endoscopic mucosal resection with ligation apparatus (EMR-L) was performed in the observation group. The surgery was performed in three steps:

(1) Marking and injection: Firstly, electrocoagulation was used to mark the edge of the lesion at a distance of 0.5 cm by argon plasma coagulation (APC), and then glycerol fructose-epinephrine mixture containing indigo carmine (ratio 1:100,000) was injected into the submucosa to form a blue-stained elevated area;

(2) Ligation and suction: The transparent cap with multi-ring ligature was fixed at the front end of the endoscope, the position was adjusted so that the lesion was located in the center of the field of vision, the negative pressure suction sucked the lesion into the transparent cap completely, and the ligature ring was released to tightly ligate the base of the lesion;

(3) Resection and hemostasis: Electroresection was done with a lancing device at 5 mm above the ligature ring, hemostasis with APC spot coagulation of the trauma, and prophylactic clamping of metal clips at the exposed larger vessels. Intraoperative real-time observation of bleeding was done to ensure the integrity of the resection surface.

2.3. Observation indicators

(1) Surgical indicators: The operation time, hospitalization time, and total hospitalization cost of the two groups were observed and recorded.

(2) Postoperative-related complications: The occurrence of postoperative complications such as anal swelling, abdominal pain, bleeding, perforation, and infection was recorded in both groups. Total incidence rate = number of cases/total number of cases × 100%.

2.4. Statistical methods

SPSS 21.0 statistical software was used to process the data, and the measurement information was expressed as mean ± standard deviation (SD) with *t*-test, and the count information was expressed as percentage (%) with χ^2 test, and the difference was considered statistically significant with $P < 0.05$.

3. Results

3.1. Comparison of surgical indicators between the two groups

The operation time and hospitalization time of patients in the observation group were shorter than those of the control group, and the operation cost was lower than that of the control group, and the difference was statistically significant ($P < 0.05$), see **Table 1**.

Table 1. Comparison of surgical indicators between the two groups (mean ± SD)

Groups	Surgical time (min)	Length of hospitalization (d)	Cost of surgery ($)
Control group ($n = 35$)	31.44 ± 2.65	4.73 ± 0.49	8418.62 ± 1219.30
Observation group ($n = 35$)	20.36 ± 1.46	3.37 ± 0.51	7695.85 ± 1521.42
t	21.6654	11.3763	6.9098
P	< 0.001	< 0.001	< 0.001

3.2. Comparison of short-term postoperative complication rates between the two groups

There were 1 case of postoperative complications of anal swelling, 1 case of abdominal pain, and 1 case of bleeding in the observation group, with a total incidence of 11.42%; in the control group, there were 3 cases of postoperative complications of anal swelling, 2 cases of abdominal pain, 3 cases of bleeding, 1 case of perforation, and 2 cases of infection, with a total incidence of 31.42%, and the difference between groups was statistically significant ($P < 0.05$), as shown in **Table 2**.

Table 2. Comparison of the incidence of short-term postoperative complications between the two groups [*n* (%)]

Groups	Anal swelling	Abdominal pain	Bleeding	Perforation	Infection	Total incidence
Control group ($n = 35$)	3 (8.57)	2 (5.71)	3 (8.57)	1 (2.86)	2 (5.71)	11 (31.42)
Observation group ($n = 35$)	1 (2.86)	2 (5.71)	1 (2.86)	0	0	4 (11.42)
χ^2						4.1576
P						0.0414

4. Discussion

Rectal neuroendocrine tumors (R-NETs) are relatively rare, with a detection rate of only 0.17% on colonoscopy, but are second only to gastric NETs in the distribution of GI NETs, accounting for approximately 20% of all gastrointestinal neuroendocrine tumors. Clinically, the treatment of R-NETs is aimed at achieving complete resection of the lesion, ensuring negative margins (R0 resection), and the disease preserving anal function as much as possible as the main goal [7]. However, as R-NETs are mostly located in the submucosal layer, the traditional technique of EMR, which involves the elevation of the lesion by submucosal injection of physiological saline, and then the resection of the lesion with the electric coil lancing device, is not easy; although the operation is simple, there are obvious shortcomings in the treatment of R-NETs: (1) low rate of whole resection: due to the hard texture of R-NETs and most of them locating in the submucosal layer, it is difficult to completely resect them with conventional EMR, which can easily lead to piecemeal resection, and increase the risk of residuals [8]; (2) difficulty in assessing the margins of the incision: the specimen is fragmented after piecemeal resection, and it is difficult to accurately determine the status of margins with pathology [9]; and (3) bleeding and perforation risk: the rectal wall is thin, and excessive electrocoagulation may trigger bleeding or perforation, especially larger lesions (> 10 mm) are more likely to occur, so more precise resection techniques are needed to improve the cure rate and reduce the risk of recurrence [10]. EMR-L is a combination of ligature technology based on traditional EMR, which attracts the lesion and ligates it with negative pressure through a transparent cap to form a “pseudotip” at the base of the lesion, and then performs electrocoagulation and resection. Its significant advantages include: (1) improving the whole block resection rate: the lesion is easier to be completely circled after lancing, reducing the need for piecemeal resection; (2) reducing the risk of intraoperative bleeding: lancing can compress blood vessels, reducing the need for electrocoagulation [11]; and (3) more precise operation: the transparent cap fixes the field of view, avoiding repeated adjustments of the lancing device, shortening the operation time.

The results of this study showed that the EMR-L group had a significantly shorter operation time (20.36 ± 1.46 min) than the conventional EMR group (31.44 ± 2.65 min), and the length of hospital stay (3.37 ± 0.51 d vs. 4.73 ± 0.49 d) and the cost ($7,695.85 ± 1,521.42 vs. $8,418.62 ± 1,219.30) were both lower ($P < 0.05$). The reasons for the analysis were mainly summarized as follows: (1) the lancing technique simplifies the operation process,

shortens the operation time, and reduces the burden on physicians; (2) reduced use of intraoperative consumables (e.g., hemostatic clips), which lowers the medical cost; and (3) quicker postoperative recovery and shorter hospital stay, which is more in line with the concept of rapid rehabilitation surgery (ERAS) [12].

5. Conclusion

In conclusion, EMR-L is a more optimal choice for the treatment of R-NETs and is particularly suitable for promotion in primary hospitals. Modified endoscopic mucosal resection (mEMR) has demonstrated outstanding efficacy in the treatment of R-NETs. This advanced technique not only significantly shortens operative time and reduces hospital stays but also further minimizes the risk of associated complications. Additionally, by optimizing procedural efficiency and postoperative recovery, mEMR contributes to substantial cost savings for healthcare institutions. Given its clear advantages, this method is highly recommended for widespread clinical adoption.

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Disclosure statement

The authors declare no conflict of interest.

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