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Original Article

Effect of transcutaneous electrical acupoint stimulation at Zusanli (ST36) on postoperative pain following mixed hemorrhoidectomy: a retrospective study

Qiyao Ma[1], Bo Zhang[2], Yanni Chen[1], Hao Chen[1], Xiaotao Hou[1], Rui Zhang[1], Zongyu Li[1]

[1]*Proctology Department, Zhongda Hospital Southeast University (Jiangbei), Nanjing 210048, Jiangsu, China;*
[2]*Proctology Department, Zhongda Hospital Southeast University, Nanjing 210009, Jiangsu, China*

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Abstract: Background: Post-hemorrhoidectomy affects patient rehabilitation. This study evaluated the auxiliary effect of transcutaneous electrical acupoint stimulation (TEAS) at Zusanli acupoint (ST36) on the analgesic effect of conventional non-steroidal anti-inflammatory drugs (NSAIDs). Methods: 185 patients undergoing hemorrhoidectomy were retrospectively enrolled and allocated to TEAS (95 cases receiving TEAS at ST36 post-operation) and control (90 cases receiving postoperative sham stimulation) groups. The two cohorts were comparatively assessed for pain (at rest and during defecation with the Visual Analogue Scale [VAS]), gastrointestinal function, recovery indices, gastrointestinal hormone levels, stress-induced inflammatory markers (cortisol [Cor], C-reactive protein [CRP], interleukin-6 [IL-6]), adverse events, and patient satisfaction. Finally, the correlation of the decrease in Cor, CRP, and IL-6 levels with the improvement of VAS scores and the gastrointestinal function recovery time was evaluated. Results: In the TEAS group, postoperative pain was significantly reduced relative to the control group, together with accelerated gastrointestinal function and postoperative recovery, greater improvement of gastrointestinal hormone levels, higher patient satisfaction, and lower Cor, CRP, and IL-6 concentrations. The groups were similar in the adverse event rate. ΔCor/ΔCRP was primarily related to the relief of resting pain and gastrointestinal recovery, while ΔIL-6 was mainly associated with defecation pain alleviation and gastrointestinal recovery. Conclusion: Auxiliary TEAS at ST36 can safely and effectively enhance the analgesic effect of NSAIDs following hemorrhoidectomy and promote rehabilitation outcomes. Serum Cor, CRP, and IL-6, with dynamic changes in patients, are potential reference indexes for curative effect monitoring.

Keywords: Transcutaneous electrical acupoint stimulation, Zusanli, hemorrhoidectomy, postoperative pain, ketorolac tromethamine, non-opioid multimodal analgesia

Introduction

Hemorrhoids, which involve pathological changes and distal prolapse of the hemorrhoidal tissue, affect nearly 40% of adults. Approximately 10 million people suffer from the disease in the United States [1, 2]. Rectal bleeding, anal swelling, a sensation of a foreign body or pain, local discharge, or itching, compromises the quality of life [3]. Mixed hemorrhoids are a predominant clinical type characterized by anatomical fusion of internal and external hemorrhoidal vascular plexuses. It is prone to recurrent blood loss, which may trigger substantial anemia, threatening overall health [4]. There are two primary management pathways for mixed hemorrhoids: conservative therapy for mild manifestations, and surgical resection (hemorrhoidectomy) for pronounced symptoms [5]. Mixed hemorrhoidectomy generally results in intense postoperative pain, primarily due to muscle spasm and location (in a highly somatosensitive area). Effective non-opioid pain management is crucial for early mobilization, prevention of complications, and improvement in patient satisfaction [6].

Non-opioid analgesic agents and techniques with distinct mechanisms of action are integrated in multimodal analgesia, which is the standard of care to optimize pain management while avoiding adverse effects related to the

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use of opioid [7, 8]. Non-steroidal anti-inflammatory drugs (NSAIDs) (e.g., ketorolac tromethamine), as the cornerstone of this approach, exerts potent analgesic effects by suppressing prostaglandin synthesis at the surgical site [9]. Transcutaneous electrical acupoint stimulation (TEAS) is a non-invasive modality generally used in combination with pharmacological analgesia. This technique modulates pain perception by releasing endogenous neurotransmitters and activating the descending inhibitory pathways through electrical current to specific acupoints [10]. The Zusanli (ST36) acupoint has broad effects on pain relief, anti-inflammation, and gastrointestinal function, is therefore selected as a target [11]. However, its specific role as an adjunct to a purely NSAID-based regimen for post-hemorrhoidectomy pain is not well-established.

This study was designed to observe the effect of combining TEAS at ST36 with scheduled intravenous ketorolac on postoperative pain outcomes following mixed hemorrhoidectomy.

Methods

Study design and patients

This retrospective study was approved by the Ethics Committee of Zhongda Hospital Southeast University (JIANGBEI). 185 adults who underwent mixed hemorrhoidectomy under general or spinal anesthesia (April 2023-April 2024) were categorized according to the intervention administered. The TEAS group (n=95) received TEAS at ST36 postoperatively, and the control group (n=90) underwent electrode placement without active stimulation. Both groups received identical background analgesia with intravenous ketorolac tromethamine. The study participants were selected based on the specified criteria.

Subjects were included if they: were diagnosed with mixed hemorrhoids [12]; were at least 18 years old; were appropriate candidates for standard intravenous ketorolac tromethamine analgesia and for general or spinal anesthesia; presented no contraindications to the research intervention; were undergoing the initial treatment for this condition; had not taken drugs that could confound the study findings in the last six months; had no record of surgery in the preceding six months; had complete clinical data.

Subjects were excluded if they: had concomitant perianal or intestinal diseases (e.g., abscess, fistula, intestinal tuberculosis); exhibited severe functional impairment of major organs; were pregnant or lactating; had dermatological issues (e.g., allergy, eczema, breach of skin), making TEAS at ST36 inadvisable; had a previous history of psychiatric disorders, chronic pain conditions, or substance misuse; or were diagnosed with a malignant tumor.

Intervention and analgesic protocol

All patients received a standardized non-opioid analgesic protocol: intravenous ketorolac tromethamine 30 mg at the end of surgery and then every 8 hours for the first 48 hours postoperatively as baseline analgesia.

TEAS group: Immediately postoperatively, electrodes were placed at bilateral ST36 acupoints. Stimulation was applied for 30 minutes using a mixed frequency (2/100 Hz, pulse width: sparse wave: 0.5 ms, dense wave: 0.2 ms) at an intensity producing comfortable paresthesia without muscle twitching. As to ST36, it is mainly located in the anterolateral side of the calf, 3 inches below the Dubi acupoint, and a horizontal finger (middle finger) outside the anterior crest of the tibia. Determined by the patient's sensation, the stimulation intensity was gradually increased from 0 mA until a clear feeling of comfort and persistent numbness or slight tremor, but without the perception of pain or muscle twitching (typical intensity range: 8-15 mA). Starting from the postoperative period, a 48-hour TEAS intervention was carried out. The specific plan was as follows: treatment was conducted twice daily at fixed time points (like 8:00 and 16:00), with each session lasting for 30 minutes.

Control group: Electrodes were placed at ST36 but no electrical stimulation was delivered (sham TEAS). Operated by the same research nurse, the same type of electrode pads were pasted on the control patients at the same position (bilateral ST36), which were connected to an electrical stimulator resembling the appearance of the one used in the TEAS gro-

up. The instrument was preset to output an extremely weak current only within the initial 30 seconds; the intensity was ≤ 2 mA, with which the patient could only experience a slight sensation at the moment of startup without electrical stimulation thereafter. After that, the instrument automatically stopped outputting, but the instrument screen remained in working condition. The total treatment course of electrode application, the treatment frequency (twice a day), and the duration of each application (30 minutes) in the control group were all strictly consistent with those in the TEAS group. This allowed for the maximum simulation of the operation experience of the TEAS group while eliminating specific electrical stimulation effects, thereby effectively controlling the placebo effect.

For breakthrough pain (VAS > 4), a supplemental intravenous dose of ketorolac tromethamine (15 mg) was available as rescue analgesia, with a minimum 4-hour interval between doses.

Outcome measures

Postoperative analgesia efficacy [13]. Evaluation criteria: Markedly effective: no or minimal pain during wound care, dressing changes, and defecation. Satisfactory: manageable pain during these activities, not necessitating medication. Ineffective: moderate or severe pain at the wound site, exacerbated during dressing changes/defecation, necessitating opioid or non-opioid analgesics for control. The total effectiveness rate was the proportion of patients in the Markedly effective and Effective categories.

Pain intensity [14]. Using the Visual Analogue Scale (VAS; 0-10, where higher scores denote greater pain), the pain levels of both patient groups were compared. Evaluations were conducted at rest and during defecation at 6, 12, 24, and 48 hours after surgery.

Gastrointestinal function restoration. Time to bowel sound return and time to first flatus were recorded.

Postoperative recovery metrics. Time to wound healing, complete slough detachment, and initial ambulation was tracked.

Clinical parameters. Total supplemental doses of ketorolac and overall hospital stays were documented.

Gastrointestinal function-associated indices. Using radioimmunoassay, 2-mL venous blood samples were collected from each patient's antecubital vein to determine vasoactive intestinal peptide (VIP), motilin (MTL), and gastrin (GAS) levels. Measurements were taken before surgery and on postoperative day 1 in both study groups.

Serum stress and inflammation markers. Before and 1 day after surgery, serum samples obtained from patients were analyzed for cortisol (Cor), C-reactive protein (CRP), and interleukin-6 (IL-6) levels. The enzyme-linked immunosorbent assay (ELISA) was applied for the measurement of Cor and IL-6, and the immunoturbidimetric assay for CRP.

Adverse events. The patients were monitored for nausea, vomiting, dizziness, and local skin irritation. The frequency and incidence of these events were summarized.

Patient satisfaction [15]. Patient satisfaction was evaluated using a 100-point survey. The evaluation items covered four core dimensions, each scored 25 points: pain control effect, rehabilitation process speed, nursing service quality, and nurse-patient communication efficacy. The total score was obtained by summarizing the scores of the items, with a score of > 85 deemed "Very Satisfied", 70-84 "Satisfied", 55-69 "Neutral", and < 55 "Dissatisfied". The satisfaction rate was the proportion of "Very Satisfied" plus "Satisfied" respondents.

Of the above outcome measures, postoperative analgesia efficacy, pain intensity, clinical parameters, and adverse events served as primary endpoints, while the others were secondary.

Statistical analysis

Data were analyzed using SPSS software. Following Shapiro-Wilk test-based normality testing, continuous data are represented as the mean ± SD (normal distribution) or the median (interquartile range, M [Q1, Q3]; non-normal distribution). Continuous data were

Table 1. Patient baseline characteristics (n = 185)

Characteristic	TEAS Group (n = 95)	Control Group (n = 90)	χ^2/t/Z-value	*P*-value
Age (years)	45.38±6.49	44.83±7.88	0.519	0.604
Gender (M/F)	48/47	50/40	0.469	0.493
BMI (kg/m^2)	24.00 (23.00, 26.00)	24.00 (22.75, 26.00)	-0.334	0.738
Anesthesia type (GA/SA)	42/53	47/43	1.188	0.276
Duration of surgery (min)	35.63±6.19	35.87±6.75	0.252	0.801

Notes: The data are expressed as mean ± standard deviation or number of cases. BMI: body mass index; GA: general anesthesia; SA: spinal anesthesia (lumbar anesthesia); TEAS: transcutaneous electrical acupoint stimulation.

Table 2. Postoperative pain relief outcomes

Category	TEAS Group (n = 95)	Control Group (n = 90)	χ^2-value	*P*-value
Markedly effective	50 (52.63)	34 (37.78)		
Effective	36 (37.89)	34 (37.78)		
Ineffective	9 (9.47)	22 (24.44)		
Overall efficacy	86 (90.53)	68 (75.56)	7.426	0.006

Notes: TEAS: transcutaneous electrical acupoint stimulation.

Table 3. Postoperative VAS pain scores at rest and during defecation

Indicators	TEAS Group (n = 95)	Control Group (n = 90)	Z-value	*P*-value
VAS at rest (score)				
6 hours	3.00 (3.00, 4.00)	5.00 (4.00, 5.00)	-7.460	< 0.001
12 hours	3.00 (2.00, 3.00)	4.00 (3.00, 5.00)	-8.207	< 0.001
24 hours	2.00 (2.00, 3.00)	4.00 (3.00, 5.00)	-9.503	< 0.001
48 hours	2.00 (1.00, 2.00)	2.00 (2.00, 3.00)	-5.368	< 0.001
VAS during defecation (score)				
6 hours	5.00 (5.00, 6.00)	7.00 (6.00, 8.00)	-7.891	< 0.001
12 hours	5.00 (4.00, 5.00)	6.00 (5.00, 7.00)	-6.363	< 0.001
24 hours	4.00 (3.00, 5.00)	6.00 (5.00, 7.00)	-9.375	< 0.001
48 hours	3.00 (3.00, 4.00)	5.00 (4.00, 5.00)	-6.984	< 0.001

Note: VAS: Visual Analogue Scale; TEAS: transcutaneous electrical acupoint stimulation.

compared using Student's t-test (for normally distributed data) or Mann-Whitney U test (for those with a non-normal distribution); within-group differences pre- and post-treatment were examined by paired t-tests. Categorical data were compared between the groups using the Chi-square test or Fisher'sexact test (when the frequency was < 5). A *P*-value < 0.05 was considered statistically significant.

Results

Patient characteristics

Demographic data (age, gender, BMI, type of anesthesia, and duration of surgery) were comparable between the two groups (P > 0.05, **Table 1**).

Postoperative analgesia efficacy

In the evaluation of postoperative pain control, the overall effectiveness of pain relief was greater in patients receiving TEAS than that in controls (90.53% vs. 75.56%; P = 0.006; **Table 2**).

Pain scores

Patients in the TEAS group reported significantly lower VAS scores both at rest and during defecation at 6, 12, 24, and 48 hours postopera-

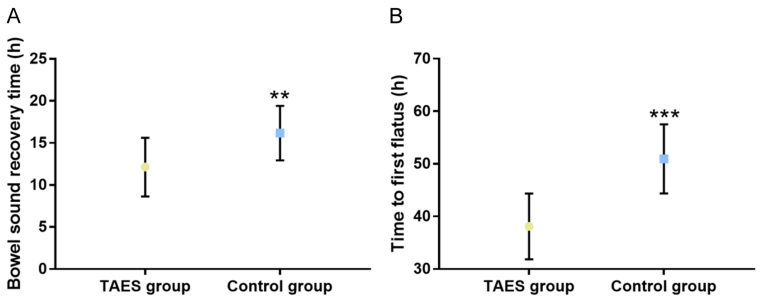

Figure 1. Intergroup comparison of gastrointestinal function restoration. A. Bowel sound recovery time. B. Time to first flatus. Note: **P < 0.01, ***P < 0.001 versus control group. TEAS, transcutaneous electrical acupoint stimulation.

tively compared to the control group (all P < 0.05, **Table 3**).

Gastrointestinal function restoration

Compared with controls, the TEAS group showed significantly accelerated recovery of bowel sounds and earlier flatus (P < 0.05, **Figure 1**).

Postoperative recovery

According to postoperative recovery analysis, the durations required for wound healing, complete slough detachment, and initial ambulation were significantly shortened in the TEAS group (P < 0.05 versus controls, **Figure 2**).

Clinical parameters

A marked reduction in total supplemental ketorolac doses and a shorter hospital stay were observed in the TEAS group versus controls, with both differences being statistically significant (P < 0.001, **Table 4**).

Gastrointestinal function-associated indices

The two groups showed similar baseline measurements for VIP, MTL, and GAS (P > 0.05). Post-intervention, increases in VIP and GAS and a decrease in MTL were observed in both groups (P < 0.05). The TEAS group, however, had lower VIP and GAS, and higher MTL, compared to controls (P < 0.05; **Table 5**).

Serum stress and inflammatory markers

There were no significant differences in baseline measurements of Cor, CRP, and IL-6 between the two groups (P > 0.05). After intervention, all indicators increased significantly in both groups (P < 0.05). Notably, the levels of all indicators were lower in the TEAS group compared to the control group (P < 0.001; **Table 6**).

Adverse events

Evaluation of the two treatments showed comparable clinical safety. The incidence of adverse events (nausea, vomiting, dizziness, local skin irritation) was equivalent between the TEAS and control groups (P > 0.05, **Table 7**).

Patient satisfaction

Patient satisfaction analysis demonstrated a statistically higher overall satisfaction rate in the TEAS group versus the control group (P < 0.05, **Table 8**).

Correlation of the decrease in Cor, CRP, and IL-6 levels with the improvement of VAS scores and the recovery time of gastrointestinal function

Through correlation analysis, we found that ΔCor and ΔCRP were negatively correlated with ΔVAS at Rest (P < 0.01), while showing a positive association with the bowel sound recovery time and the time to first flatus (P < 0.001); however, they did not correlate with ΔVAS during Defecation (P > 0.05). ΔIL-6 exhibited an inverse relationship with ΔVAS during defecation (P < 0.001), and a positive correlation with bowel sound recovery time and exhaust time (P < 0.001), but with no marked link with ΔVAS at rest (P > 0.05, **Table 9**).

Discussion

Pain is a major concern post mixed hemorrhoidectomy, impacting 75% of patients, with up to 80% reporting moderate-to-severe levels [16]. Such pain has adverse effects on recovery, wound healing, and daily functioning [17]. Therefore, improved pain management and the development of safe, non-drug therapies are required for relief [18].

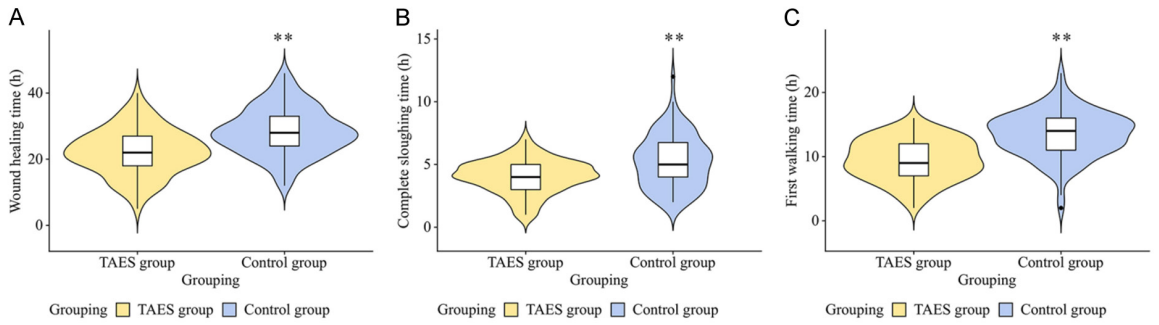

Figure 2. Comparative analysis of postoperative recovery. A. Wound healing time. B. Duration until complete slough detachment. C. Time to first ambulation. Note: **P < 0.01 vs. control group. TEAS, transcutaneous electrical acupoint stimulation.

Table 4. Clinical parameters

Outcome Measure	TEAS Group (n = 95)	Control Group (n = 90)	Z-value	*P*-value
Total supplemental ketorolac doses (number)	2.00 (1.00, 2.00)	3.00 (2.00, 4.00)	-7.787	< 0.001
Hospital stay (d)	6.00 (5.00, 6.00)	7.00 (6.00, 7.00)	-6.458	< 0.001

Note: TEAS: transcutaneous electrical acupoint stimulation.

Table 5. Intergroup comparison of gastrointestinal function-associated indices

Indicators	TEAS Group (n = 95)	Control Group (n = 90)	t-value	*P*-value
VIP (pg/mL)				
Pre-intervention	110.58±19.96	115.17±21.65	1.500	0.135
Post-intervention	183.09±37.53*	209.39±35.27**	4.905	< 0.001
MTL (pg/mL)				
Pre-intervention	176.53±22.76	171.33±21.04	1.611	0.109
Post-intervention	159.19±43.28*	129.24±34.03**	5.213	< 0.001
GAS (pg/mL)				
Pre-intervention	46.05±9.34	44.73±8.04	1.028	0.306
Post-intervention	114.33±28.58*	148.98±35.13**	7.377	< 0.001

Note: *P < 0.05, **P < 0.01 vs. pre-intervention within the group. VIP, vasoactive intestinal peptide; MTL, motilin; GAS, gastrin; TEAS, transcutaneous electrical acupoint stimulation.

Table 6. Intergroup comparison of serum stress and inflammatory markers

Indicators	TEAS Group (n = 95)	Control Group (n = 90)	t-value	*P*-value
Cor (μg/L)				
Pre-intervention	175.03±36.28	166.23±32.75	1.729	0.086
Post-intervention	378.88±68.47*	497.84±77.97**	11.041	< 0.001
CRP (mg/L)				
Pre-intervention	8.76±2.68	8.03±2.99	1.751	0.082
Post-intervention	36.49±11.37*	55.69±11.09**	11.618	< 0.001
IL-6 (ng/L)				
Pre-intervention	11.39±3.65	11.76±4.21	0.640	0.523
Post-intervention	65.26±16.35*	89.87±20.80**	8.972	< 0.001

Note: *P < 0.05, **P < 0.01 vs. pre-intervention within the group. Cor, cortisol; CRP, C-reactive protein; IL-6, interleukin-6; TEAS, transcutaneous electrical acupoint stimulation.

Table 7. Incidence of adverse events

Adverse Event	TEAS Group (n = 95)	Control Group (n = 90)	χ^2/Fisher's-value	*P*-value
Nausea	12 (12.63%)	14 (15.56%)	0.327	0.567
Vomiting	3 (3.16%)	7 (7.78%)		0.204
Dizziness	7 (7.37%)	4 (4.44%)		0.538
Local skin irritation	5 (5.26%)	3 (3.33%)		0.721

Note: TEAS, transcutaneous electrical acupoint stimulation.

Table 8. Patient satisfaction ratings across the study cohorts

Satisfaction	TEAS Group (n = 95)	Control Group (n = 90)	χ^2-value	*P*-value
Very satisfied	38 (40.00)	23 (25.56)		
Satisfied	28 (29.47)	23 (25.56)		
Neutral	19 (20.00)	20 (22.22)		
Dissatisfied	10 (10.53)	24 (26.67)		
Total satisfaction	85 (89.47)	66 (73.33)	8.026	0.005

Note: TEAS, transcutaneous electrical acupoint stimulation.

Table 9. Correlation analysis results

Indicators	ΔVAS at Rest (score)	ΔVAS during Defecation (score)	Bowel sound recovery time (h)	Time to first flatus (h)
ΔCor (μg/L)	r = -0.250, P < 0.001	r = -0.122, P = 0.098	r = 0.319, P < 0.001	r = 0.405, P < 0.001
ΔCRP (mg/L)	r = -0.221, P = 0.003	r = -0.110, P = 0.135	r = 0.369, P < 0.001	r = 0.514, P < 0.001
ΔIL-6 (ng/L)	r = -0.120, P = 0.102	r = -0.280, P < 0.001	r = 0.273, P < 0.001	r = 0.303, P < 0.001

Note: Cor, cortisol; CRP, C-reactive protein; IL-6, interleukin-6; VAS, Visual Analogue Scale.

In the present study, superior analgesia following mixed hemorrhoidectomy was achieved by TEAS at ST36 combined with intravenous ketorolac. The combined approach significantly decreased pain scores across all postoperative intervals (6, 12, 24, and 48 hours) compared to controls, proving that TEAS and NSAIDs acted synergistically through distinct mechanisms. Ketorolac acts predominantly peripherally through inhibiting cyclooxygenase (COX) enzymes and reducing the synthesis of inflammatory prostaglandins at the surgical site [9]. TEAS acts centrally by stimulating the release of endogenous opioids (e.g., endorphins) and serotonin, and by modulating pain signals in the spinal cord and brain [10, 19]. When the peripheral anti-inflammatory action and central neuromodulation are combined, a more comprehensive and effective non-opioid analgesic strategy is therefore developed. Huang et al. [20] demonstrated that in colorectal cancer patients undergoing laparoscopic resection, TEAS at ST36 effectively alleviated postoperative pain at 48 hours and accelerated gastrointestinal function restoration, consistent with our study findings.

Moreover, TEAS at ST36 reduced the time to bowel sound return and first flatus, improved wound healing, promoted slough detachment, and enabled earlier ambulation, therefore accelerating postoperative recovery. These effects may be mediated through the preservation of interstitial cells of Cajal and activation of vagal and parasympathetic pathways, which enhance gastrointestinal motility [21, 22]. These findings are consistent with a previous study by Kao et al. [23], in which electroacupuncture at ST36 also improved postoperative gastrointestinal function and shortened the time to first flatus and defecation. Greater treatment efficiency was observed in patients treated with TEAS, as evidenced by fewer supplemental ketorolac doses and shorter hospital stays. It is believed that non-invasive stimulation delivered by TEAS at acupoints via surface electrodes inhibits pain signaling, strengthens local blood circulation, and improves immunity and anti-inflammatory meta-

bolic activity, therefore achieving the effects above. TEAS also facilitateed rapid analgesic effects through these multifaceted mechanisms [24]. In a study by Wang et al. [24], TEAS reduced pain following surgery and analgesic requirements, consistent with the current study. It was found that TEAS at ST36 stabilized critical gastrointestinal hormones (VIP, GAS, and MTL), thereby promoting gastrointestinal functional recovery. Pathophysiologically, peristalsis is suppressed when VIP (an inhibitory gastrointestinal hormone) is expressed abnormally, resulting in dysfunction; insufficient MTL (produced by small intestinal Mo cells) delays recuperation; and excessive GAS (secreted from G cells) contributes to disease progression by increasing the release of gastric acid and pancreatic juice [25, 26]. Here, in patients with mixed hemorrhoids, TEAS at ST36 effectively reduced surgical trauma-related excessive stress and inflammatory response. In terms of safety, the application of TEAS at ST36 did not result in increased incidence in adverse event, supporting its tolerability. In patients receiving ST36-targeted TEAS after mixed hemorrhoidectomy, the treatment satisfaction level was higher, reflecting stronger patient preference. Finally, the correlation evaluation found that the down-regulation of postoperative stress hormones and systemic inflammatory markers (ΔCor, ΔCRP) was mainly related to the relief of resting pain; the decrease in local inflammatory factor (ΔIL-6), however, showed a close correlation with defecation activity-associated pain alleviation. Thus, stress and inflammation mitigation help promote the recovery of gastrointestinal motility in patients undergoing hemorrhoidectomy.

Our findings are in line with the growing body of evidence that supports the application of integrative medicine in perioperative care and the shift towards an opioid-free analgesic paradigm. The novelty of our study lies in the demonstration of TEAS's efficacy as an adjunct to a purely NSAID-based regimen, generating a potent non-opioid multimodal strategy. For the current clinical environment where emphasis is placed on the elimination of side effects related to opioid (especially constipation, a critical concern in anorectal surgery patients), this approach is of great significance [8].

Several limitations in this study need to be addressed in the future. First of all, there is a lack of data about the time to the first postoperative bowel movement, defecation difficulty extent, pain duration during defecation, and the impact of pain on sleep; in the future, relevant indicators should be supplemented prospectively to compare the clinical effectiveness of the two therapies. Second, despite the confirmed statistical association between decreased inflammation and improved symptoms by correlation analysis, mediation analysis should be supplemented to further evaluate the causal relationship between inflammation attenuation and symptom amelioration. The third limitation is the absence of basic research to analyze whether TEAS exerts its efficacy by mediating other inflammatory pathways. Fourth, although we identified a significant statistical correlation between changes in indicators such as ΔCor, ΔCRP, and ΔIL-6 and pain alleviation, we did not further establish a regression model to precisely quantify the potential dose-response relationship (e.g., the specific reduction in the VAS pain score corresponding to each unit decrease in the IL-6 level). In the future, we will conduct further explorations through the design of a prospective study. Fifth, adverse reactions were not stratified by stimulation intensity, warranting prospective supplementation of relevant analysis in the future to determine the association between stimulation parameters and safety. Finally, the adverse events documented are largely routine analgesia-related reactions (nausea, vomiting, dizziness), leaving the possible TEAS-specific adverse events (e.g., skin redness/swelling at acupoints, pain, aggravated dizziness) not systematically monitored or recorded; further relevant analyses should be supplemented in the future to clarify the source of adverse reactions. In the future, we will further refine this study from the above angles.

Conclusion

Scheduled NSAID (ketorolac) regimen plus noninvasive TEAS at ST36 demonstrated superior pain management, reduced the need for supplemental analgesia, and facilitated recovery following mixed hemorrhoidectomy. This combination is effective, safe, and completely opioid-free multimodal analgesic, which can be easily implemented in clinical practice to improve patient outcomes and satisfaction.

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Disclosure of conflict of interest

None.

Address correspondence to: Qiyao Ma, Proctology Department, Zhongda Hospital Southeast University (Jiangbei), Nanjing 210048, Jiangsu, China. Tel: +86-13655178492; E-mail: 13655178492@163.com

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