

Clinical Analysis of Endoscopic Esophageal Dilation Combined with Mitomycin in the Treatment of Corrosive Esophageal Stenosis in Children

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Abstract: *Objective:* To explore the clinical application of endoscopic esophageal dilation combined with mitomycin in the treatment of corrosive esophageal stenosis in children. *Methods:* Twenty children with corrosive esophageal stenosis treated in our hospital from August 2023 to March 2025 were selected and divided into an intervention group ($n = 10$, combined with mitomycin) and a control group ($n = 10$, simple dilation) according to the treatment plan. The Stooler swallowing grade, diameter of the stenotic segment, total effective rate, number of dilations, and complications were compared between the two groups before and after treatment. *Results:* After treatment, the swallowing function improved in both groups, but the increase in the diameter of the stenotic segment was greater in the intervention group ($P < 0.05$), and the total effective rate was higher ($P < 0.05$). The average number of dilations in the intervention group (3.20 ± 1.03) was significantly less than that in the control group (5.00 ± 1.63) ($P < 0.05$). There was no statistical difference in the incidence of complications between the two groups, mainly mild bleeding and chest pain. *Conclusion:* Combined mitomycin can improve efficacy, reduce treatment frequency, and has good safety, which is worthy of priority clinical application.

Keywords: Children; Corrosive esophageal stenosis; Endoscopy; Esophageal dilation; Mitomycin

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1. Introduction

As a recognized major public health issue in childhood, corrosive esophageal stricture in children is a serious digestive system disease, mostly caused by accidental ingestion of corrosive substances such as strong acids and alkalis ^[1]. These substances can corrode and invade the esophageal mucosa, inducing inflammatory reactions and ulcers, which can lead to fibrosis and subsequent luminal stenosis, causing feeding difficulties, developmental delays, and even complications such as perforation or mediastinal infection ^[2]. Currently, there are many clinical treatments for corrosive esophageal stricture in children, among which esophageal dilation is one of the commonly used therapeutic methods ^[3]. This method can temporarily relieve the symptoms of dysphagia in children by

mechanically expanding the stenotic esophageal segment ^[4]. However, simple esophageal dilation is prone to recurrence, often requiring repeated procedures, which can increase the physical and psychological suffering of the child and the economic pressure on the family. Mitomycin is an antitumor antibiotic that inhibits fibroblast proliferation and collagen protein synthesis ^[5]. Recent studies have found that mitomycin can inhibit esophageal scar formation and reduce the recurrence rate of stenosis ^[6]. This study focuses on corrosive esophageal stricture in children and evaluates the therapeutic effect of dilation combined with drug therapy to provide a reference for clinical treatment.

2. Materials and methods

2.1. Subjects

This study adopts purposive sampling and selects children with corrosive esophageal stricture who were hospitalized in our hospital from August 2023 to March 2025 and underwent esophageal dilation combined with mitomycin treatment as the research subjects. Inclusion criteria include: (1) meeting the diagnostic criteria and confirmed by endoscopy and imaging; (2) aged 1–12 years old; (3) informed consent from family members. Exclusion criteria include those with severe organ dysfunction, mitomycin allergy, or esophageal perforation/major bleeding. A non-concurrent control design was adopted, with 10 cases in each of the control group and the intervention group based on treatment time. Retrospective analysis showed no significant difference in baseline data between the two groups ($P > 0.05$), as shown in **Table 1**. This study was approved by the Ethics Committee of Kunming Children's Hospital (Approval No.: 2023-03-217-K01).

Table 1. Comparison of clinical data between the two groups

Category	Control group ($n = 10$)	Intervention group ($n = 10$)	t/χ^2	P -value
Age (years old)				
Gender			0.808	0.369
Male	7	4		
Female	3	6		
Stricture location			0.770	0.857
Upper 1/3 esophagus	2	1		
Middle 1/3 esophagus	3	3		
Lower 1/3 esophagus	3	4		
Multiple strictures	1	2		
Stricture length			0.202	0.653
≤ 3 cm	4	5		
> 3 cm	6	5		
Corrosive agent			0.850	0.654
Strong alkali	2	3		
Strong acid	3	4		
Button battery	5	3		

2.2. Research methods

2.2.1. Preoperative preparation

Preoperative preparation and counseling were completed according to the standard protocol for painless gastroscopy, and double-informed consent forms were signed. All pediatric patients underwent endoscopic dilation under general anesthesia with endotracheal intubation, and underwent anesthesia evaluation before surgery. Strict fasting for 8 hours and water deprivation for 4 hours were implemented. A fixed team of senior physicians performed individualized endoscopic diagnosis and treatment based on preoperative imaging results, using balloons (Micro-Tech (Nanjing) Co., Ltd., MBD-0855-18) or bougies (COOK Company, USA) for dilation. The degree of esophageal stenosis was evaluated, and the initial dilator diameter was selected for gradual dilation.

2.2.2. Treatment method for the control group

The control group adopted a standardized protocol, performing bougie/balloon dilation according to the degree of stenosis, with a single target diameter of 10–12 mm. The procedure was repeated every 2–4 weeks until a significant improvement in swallowing function or clinical cure was achieved.

2.2.3. Treatment method for the intervention group

The intervention group received a combined local application of mitomycin (0.4 mg/mL) on the basis of the control treatment. The duration of action was 2-5 minutes, with a frequency of 1-4 times. The drug was applied through endoscopic cotton pad placement or multi-point injection using a needle, and normal saline was used for flushing to ensure safety. Drinking water was allowed 4 hours after surgery, trial feeding was attempted at 6 hours, and oral feeding was resumed the next day without complications, along with concurrent acid suppression therapy.

2.3. Evaluation indicators

2.3.1. Improvement in dysphagia

Dysphagia was evaluated after treatment using the Stooler grading system ^[7]:

- (1) Grade 0: No dysphagia, food can pass smoothly through the mouth, throat, and esophagus to reach the stomach.
- (2) Grade I: Mild dysphagia, food can pass through the mouth and throat but encounters some obstruction in the esophagus, requiring additional effort to swallow.
- (3) Grade II: Moderate dysphagia, food encounters obstruction in both the throat and esophagus, requiring extra effort to swallow.
- (4) Grade III: Complete inability to eat, unable to pass through the mouth and throat, unable to swallow any food, including liquids.
- (5) Grade IV: Severe dysphagia, unable to pass through the mouth and throat, unable to swallow any food, including liquids.

(Note: There seems to be an overlap between Grade III and Grade IV in the original description. Clarification or revision may be needed to distinguish the two grades more clearly.)

2.3.2. Diameter of stenotic segment

Measure the diameter of the narrowest part of the stenotic segment through gastroscopy before and after treatment.

2.3.3 Treatment frequency

Record the total number of dilations required to achieve the criteria for cure after treatment. Clinical efficacy: Evaluate the efficacy after treatment by combining the number of dilation treatments, eating status, and gastroscopy review status. The evaluation is divided into cured, markedly effective, effective, and failed. After treatment evaluation, the total effective rate = (cured + markedly effective + effective) / total number of cases × 100%.

2.3.4. Treatment safety

Record complications during treatment (bleeding, perforation, pain, etc.).

2.4. Statistical analysis

Statistical analysis of the data was performed using SPSS software. Count data are expressed as the number of cases and percentage (%), and the comparison of graded data between the two groups was performed using the Wilcoxon rank-sum test; non-normally distributed measurement data are expressed as median (interquartile range) [M(P25, P75)], and the comparison between the two groups was performed using the Wilcoxon rank-sum test. $P < 0.05$ was considered statistically significant.

3. Results

3.1. Dysphagia grading

After treatment, the Stooler dysphagia grading in the intervention group was significantly better than that in the control group, and the difference was statistically significant ($Z =$, $P < 0.05$). There was no significant difference in the distribution of Stooler grades between the two groups before treatment ($P > 0.05$); after treatment, the grades of both groups were significantly reduced ($P < 0.05$), as shown in **Table 2**.

Table 2. Stooler dysphagia grading before and after treatment in both groups

Time Point	Group	Grade I	Grade II	Grade III	Grade IV	χ^2	P -value
Pre-treatment	Control	2	4	3	1	1.981	0.576
	Intervention	1	3	4	2		
Post-treatment	Control	2	5	3	0	6.363	0.042
	Intervention	6	4	0	0		

3.2. Diameter of stenotic segment

There was no significant difference in the diameter of the stenotic segment between the two groups before treatment ($P > 0.05$); after treatment, the diameter of the intervention group was significantly larger than that of the control group ($P < 0.05$), as shown in **Table 3**.

Table 3. Diameter of the stenotic segment before and after treatment in both groups

Group	n	Pre-treatment	Post-treatment
Control	10	3.90 ± 1.37 mm	8.20 ± 1.32 mm
Intervention	10	3.20 ± 1.03 mm	9.60 ± 1.43 mm
t -value		1.290	3.457
p -value		0.213	0.045

3.3. Treatment frequency

The average number of treatments required in the intervention group was significantly less than that in the control group ($P < 0.05$), as shown in **Table 4**.

Table 4. Total number of treatment sessions for both groups after treatment

Group	n	Post-treatment (times)
Control	10	5.00 ± 1.63
Intervention	10	3.20 ± 1.03
<i>t</i> -value		2.946
<i>p</i> -value		0.009

3.4. Therapeutic effect

The total effective rate of the intervention group was significantly higher than that of the control group, and the cure rate was also significantly higher ($P < 0.05$). See **Table 5** for details.

Table 5. Comparison of treatment efficacy between the two groups after treatment

Group	Cured	Markedly effective	Effective	Ineffective	Total effective rate
Control	1	6	1	2	80%
Intervention	5	2	3	0	100%
χ^2	-	-	-	-	0.823
<i>P</i> -value					0.032

3.5. Treatment safety

Regarding complications, there were 2 cases of bleeding and 1 case of retrosternal pain in the control group; there was 1 case of bleeding and 1 case of retrosternal pain in the intervention group. There was no significant difference in the incidence between the two groups ($P > 0.05$). No serious complications, such as perforation were observed. See **Table 6** for details.

Table 6. Comparison of safety between the two groups after treatment

Group	Bleeding	Retrosternal pain	Severe complications (e.g., Perforation)	Total Incidence
Control	2	1	0	30%
Intervention	1	1	0	20%
χ^2				0.139
<i>p</i> -value				0.709

4. Discussion

4.1. Characteristics and treatment difficulties of corrosive esophageal stenosis in children

Due to the lack of safety education and weak supervision of children in China, corrosive substances are easily accessible, leading to accidental ingestion by children. The most severe complication is esophageal stenosis, which can significantly increase the risk of esophageal cancer in the long term and cause swallowing disorders,

malnutrition, repeated aspiration, and respiratory infections, seriously affecting the quality of life of children ^[8]. Studies have shown that most corrosive injuries are concentrated in the cricoid cartilage, aortic arch area, and inferior margin of the left main bronchus, involving the upper and middle segments of the esophagus ^[9]. Acidic substances cause coagulation necrosis of the mucosa, forming eschars, while alkaline substances cause liquefaction ischemia and thrombosis, both of which can lead to luminal stenosis or even occlusion. The disease ultimately leads to fibrotic stenosis and esophageal shortening ^[10]. The key to treatment lies in precise dilation and inhibition of excessive scar tissue proliferation to reduce the recurrence rate and risk of repeated treatments. Due to the thin esophageal wall and weak elasticity of children, dilation procedures must be performed with extra caution, taking into account physiological characteristics to develop a treatment plan.

4.2. Analysis of the effect of endoscopic esophageal dilation combined with mitomycin treatment

The intervention group had significant efficacy, and the reasons for this result may include:

- (1) The dual effect derived from mitomycin: as a cell cycle non-specific antiproliferative agent, it exerts an alkylating effect by inhibiting DNA and protein synthesis, targets and inhibits fibroblast proliferation, blocks scar tissue regeneration at the source, and effectively improves esophageal stenosis structure ^[11].
- (2) Simple dilation only tears the scar in the short term, leading to restenosis within 3–4 weeks due to continuous fibroblast proliferation. In the intervention group, mitomycin was locally administered during the wound repair phase, which accurately inhibits scar hyperplasia, effectively reduces the recurrence rate, and avoids high surgical risks by blocking DNA/RNA replication and protein synthesis ^[12].
- (3) Children have poor tolerance to endoscopy, and frequent anesthesia and dilation can easily lead to pain and risk of perforation; mitomycin C can reduce the frequency of treatment, which not only reduces medical expenses but also relieves family psychological pressure.
- (4) Safety evaluation showed no significant difference in complication rates between the two groups, confirming that local application of mitomycin C did not increase the risk, which is consistent with domestic and foreign studies ^[13]. In this study, the concentration was strictly controlled to 0.4 mg/mL ^[14], and the cotton pad was applied for 3–5 minutes ^[15] to effectively avoid the risk of high-concentration mucosal injury and drug overdose.

4.3. Research limitations and prospects

This study has the following limitations:

- (1) As a retrospective study, there may be selection bias, and doctors tend to choose combined therapy for severe cases;
- (2) The sample size is small;
- (3) The optimal concentration and duration of action of mitomycin C are not clear, and the applicable age needs to be verified;
- (4) There is a lack of long-term follow-up data for 3–5 years, and the observation period needs to be extended to evaluate the long-term efficacy.

Future research can:

- (1) Conduct multi-center, randomized controlled trials with strict randomization to control bias;
- (2) Expand the sample size, stratified analysis according to the injury object (acid/alkali), stenosis location and degree;

- (3) Set up a dose gradient test of 0.2-0.6mg/mL to determine the optimal concentration for children;
- (4) Explore the combination of other anti-scar drugs to provide new strategies for refractory cases.

5. Conclusion

In summary, endoscopic esophageal dilation combined with local treatment of mitomycin for corrosive esophageal stenosis in children achieves synergistic effects through mechanical dilation and scar-inhibiting medication. This significantly improves efficacy, reduces treatment frequency, lowers the risk of recurrence, and ensures reliable safety. This approach is especially suitable for injuries caused by strong alkalis and stenoses less than 2 cm. For complex cases, it can be incorporated into a comprehensive treatment system. With further research and technological advancements, this approach is expected to become the preferred clinical solution.

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Disclosure statement

The authors declare no conflict of interest.

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