

Postprocedural pain following colorectal EMR low versus high epinephrine in the submucosal injectate for non-pedunculated colorectal polyps sized 10-20 mm: a randomized controlled trial

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Abstract

Background and aims: EMR is standard for colorectal polyps. Adding epinephrine to submucosal injectate reduces bleeding but may increase postprocedural pain. The optimal concentration is uncertain. We compared low (1:500,000) versus high (1:200,000) epinephrine for postprocedural pain after EMR of 10–20 mm non-pedunculated polyps.

Methods: Single-center, randomized, double-blind trial. Patients received submucosal injectate with 1:500,000 or 1:200,000 epinephrine. Primary outcome: pain scores (100-mm VAS) at 30 and 60 minutes post-procedure. Multivariable logistic regression identified independent predictors of clinically significant pain scores.

Results

163 patients (81 low, 82 high) were analyzed. Median pain scores at 30 min were significantly lower in the low-concentration group (3.00 vs. 3.00; Hodges-Lehmann estimate – 1.0; 95% CI, -1.0 to -1.0; $P < 0.001$), as were scores at 60 min (1.00 vs. 2.00; difference – 1.0; 95% CI, -1.0 to 0.00; $P < 0.001$). Intraprocedural bleeding (7.4% vs. 6.1%; $P = 0.98$) and postprocedural bleeding (1.2% vs. 1.2%; $P > 0.99$) did not differ significantly. Multivariable analysis confirmed high concentration epinephrine (OR 3.82; 95% CI, 1.74–8.93; $P < 0.001$) and larger injection volume (OR 1.44; 95% CI, 1.06–2.03; $P = 0.018$) as independent predictors of clinically significant pain scores.

Conclusions: For EMR of 10–20 mm non-pedunculated colorectal polyps, submucosal injection with 1:500,000 epinephrine significantly reduced postprocedural pain compared with 1:200,000, while maintaining equivalent hemostatic efficacy and safety.

Trial Registration

ChiCTR2500110027||<http://www.chictr.org.cn/>) with the Chinese Clinical Trial Registry. Date: 29–09-2025.

Introduction

Endoscopic mucosal resection (EMR) of colorectal polyps is essential to reduce the incidence and mortality of colorectal cancer (CRC)¹. Submucosal injection expands the submucosal layer and provides a protective cushion that reduces complications, such as thermal deep mural injury (DMI) and perforation². Diluted epinephrine is generally added to the submucosal lifting solution to induce vasoconstriction and reduce intraprocedural bleeding². However, the concentrations of diluted epinephrine are controversial, ranging between 1:10,000 and 1:500,000. Additionally, Rex DK *et al.* found that for EMR of colorectal polyps, the addition of diluted epinephrine (1:200,000) to the submucosal injectate increased postprocedural pain compared with injectate alone³. Mechanistically, epinephrine may induce intestinal ischemia, leading to abdominal or pelvic discomfort. Whether a low concentration of epinephrine (1:500,000) in the submucosal injectate reduces postprocedural pain compared with a

high concentration (1:200,000) after colorectal EMR, without compromising hemostatic efficacy during the procedure, which is uncertain. Therefore, we conducted a randomized controlled trial to compare postprocedural pain following colorectal EMR using submucosal injectate containing low-dose (1:500,000) versus high-dose (1:20,000) epinephrine for non-pedunculated colorectal polyps sized 10–20 mm.

Methods

Study design

We conducted a single-center, randomized, controlled, double-blind trial to compare postprocedural pain following EMR using a low-concentration epinephrine (1:500,000) versus a high-concentration epinephrine (1:200,000) in the submucosal injectate between June 2025 and May 2026. Participants were randomly assigned in a 1:1 ratio. This study was complied with the principles of the Declaration of Helsinki and approved by the institutional review board of Shenzhen People's Hospital. The study was registered with Chinese Clinical Trial Registry (ChiCTR2500110027).

Participants

Patients eligible for inclusion were aged 18 to 80 years with non-pedunculated colorectal polyps sized 10–20 mm. Informed consent should be signed. Exclusion criteria were following: informed consent refused, pedunculated polyp, residual/recurrent polyps, endoscopic suspicion of malignancy, pregnancy, coagulation disorders, Chronic inflammatory bowel disease, poor bowel preparation (grade 0–3 in the Boston Bowel Preparation Scale), antiplatelet/anticoagulant medication that could not be paused as recommended in the current guideline⁴, severe cardiopulmonary dysfunction, cirrhosis, chronic kidney disease, other malignant tumors, or severe infectious diseases, and other trials enrolled.

Randomization and masking

After informed consent had been obtained, eligible patients were randomly allocated to receive either low-concentration epinephrine group and high-concentration epinephrine group in a ratio of 1:1 using block randomization. A computer-generated randomization sequence was generated by the study coordinator and placed in sequentially numbered sealed opaque envelopes, which were opened by the investigators prior to the procedure. The research assistants added 0.5 ml or 0.2 ml of 1:10,000 epinephrine to indigo carmine and saline solution of 10 ml, and obtained a final concentration of 1:200,000 or 1:500,000 epinephrine dilute. Another research assistant recorded and assessed the outcome data. The endoscopists, patients and research assistant who recorded the outcomes were blinded to the group allocation to minimize bias.

Procedures

The bowel preparation was performed according to our previous study⁵. The procedures were carried out as previously described⁶. Carbon dioxide was used during the entire procedure. Briefly, the patient was anesthetized by the anesthesiologist using midazolam (5mg) and pethidine (50mg). The epinephrine indigo carmine saline solution was injected into submucosa to lift the colorectal polyps using injector (). The polyps were removed by an electrosurgical snare (MTN-PFS-E-24/23, Micro-Tech, Nanjing, China) and effect 2 (VIO300D, Erbe, German). The defects were completely closed using the endoscopic clips (Micro-Tech, Nanjing, China). Three endoscopists participated in the procedures, who have at least 3 years of operation experience and more than 500 patients of EMR experience.

After awakening from the procedure, a research assistant recorded and assessed patients pain based on 100-mm visual analog scale (VAS) at 30 and 60 minutes after the procedure. Tramadol Hydrochloride Injection could be administered and recorded at the discretion of the anesthesiologist for patients reporting pain. All patients were contacted by telephone for adverse event assessment at 24 to 72 hours post-procedure and again at 14 days. Patients were instructed to receive a liquid diet for 3 days after the procedure.

Outcomes and definitions

The primary outcome was the pain scores at 30 and 60 minutes after the procedure. The second outcomes included the amount of epinephrine dilute, procedural duration, Tramadol Hydrochloride Injection administered, the rates of technical success, *en bloc* resection, R0 resection, intra-procedural bleeding and perforation and post-procedural bleeding and perforation, and post-procedural bleeding according our previous studies⁵⁻⁸.

Sample size

The sample size calculation was based on a previous clinical trial conducted at our hospital with 20 patients in the low-concentration epinephrine group and high-concentration epinephrine group. The pain score was 2.60 ± 0.681 and 3.05 ± 0.605 , respectively. A minimum sample size of 83 was determined to be required, according to α of 0.01, power of 0.05, and a dropout rate of 10% using PASS software.

Statistical analysis

Data are presented as mean $\pm$ standard deviation (SD) or median (interquartile range (IQR)) based on the distribution for continuous variables, and counts and frequencies (%) for categorical variables. The Student's t-test or Mann-Whitney U test was calculated for continuous variables, while the chi-squared test, Fisher's exact test, and Bonferroni method χ^2 test were performed for categorical variables. Additionally. Univariable and multivariable analysis was performed to identify independent predictors for

pain scores. A P value < 0.05 (2-sided) was considered statistical significance. All analyses were performed using the SPSS 23.0 software (SPSS Company, Chicago, IL, USA).

Results

Baseline data and clinical characteristics

Between June 2025 and May 2026, 166 eligible patients with 193 polyps were eligible, and randomly assigned to low-concentration epinephrine group and high-concentration epinephrine group. Of these patients, 3 patients (2 in low-concentration epinephrine group and 1 high-concentration epinephrine group) were schedule cancellation. At last, 81 patients with 92 polyps in low-concentration epinephrine group and 82 patients with 98 polyps in high-concentration epinephrine group were enrolled for intention-to-treat analysis (ITT) analysis. The baseline demographic and characteristics of the recruited patients are available in Table 1. There were no significant differences in baseline characteristics of gender, age, procedure duration, amount of polyp, polyp size, location of polyps, amount of injection, histology and polyp multiplicity between the two study arms ($P = 0.687$, $P = 0.397$, $P = 0.235$, $P = 0.207$, $P = 0.806$, $P = 0.545$, $P = 0.613$, $P > 0.999$, and $P = 0.252$, respectively).

Table 1
Characteristics of participants at baseline.

Characteristics	Low-concentration epinephrine group (N = 81)	High-concentration epinephrine group (N = 82)	P- value
Gender, n (%)			0.687
Male	47 (58%)	44 (54%)	
Female	34 (42%)	38 (46%)	
Age, mean $\pm$ SD	53.4 (14.1)	51.6 (12.6)	0.397
Procedure duration (min), mean (IQR)	10.0 (8.0, 12.0)	10.0 (9.0, 12.0)	0.235
Polyps size (mm), mean (IQR)	16.0 (14.0, 18.0)	16.0 (14.0, 18.0)	0.806
Location of polyps, n (%)	92	98	0.545
Rectum	18 (19.6%)	17 (17.3%)	
Sigmoid colon	26 (28.3%)	31 (31.6%)	
Descending colon	16 (17.4%)	20 (20.4%)	
Transverse colon	22 (23.9%)	19 (19.4%)	
Ascending colon	8 (8.7%)	6 (6.1%)	
Cecum	2 (2.1%)	5 (5.2%)	
Amount of injection (ml), mean (IQR)	3.2 (2.9, 3.7)	3.2 (2.9, 4.0)	0.613
Histology, n (%)			> 0.999
Tubular adenoma	85 (92.4%)	91 (92.9%)	
Adenoma low-grade dysplasia	5 (5.4%)	5 (5.1%)	
Adenoma with villous components	2 (2.2%)	2 (2.0%)	
Polyp multiplicity, n (%)			0.252
Multiple polyps	8 (9.9%)	14 (17%)	
Single polyp	73 (90%)	68 (83%)	
Data are numbers (%) unless stated otherwise. SD, Standard deviation. IQR, Interquartile range.			

Primary outcomes

As Table 2 shown, at 30 minutes post-procedure, the median pain score (IQR) was significantly lower in the low-concentration epinephrine group (3.00 [2.00–3.00]) compared to the high-concentration group (3.00 [3.00–4.00]), with a Hodges-Lehmann estimate of -1.0 (95% CI, -1.0 to -1.0, $P < 0.001$). The distribution of pain scores also differed notably: in the low-concentration group, 47% of patients reported a score of 2 and 37% a score of 3, whereas in the high-concentration group, the majority (57%) had a score of 3, followed by 32% with a score of 4. None of the patients in the low-concentration group had scores ≥ 5 , while 4.9% and 3.7% in the high-concentration group had scores of 5 and 6, respectively.

Table 2
Epinephrine and Pain scores at 30 minutes and 60 minutes

Pain scores at 30 min (Median, IQR)	Low-concentration epinephrine group	High-concentration epinephrine group	Difference ¹	95% CI ¹	p-value ¹
	3.00 (2.00, 3.00)	3.00 (3.00, 4.00)	-1.0	-1.0, -1.0	< 0.001
Pain at 30 min					
2	38 (47%)	2 (2.4%)			
3	30 (37%)	47 (57%)			
4	13 (16%)	26 (32%)			
5	0 (0%)	4 (4.9%)			
6	0 (0%)	3 (3.7%)			
Pain scores at 60 min (Median, IQR)	1.00 (0.00, 2.00)	2.00 (1.00, 2.00)	-1.0	-1.0, 0.00	< 0.001
Pain at 60 min					
0	27 (33%)	6 (7.3%)			
1	32 (40%)	29 (35%)			
2	12 (15%)	41 (50%)			
3	10 (12%)	1 (1.2%)			
4	0 (0%)	3 (3.7%)			
5	0 (0%)	2 (2.4%)			

¹ Data are presented as Median (IQR) or values are n (%) unless otherwise defined. Differences (Hodges-Lehmann estimates) and 95% CIs were calculated using the Wilcoxon rank-sum test.

At 60 minutes, the median pain score was again lower in the low-concentration group (1.00 [0.00–2.00]) than in the high-concentration group (2.00 [1.00–2.00]), with a difference of -1.0 (95% CI, -1.0 to 0.00, $P < 0.001$). At this time point, 33% of patients in the low-concentration group reported no pain (score 0) compared to only 7.3% in the high-concentration group, and 40% versus 35% had a score of 1. Conversely, 50% of the high-concentration group still had a score of 2 at 60 minutes, while only 15% of the low-concentration group did. Scores of 3–5 were rare in both groups but more frequent in the high-concentration arm (Table 2).

Secondary outcomes

Regarding secondary efficacy and safety outcomes (Table 3), no significant differences were observed between the two groups. Procedure duration was similar (10.21 ± 3.27 min vs. 10.67 ± 3.22 min, $P = 0.23$). The use of rescue analgesia (tramadol) was numerically lower in the low-concentration group (2.5% vs. 7.3%), but the difference did not reach statistical significance ($P = 0.28$). Technical success and *en bloc* resection were achieved in 100% of patients in both groups. R0 resection rates were 98% in the low-concentration group and 100% in the high-concentration group ($P = 0.25$). Although the low-concentration group had a higher rate of intraoperative bleeding compared with the high-concentration group (7.4% vs. 6.1%), this difference was not statistically significant ($P = 0.98$). Postoperative bleeding rates were identical (1.2% vs. 1.2%, $P > 0.99$). No intraoperative or postoperative perforations occurred in either group ($P > 0.99$).

Table 3
Efficacy and safety outcomes of Low-concentration epinephrine or High-concentration

Procedure duration (min)	Low-concentration epinephrine group ¹	High-concentration epinephrine group ¹	p-value ²
	10.21 (± 3.27)	10.67 (± 3.22)	0.23
Tramadol Hydrochloride Injection use, n (%)	2 (2.5%)	6 (7.3%)	0.28
Technical success, n (%)	81 (100%)	82 (100%)	> 0.99
En bloc resection, n (%)	81 (100%)	82 (100%)	> 0.99
R0 resection, n (%)	79 (98%)	82 (100%)	0.25
Intra-procedural bleeding, n (%)	6 (7.4%)	5 (6.1%)	0.98
Post-procedural bleeding, n (%)	1 (1.2%)	1 (1.2%)	> 0.99
Intra-procedural perforation, n (%)	0 (0%)	0 (0%)	> 0.99
Post-procedural perforation, n (%)	0 (0%)	0 (0%)	> 0.99
1 Mean (± SD); n (%)			
2 Wilcoxon rank sum test; Fisher's exact test; Pearson's Chi-squared test			

Factors associated with pain scores

To identify independent predictors of clinically significant postprocedural pain (pain score ≥ 4 at 30 min), univariable and multivariable logistic regression analyses were performed (Table 4).

Table S1
Definitions of Study Outcomes and scores

Category	Outcome/Parameter	Definition and Criteria
Resection Efficacy	Technical Success	Complete macroscopic removal of the neoplastic tissue during the procedure, as assessed by the endoscopist using high-definition white light and narrow-band imaging.
	En bloc Resection	Resection of the polyp in a single, macroscopic piece.
	R0 Resection	An en bloc resection with both horizontal and vertical margins confirmed to be free of neoplastic tissue upon pathological examination.
Safety & Complications	Intra-procedural Bleeding	Bleeding occurring during the procedure that persists for more than 30 seconds or requires immediate endoscopic intervention
	Delayed Bleeding	Any evidence of hematochezia or melena occurring after the completion of the procedure up to 14 days, necessitating emergency department visit, hospitalization, or repeat endoscopy.
	Delayed Perforation	Presence of free air on abdominal imaging or clinical signs of peritonitis
Pain Assessment	VAS Pain Score	A 100-mm Visual Analog Scale where 0 represents "no pain" and 100 represents "the most severe pain imaginable."
	Grade Criteria	
Other Parameters	Procedure Duration	The time interval from the initial submucosal injection to the final application of the last endoscopic clip.

Table 4
Logistic regression analysis associated the factors with pain scores.

Characteristic ¹	Univariate Analysis ²			Multivariate Analysis ³		
	OR	95% CI	P-value	OR	95% CI	P-value
Groups			< 0.001			< 0.001
Low group	Ref	Ref		Ref	Ref	
High group	3.52	1.71, 7.59		3.82	1.74, 8.93	
Gender			0.643			
Male	Ref	Ref				
Female	0.85	0.42, 1.69				
Ages	1.01	0.99, 1.04	0.379			
Max Polyp size	1.03	0.91, 1.17	0.628			
Amount of injection	1.6	1.27, 2.09	< 0.001	1.44	1.06, 2.03	0.018
Procedure duration	1.25	1.11, 1.42	< 0.001	1.09	0.92, 1.30	0.30
1 The dependent variable (pain) was dichotomized, defined as a pain score (at 30s min) > = 4 indicating clinically significant pain, and < 4 indicating no/mild pain.						
2 Variables including polyp multiplicity, location of max polyp, and histology were excluded from this analysis due to complete separation						
3 The multivariate logistic regression model was adjusted for covariates that demonstrated a potential association in the univariate analysis, including groups, amount of injection, and procedure duration.						

In the univariable analysis, three factors were significantly associated with higher pain scores: high-concentration epinephrine group (OR = 3.52, 95% CI: 1.71–7.59, $P < 0.001$), greater amount of injection (OR = 1.60, 95% CI: 1.27–2.09, $P < 0.001$), and longer procedure duration (OR = 1.25, 95% CI: 1.11–1.42, $P < 0.001$). Gender, age, and maximum polyp size showed no significant associations (Table 3).

In the multivariable analysis adjusting for group allocation, amount of injection, and procedure duration, both high-concentration epinephrine (OR = 3.82, 95% CI: 1.74–8.93, $P < 0.001$) and greater amount of injection (OR = 1.44, 95% CI: 1.06–2.03, $P = 0.018$) remained independent predictors of clinically significant pain. Procedure duration was no longer significant ($P = 0.30$).

Discussion

In this randomized, double-blind controlled trial comparing low- (1:500,000) with high-concentration (1:200,000) epinephrine in the submucosal injectate for EMR of 10–20 mm non-pedunculated colorectal

polyps, we found that using a low epinephrine concentration significantly reduced postprocedural pain at both 30 and 60 min, without compromising key efficacy measures (technical success, *en bloc* and R0 resection) or increasing the rates of bleeding. Multivariable analysis confirmed that the high-concentration epinephrine group and a larger volume of injected fluid were independent predictors of clinically significant pain scores. These results extend the previous observation by Rex *et al.* that adding epinephrine (1:200,000) to the injectate increases postprocedural pain compared with no epinephrine, by demonstrating that a five-fold further dilution (1:500,000) can substantially reduce discomfort while preserving the hemostatic and safety profile of the procedure³. Our findings therefore provide a practical strategy to optimize the epinephrine concentration in the submucosal lifting solution, balancing the well-recognized benefit of vasoconstriction against the clinically relevant goal of improving patient comfort and potentially shortening recovery room stay after colorectal EMR.

The epinephrine dilute is often added to the submucosal lifting solution, aiming to induce vasoconstriction, and decrease the intra- and post- bleeding. Recently, Yip HC *et al.* found the addition of diluted epinephrine to the injection solution significantly reduced the number of intraprocedural hemorrhages requiring hemostatic forceps compared to without diluted epinephrine⁹. Moreover, European Society of Gastrointestinal Endoscopy (ESGE) suggested that injection with 1:10,000 diluted epinephrine can reduce the risk of complications for the removal of colorectal polyps larger than 10 mm². Katagiri A *et al.* found that the time required to cessation of immediate bleeding was significantly shorter in cold EMR with 1:100,000 diluted epinephrine added saline submucosal injection than saline alone for colorectal polyp ≤ 10 mm¹⁰. Additionally, Dobrowolski S *et al.* demonstrated that the intra-procedural bleeding rate was significantly decreased compared 1:10,000 diluted epinephrine submucosal injection than saline alone during EMR removing colorectal polyp ≥ 10 mm (2% vs. 16%)¹¹. However, Yamaguchi D *et al.* reported that there were no significant differences in complications, such as intra- and post- EMR bleeding (7.5% vs. 2.5%, $P = 0.28$ and 8.8% vs. 3.8%, $P = 0.33$, respectively) comparing 1:10,000 epinephrine solution with hypertonic saline submucosal injection in colorectal polyps with sizes 10 mm – 20 mm for the patients taking antithrombotic agents¹². In this study, we discovered that the intraprocedural bleeding rate was numerically higher comparing low- (1:500,000) with high-concentration (1:200,000) epinephrine (7.4% vs. 6.1%), but this difference was not statistically significant ($P = 0.98$). Postprocedural bleeding rates were identical (1.2% vs. 1.2%, $P > 0.99$). Unlike most prior studies that compared epinephrine (often at 1:10,000 to 1:100,000) with saline or other agents, our trial was the first to directly compare two epinephrine concentrations for hemostatic efficacy in the same setting. Furthermore, while higher concentrations (e.g., 1:10,000) have been shown to significantly reduce bleeding compared with saline, our findings suggested that for 10–20 mm non-pedunculated polyps, further diluting epinephrine from 1:200,000 to 1:500,000 did not result in a statistically significant increase in intraprocedural bleeding, and postprocedural bleeding remains equally low. Thus, from a hemostatic perspective, 1:500,000 epinephrine appeared to provide comparable safety to 1:200,000 in this polyp size category.

Normally, the submucosal injection of epinephrine solution resulting in abdominal pain is overlooked, which may be related with epinephrine-induced intestinal ischemia. It has found that although submucosal injection of 1:200,000 diluted epinephrine is commonly decreased intraprocedural bleeding, pain scores are significantly increased at 30 and 60 min post-procedure and experienced longer recovery times compared to those who received injectate without epinephrine when EMR removing colorectal polyps larger than 20 mm³. These results highlight a trade-off between the perceived hemostatic benefit of epinephrine and its clinically relevant impact on patient discomfort and recovery. In this study, we found that using a five-fold more dilute epinephrine concentration (1:500,000) achieved comparable hemostatic efficacy to the standard 1:200,000 dilution, as evidenced by similar intraprocedural bleeding rates (7.4% vs. 6.1%, $P = 0.98$) and identical postprocedural bleeding rates (1.2% vs. 1.2%, $P > 0.99$). Notably, the low epinephrine concentration group experienced significantly less postprocedural pain at both 30 and 60 minutes. Thus, by simply reducing the epinephrine concentration from 1:200,000 to 1:500,000, we were able to dissociate the hemostatic benefit from the pain-inducing effect, thereby resolving the trade-off. This finding was particularly relevant for the routine clinical setting where most polyps were 10–20 mm, as it offered a simple, no-cost modification to the injection solution that improved patient comfort without sacrificing safety or efficacy. In addition, the logistic regression analyses further confirmed that only high-concentration epinephrine (OR = 3.82, 95% CI: 1.74–8.93, $P < 0.001$) and injection volume (OR = 1.44, 95% CI: 1.06–2.03, $P = 0.018$) independently drove the increase in postprocedural pain.

This study had several strengths. First, to our knowledge, it was the first randomized, double-blind controlled trial to directly compare two clinically relevant low concentrations of epinephrine (1:200,000 vs. 1:500,000) in the submucosal injectate for colorectal EMR. Second, the double-blind design (patients and outcome assessors) minimized performance and detection bias. Third, the inclusion of multivariable logistic regression allowed us to isolate the independent effect of epinephrine concentration from potential confounders such as injection volume and procedure duration.

However, several limitations should be acknowledged. First, this was a single-center study performed by experienced endoscopists, which may limit extrapolation to lower-volume centers or less experienced operators. Second, the sample size, although adequate for the primary pain outcome, was not powered to detect small differences in rare adverse events such as perforation or delayed bleeding. Third, we only enrolled polyps sized 10–20 mm; therefore, our findings may not be generalizable to smaller or larger lesions (e.g., > 20 mm or < 10 mm). Fourth, we did not assess the optimal epinephrine concentration below 1:500,000; whether further dilution (e.g., 1:1,000,000) could achieve even less pain while preserving hemostasis remains unknown. Fifth, the follow-up period was limited to 14 days, and we did not capture long-term outcomes such as recurrence rate. Despite these limitations, our findings provide a practical, no-cost strategy to improve patient comfort after EMR removing colorectal polyps sized 10–20 mm.

In conclusion, this randomized, double-blind trial directly comparing two epinephrine concentrations for colorectal EMR showed that a five-fold dilution from 1:200,000 to 1:500,000 significantly reduces

postprocedural pain scores at 30 and 60 min, while maintaining equivalent hemostatic efficacy and safety. For the common clinical scenario of 10–20 mm non-pedunculated polyps, using 1:500,000 epinephrine in the submucosal injectate offers a simple, no-cost strategy to improve patient comfort without compromising procedural outcomes.

Declarations

Conflict of interest

The authors declare no competing interests.

Ethical approval

The study complied with the Declaration of Helsinki, was approved by ethics committees (Ethics Committee of Shenzhen People's Hospital. ID:LL-KY-2025053-01).

Consent to participate

Written informed consent was obtained from all individual participants included in the study.

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Author Contribution

D-F L and JY: conception and design. M-H L and Y-F Y: material preparation, data collection, drafting of the manuscript and statistical analysis. Y L, Z-Y Z, L-S W, J Y and D-F L performed endoscopic procedures. All authors read and approved the final manuscript.

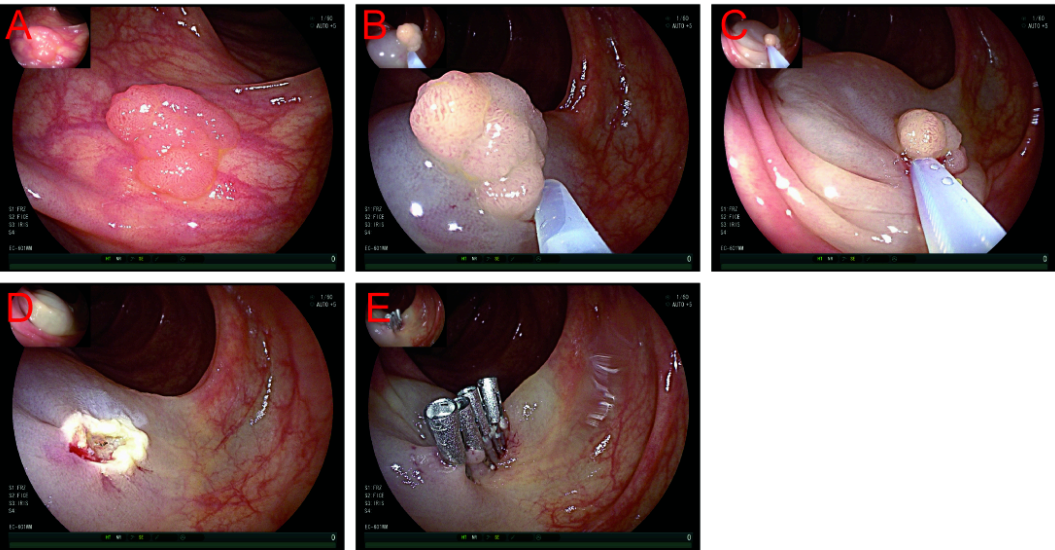
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Figures

Low-concentration
epinephrine group



High-concentration
epinephrine group

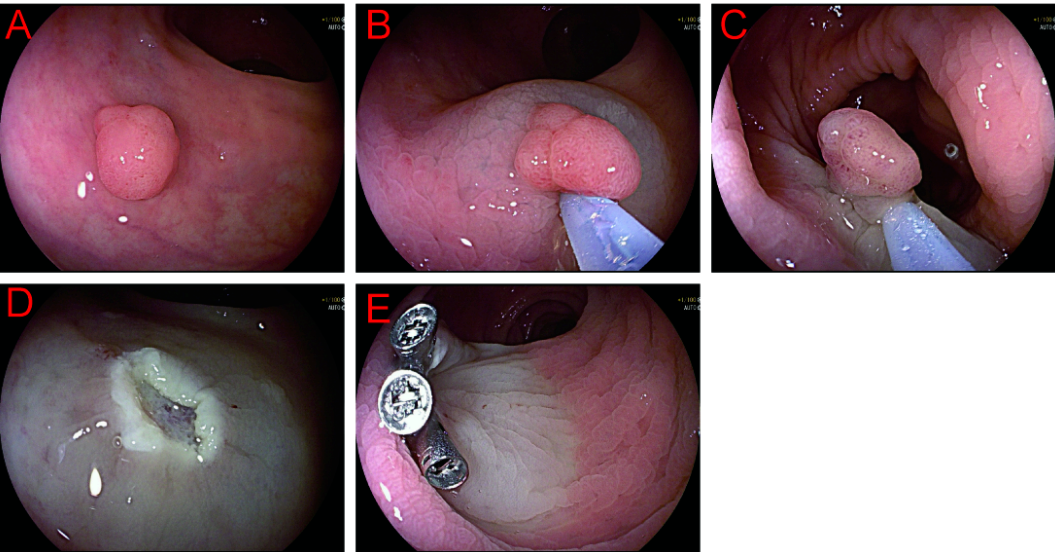


Figure 1

Legend not included with this version.

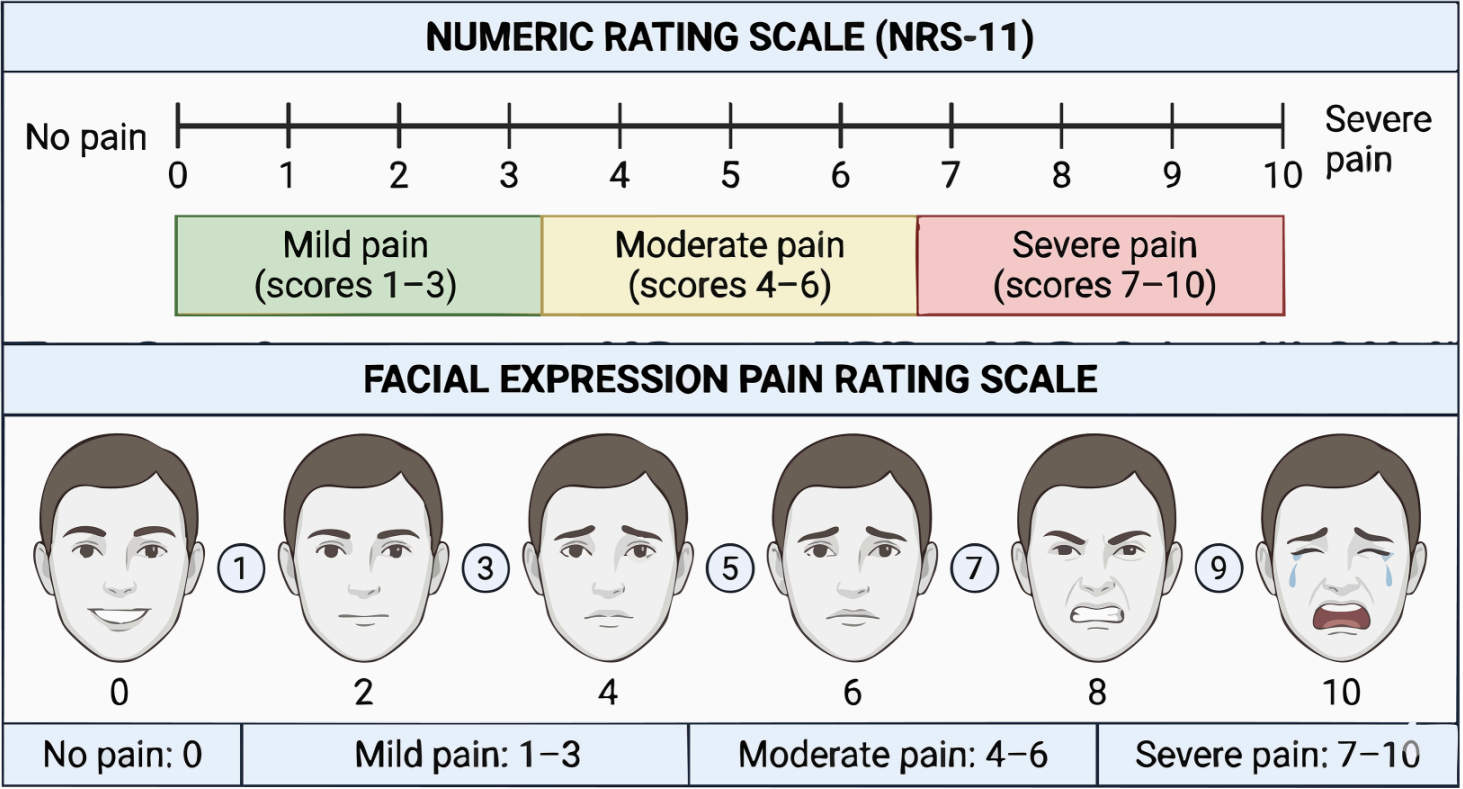


Figure 2

Legend not included with this version.