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Clinical Observation of Endoscopic Retrograde Appendicitis Therapy and Double Appendiceal Stent Placement

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Abstract

Objective: To investigate the feasibility of endoscopic retrograde appendicitis therapy (ERAT) combined with double appendiceal stent placement in treating acute appendicitis and its impact on recurrence. **Methods:** A retrospective analysis was performed on 23 patients diagnosed with acute appendicitis in The Third People's Hospital of Jingzhou from March 2023 to March 2025. All patients underwent standard ERAT procedures, including appendiceal observation, irrigation, angiography, stone extraction, and placement of single or double appendiceal stents. Postoperative pain relief, complications, hospital stay, changes in infection indicators, etc., were observed, and follow-up evaluations were conducted. **Results:** Among the 23 patients, 22 completed the treatment. Postoperative pain relief was significant, with no complications, and infection indicators decreased. One patient failed intubation and was converted to surgical treatment, which confirmed a mucinous cystadenoma at the appendiceal orifice. However, there was no significant statistical difference in stent retention duration between the single-stent group and the double-stent group. **Conclusion:** Endoscopic retrograde appendicitis therapy and stent placement are effective for acute appendicitis, featuring minimal trauma, fewer complications, rapid recovery, and complete preservation of appendiceal function. However, large-sample studies are needed to evaluate the therapeutic effects of single and double stents.

Keywords

Appendicitis, Endoscopic Retrograde Appendicitis Therapy (ERAT), Single Appendiceal Stent, Double Appendiceal Stent, Therapeutic Efficacy

1. Introduction

Acute appendicitis is one of the most common acute abdominal emergencies in clinical practice, with an incidence of approximately 233 per100,000 [1]. It can occur in any age group, but it is more prevalent in young adults aged 20 - 30. Data show that its incidence is about 40%, and the male-to-female ratio is approximately 2 - 3:1 [2]. Acute appendicitis can present with various symptoms such as abdominal pain, diarrhea, nausea, and vomiting. In severe cases, it can even threaten the patient's life. The mortality rate caused by appendicitis is about 1 to 5 per 1000, and early treatment is the key to reducing the mortality rate [3]. Since the 19th century, appendectomy has been widely accepted as the standard treatment for acute appendicitis [4], but it still carries risks such as postoperative infection, bleeding, intestinal obstruction, and appendiceal stump fistula/fecal fistula [5]. Moreover, appendectomy is one of the important factors in the occurrence of colorectal cancer [6] [7]. In 2012, inspired by endoscopic retrograde cholangiopancreatography (ERCP), Professor Liu Bingrong first proposed endoscopic retrograde appendicitis therapy (ERAT) for appendix preservation internationally, which has attracted attention and recognition from domestic and foreign scholars. At present, many Chinese scholars have taken the lead in innovations and research on endoscopic retrograde appendicitis therapy. Some surgeons believe that the transparent cap assistance can increase the success rate of intubation [8], and some studies have proved that stent placement with appropriate extension of indwelling time can reduce the recurrence risk of acute appendicitis patients [9]. This therapy has now been carried out in 31 provinces, autonomous regions, and municipalities in China. The purpose of this study is to verify the effects of single and double stents on patient recurrence and prognosis by placing different num.

2. Subjects and Methods

2.1. Research Subjects

A total of 23 patients with acute appendicitis admitted to Jingzhou Third People's Hospital from March 2023 to March 2025 were selected as the research subjects, including 11 males and 12 females, aged 16 - 73 years, with an average age of 42.87 years.

Inclusion criteria

(1) Onset time within 72 hours, in line with the diagnostic criteria for acute appendicitis, excluding complex appendicitis, other acute abdominal emergencies, and hollow organ perforation; (2) Appendiceal ultrasound and/or lower abdominal CT indicates appendiceal enlargement and/or appendiceal fecaliths, while color ultrasound or lower abdominal CT does not show signs of peri-appendiceal space-occupying lesions or pneumatosis; (3) Patients with clinical symptoms related to appendicitis such as right lower quadrant pain, nausea, and vomiting; (4) Patients and their families were informed about the study and signed the informed

consent form; (5) Body temperature not higher than 39.5˚C; (6) No signs of septic shock (normal shock index, no decrease in systolic blood pressure, etc.); and (7) Patients who cannot tolerate colonoscopy and cannot undergo bowel preparation.

Exclusion criteria

(1) Malignant tumor patients; (2) Patients with immune system diseases; (3) Patients with coagulation disorders; (4) Patients with organic diseases of important organs; (5) Patients with other underlying diseases and colon stenosis or obstruction who cannot tolerate colonoscopy; (6) Pregnant women and patients with mental diseases; and (7) Patients lost to follow-up during the follow-up period.

Before the operation, the patients and their families were fully communicated, informed of the possible risks and complications during the treatment process, and they signed the consent form for endoscopic retrograde appendicitis therapy + double appendiceal stent placement. This technology has passed the review of the hospital ethics committee.

2.2. Treatment Method (ERAT Method)

Patients signed the informed consent form before the operation, fasted before the operation, and underwent routine bowel preparation. Before ERAT examination and treatment, they orally took compound polyethylene glycol electrolyte powder + 2000 ml of boiled water, divided into two oral administrations, and drank it up within 1 hour. For patients with poor bowel preparation, a clean enema was given, once every 30 minutes until the bowel preparation requirements were met. Antibiotics were given intravenously within 2 hours before the operation, and infection treatment was continued after the operation until the body temperature and white blood cells returned to normal. The specific surgical steps are as follows:

1) Appendiceal cavity intubation: The patient took the left lateral position. After successful intravenous anesthesia, routine colonoscopy was performed with a conical transparent cap until the ileocecal valve was reached, and the appendiceal orifice was routinely observed. The condition of the appendiceal orifice was carefully observed, including whether there was congestion, edema, erosion, etc., and whether there was pus outflow. The conical transparent cap was used to gently push aside Gerlach's valve to fully expose the opening of the appendiceal lumen.

2) Endoscopic appendiceal lumen angiography: Using the alternate technique of guidewire and catheter, the catheter is placed at the root of the appendix under the guidance of the guidewire (X-ray positioning); the fluid in the appendiceal lumen is fully aspirated to observe the properties of the fluid flowing out of the appendiceal lumen; angiography under X-ray shows the appendiceal lumen, and the internal diameter, course, presence of stenosis, fecaliths and other conditions of the lumen are observed.

3) Appendiceal cavity irrigation and stone extraction: After repeated saline irrigation and aspiration, angiography was performed again. If the fecaliths had been washed out, irrigation was continued until the irrigating fluid was clear. If

the fecaliths had not been washed out, these were removed with a stone extraction balloon, and then irrigation was continued until the irrigating fluid was clear.

4) Appendiceal stent placement: After angiography showed no residual fecaliths, two plastic stents were placed along the guidewire to support the stenosis and continuously reduce the pressure in the appendiceal lumen.

5) After the operation, the patient could generally move. After 4 hours of fasting, if there was no discomfort, the patient could eat liquid food. The changes in vital signs and the occurrence of complications were observed.

6) The stent shedding situation was observed, and patients with unshed stents returned to the hospital to have the stents removed 1 month later.

2.3 Instruments and Consumables

Olympus electronic colonoscopy system (CF260/290), Nanjing Micro-Creation angiography catheter (BDC-08/55-7/18), zebra guidewire (0.035inch × 450 cm), conical transparent cap (D-20113404), integrated plastic stent (8F (6 cm, 8 cm, 10 cm), 8.5F (8 cm, 10 cm)), iohexol contrast agent (iohexol: normal saline = 1:1), and Siemens mobile C-arm X-ray machine.

2.4. Observation Indicators

2.4.1. Treatment Situation

Observe the patient's operation time, abdominal pain relief time, white blood cell count (White blood cells are an important component of the human immune system. They can release various inflammatory mediators and chemical substances, through which the occurrence and development process of inflammation can be understood…), postoperative fever situation, ERAT mirror findings, ERAT intraoperative operations, hospital stay, number of recurrences, stent removal situation, surgical operations, and complications etc.

2.4.2. Complications

Digestive tract perforation, bleeding, appendiceal perforation, stent displacement, etc.

2.4.3. Postoperative Follow-up

The postoperative follow-up time was 3, 6, 9, and 12 months, including: Whether there was repeated abdominal pain, and whether antibiotic treatment or surgical treatment was performed again due to appendicitis.

2.4.4. Statistical Method

Assigning a purpose to data creates valuable insights. SPSS 22.0 was selected for data calculation in this study. Furthermore, according to Hejase and Hejase, "descriptive statistics deals with describing a collection of data by condensing the amounts of data into simple representative numerical quantities or plots that can provide a better understanding of the collected data" (p. 272). The count data were expressed as the number of cases and percentages, the continuous variables were expressed as the median (lower quartile, upper quartile), and the rank sum test

was used for statistical analysis; the discrete variables were expressed as percentages, and the Chi-square test was used for statistical analysis.

3. Results

3.1. Patient Characteristics

A total of 22 cases meeting the standards were collected in this study, including 10 cases in the single-stent group and 12 cases in the double-stent group, including 12 males and 10 females, with a median age of 42.5 years, a median onset time of 2 days, and a preoperative median white blood cell count of 12.565×10^9/L. All patients received antibiotic treatment before the operation and were confirmed to have appendicitis by color ultrasound or CT. The basic characteristics of the patients are shown in Table 1.

Table 1. Baseline Characteristics of Included Patients [M (QL, Qu), n (%)].

Project	ERAT = 22
Age (years)	42.5 (29.5 - 55.5)
Gender	
- Male	12 (54.5%)
- Female	10 (45.5%)
Onset time	2.00 (1, 4)
Preoperative white blood cell count	12.565 (11.55 - 14.81)
Postoperative white blood cell count	9.17 (8.17 - 10.55)
Preoperative antibiotic use	22 (100%)
Preoperative diagnosis of appendicitis	22 (100%)

3.2. ERAT Treatment Situation

Table 2. ERAT Treatment Status of Included Patients [M (QL, Qu), n (%)].

Project	
ERAT mirror findings	
- Appendiceal enlargement	1 (4.5%)
- Appendiceal cavity pus	5 (22.7%)
- Appendiceal cavity pus + fecaliths	16 (72.7%)
ERAT intraoperative operations	
- Irrigation	22 (100%)
- Single stent	10 (45.4%)
- Double stent	12 (54.5%)

Table 2 illustrates that among the 23 patients, 2 patients only showed appendiceal enlargement under the endoscope, 5 patients showed appendiceal enlargement

and pus, 16 patients showed appendiceal enlargement, fecaliths, and pus under the mirror, and pus was seen flowing out from the appendiceal cavity during endoscopic irrigation; 1 patient did not find the appendiceal opening and was converted to surgical treatment, which confirmed a mucinous cystadenoma at the appendiceal orifice after the operation; 10 patients had single stents indwelling, and 12 patients had double stents indwelling.

3.3. Comparison of Data before and after Treatment between the Single-Stent Group and the Double-Stent Group

A total of 22 patients with acute appendicitis meeting the standards were selected in this study, including 10 cases in the single-stent group and 12 cases in the double-stent group (Table 3). The single-stent group had 4 males and 6 females; the median age was 44.60±17.57, the preoperative median white blood cell count was 13.65 × 10^9/L, and the postoperative median white blood cell count was 12.09 × 10^9/L. The abdominal pain relief days in the two groups were 1 day, the hospital stay was 5 days, the number of recurrences was 2, and the number of complications was 0.

Table 3. Treatment Outcomes of Patients in Single-Stent Group and Double-Stent Group [M (QL, Qu), n (%)].

Project	Single-stent group (n = 10)	Double-stent group (n = 12)	Statistic	P value
Age (years)	42 (28.5, 59.3)	42.5 (28.5, 49.8)	Z = −0.297	0.767
Preoperative white blood cell count	13.64 (11.6, 16.1)	12.09 (10.3, 14.0)	Z = −1.385	0.166
Postoperative white blood cell count	9.03 (8.6, 10.1)	9.19 (7.2, 10.5)	Z = −0.165	0.869
Abdominal pain relief duration (days)	1.00 (1.0, 2.0)	1.00 (1.0, 2.0)	Z = −0.316	0.752
Hospital stay (days)	5.00 (4.0, 5.0)	4.50 (3.3, 5.0)	Z = −0.925	0.355

3.4. Comparison of Recurrence and Indwelling Time between Single-Stent and Double-Stent Patients

Table 4. Comparison of stent indwelling time between the single-stent group and the double-stent group.

Project	Median: Single-stent group (n = 10)	Median: Double-stent group (n=12)	Statistic	P value
Stent indwelling time (months)	2.00 (1.0, 2.0)	2.00 (2.0, 2.0)	Z = −0.726	0.468

The median stent indwelling time in the single-stent group was 2.00, and the median stent indwelling time in the double-stent group was 2.00. Among them, 3

patients in the single-stent group had automatic stent shedding, and 2 patients in the double-stent group had automatic stent shedding. There was no statistical significant difference between the two groups of patients (Table 4).

4. Discussion

Among the 22 patients who completed ERAT examination and treatment, the procedures were performed by a fixed team of two doctors and two nurses. The operation time was calculated from the start of colonoscopy to the complete withdrawal of the colonoscope from the intestine, ranging from 30 to 50 minutes. As the number of treated cases increased, surgical proficiency improved, leading to shorter operation times. Since ERAT preserves the appendix, there is a risk of recurrence. Currently, mainstream ERAT treatments primarily involve single stent placement, with multiple reports on recurrence cases, mostly attributed to postoperative stent obstruction. Potential causes of obstruction may include stent size, viscous pus, and incomplete removal of fecaliths. Therefore, this study observed double appendiceal stent placement to evaluate both therapeutic efficacy and postoperative recurrence. After double stent placement, the gaps between stents and the stent size itself enable more thorough drainage of the appendiceal lumen. Even small fecaliths can be discharged through the drainage of double stents, potentially reducing recurrence. However, in this study, no significant statistical difference was found in stent retention between the two groups, likely due to the small sample size, necessitating further research with a larger sample.

5. Conclusions and Recommendation

5.1. Conclusions

In this study, among all 23 patients, 22 patients succeeded in intubation, and the intubation success rate was 95.65%, which was similar to that of Professor Liu. All 22 patients underwent ERAT examination and stent placement for drainage. One patient did not find the appendiceal orifice, and it was confirmed by surgical treatment that it was a mucinous cystadenoma at the appendiceal orifice. After the operation, the abdominal pain of all patients was rapidly relieved, and the blood routine white blood cell index and neutrophil index significantly decreased after 24 hours of reexamination. However, there was no significant statistical difference between the single-stent group and the double-stent group. There were no complications such as bleeding and perforation in the two groups after the operation, and 22 patients were discharged after symptom relief by ERAT treatment. The stents of 5 patients spontaneously fell off within 2 months, and 17 patients returned to the hospital for colonoscopy to remove the stents 2 months after the operation. There was no significant statistical difference in the indwelling time between the single-stent group and the double-stent group. The shape of the appendiceal orifice was normal during colonoscopy. Three patients (13.6%) were diagnosed with recurrence by medical institutions within one year after treatment. Therefore, this study shows the important role of ERAT in the treatment of acute

appendicitis, which can not only preserve the function of the appendix but also has the characteristics of fewer complications and rapid recovery. It can also improve colonoscopy during the treatment process and timely treat related diseases such as colorectal polyps, internal hemorrh.

This study performed endoscopic retrograde appendicitis therapy combined with appendiceal stent placement on 23 recently admitted patients with acute appendicitis. Twenty-two cases achieved significant therapeutic effects, while one case failed due to insufficient preoperative analysis of imaging results, warranting caution. In the 22 successful cases, abdominal pain was relieved immediately postoperatively, and inflammatory markers significantly decreased. Patients could ambulate freely on the first postoperative day, and there were no concerns about wound dressing changes or complications, with all patients retaining intact appendiceal function. During ERAT, 6 patients were diagnosed with colonic adenomas, which were treated with endoscopic mucosal resection (EMR) simultaneously. Postoperative pathology confirmed tubular adenomas, eliminating the risk of adenoma carcinogenesis for these patients.

In conclusion, compared with traditional surgical procedures, endoscopic acute appendicitis treatment with stent placement is of great significance. As the treatment does not enter the abdominal cavity, it features minimal trauma, fewer complications, and rapid recovery, while preserving the appendix and its potential physiological functions.

5.2. Recommendation

Double appendiceal stent placement enables more thorough drainage and a relatively lower risk of postoperative recurrence, representing an effective method for treating acute appendicitis.

5.3. Limitation

This study only followed up for a maximum of 12 months, requiring extended follow-up to assess recurrence. Additionally, the small sample size affects the results, necessitating large-scale, multicenter, randomized controlled trials for scientific evaluation.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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