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Original Article

Application value of transcutaneous electrical acupoint stimulation in improving knee joint function after knee arthroplasty in elderly patients

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Abstract: Aim: To evaluate the effects of adjunctive transcutaneous electrical acupoint stimulation (TEAS) within an enhanced recovery after surgery (ERAS) pathway on recovery, knee function, and complications in elderly patients undergoing total knee arthroplasty (TKA). Methods: This retrospective cohort study was conducted at a tertiary hospital between January 2023 and May 2025, enrolling 182 elderly patients (aged 60-80 years) who underwent primary unilateral TKA. Based on perioperative TEAS use, patients were categorized into an TEAS group (n=91, receiving standardized ERAS plus daily TEAS from preoperative day 1 until discharge) and a conventional group (n=91, receiving ERAS alone). Statistical analyses included t-tests, chi-square tests, repeated-measures ANOVA, and logistic regression, were all performed using SPSS 26.0. Results: The TEAS group had a significantly shorter hospital stay (6.22±0.80 vs 6.97±1.21 days, P<0.001) and a lower Western Ontario and McMaster Universities Osteoarthritis Index score at discharge (48.38±5.94 vs 50.79±6.52, P=0.010). Postoperative Visual Analogue Scale scores for pain were lower in the TEAS group, as were inflammatory markers. The overall complication rate was significantly lower in the TEAS group (16.5% vs 30.8%, P=0.023). Patient satisfaction was higher in the TEAS group, with a greater proportion reporting "very satisfied" (45.05% vs 31.87%, P=0.042). Multivariate analysis identified TEAS as an independent protective factor against complications (OR=0.120, 95% CI: 0.039-0.366, P<0.001). Conclusion: Adjuvant TEAS within an ERAS pathway enhances recovery, improves knee function, reduces complications, and increases satisfaction in elderly TKA patients, supporting its integration into perioperative care.

Keywords: Transcutaneous electrical acupoint stimulation, total knee arthroplasty, elderly patients, enhanced recovery after surgery

Introduction

Currently, global population aging is recognized as a significant challenge to public health in the modern era. As indicated in reports, it is projected that by 2050, individuals over the age of 65 will constitute approximately 20% of the world's population, with 80% of this elderly demographic originating from low- and middle-income countries [1]. In this scenario, the prevalence of geriatric osteoarticular conditions, particularly Knee Osteoarthritis (KOA), is on the rise [2-4]. Total Knee Arthroplasty (TKA) has become an increasingly common intervention for elderly patients, serving as an effective treatment for a range of advanced knee diseases, relieving pain, and restoring joint function [5, 6]. Nevertheless, due to the presence of multiple underlying health issues and reduced physiological resilience, elderly patients are prone to severe pain, significant swelling, delayed functional recovery, and a higher incidence of complications following TKA [7, 8]. These factors not only hinder the initial rehabilitation phase but also prolong hospital stays and increase the overall medical burden.

In this field, the concept of enhanced recovery after surgery (ERAS) has attracted growing attention in orthopedics [9]. In the perioperative nursing of TKA, ERAS covers multiple aspects such as pain management, swelling control, early rehabilitation exercises, nutritional support, and psychological intervention [10, 11]. How to effectively integrate safe, efficient, and low-side-effect interventions to optimize the ERAS pathway for elderly TKA patients has become the focus of current clinical and scien-

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tific research. Traditional Chinese medicine has accumulated rich experience in the prevention and treatment of musculoskeletal diseases and the promotion of postoperative rehabilitation. As a therapy combining traditional acupuncture and modern electrophysiological techniques, transcutaneous electrical acupoint stimulation (TEAS) is considered to have multiple effects, such as dredging meridians, regulating qi and blood, relieving pain, reducing inflammation, and regulating muscle tension, by applying pulsed current at specific acupoints [12, 13]. Theoretically, TEAS at specific acupoints could help alleviate postoperative pain, reduce local inflammation and swelling, and enhance the functional capacity of muscles surrounding the knee joint, such as the quadriceps femoris. This potentially provides an effective strategy to accelerate postoperative mobility and functional recovery in elderly patients.

At present, although some studies have explored the auxiliary effect of acupuncture or TEAS on postoperative rehabilitation of orthopedic surgery [14, 15], there is still insufficient research to systematically evaluate the comprehensive effect of TEAS integrated into the ERAS program during the perioperative period of TKA for the special group of elderly patients. This study aims to analyze the efficacy of TEAS in elderly TKA patients by conducting a retrospective analysis and systematically compiling real-world treatment data. The goal is to provide insights for optimizing perioperative management strategies for this specific group of elderly TKA patients.

Materials and methods

Patient characteristics

After obtaining ethical approval, 182 patients who underwent TKA at Hebei Provincial Hospital of Traditional Chinese Medicine from January 2023 to May 2025 were selected as the research subjects.

(1) Inclusion criteria: ① Aged 60-80 years; ② Underwent primary unilateral TKA for end-stage knee disease with surgical indications; ③ American Society of Anesthesiologists (ASA) grade I-III before surgery; ④ Complete and sufficient perioperative and follow-up data recorded in the medical record system to meet the analysis requirements of this study.

(2) Exclusion criteria: ① TKA due to special causes such as acute suppurative arthritis, knee tumor, or neuropathic arthropathy (Charcot joint); ② Complicated with uncontrolled severe heart, lung, liver, or renal failure, intractable coagulopathy, or active systemic infection; ③ A history of lower extremity neurovascular disease or deep vein thrombosis; ④ Clear contraindications to acupuncture, such as skin damage or infection at the acupoint site, as documented in medical records; ⑤ Regular receipt of other characteristic Traditional Chinese Medicine (TCM) therapies (e.g., other forms of acupuncture, manipulation, TCM fumigation, etc.) or physical therapy programs that may significantly affect postoperative rehabilitation during the observation period, as recorded in medical records of the same period.

This study was approved by the Ethics Committee of Hebei Provincial Hospital of Traditional Chinese Medicine.

Grouping and intervention methods

Initially, 213 TKA patients were enrolled; after excluding 31 patients, 182 patients were finally included. The screening and research process of the study subjects is shown in **Figure 1**. In this retrospective study, 182 patients were divided into two groups according to whether they received TEAS during the perioperative period: the conventional group (91 cases) and the TEAS group (91 cases).

(1) All patients in the conventional group received a standardized ERAS protocol: They strictly followed the perioperative ERAS pathway for TKA established by our hospital, including preoperative education and evaluation, intraoperative minimally invasive procedures and multimodal analgesia, postoperative systematic pain management (patient-controlled intravenous analgesia pump combined with rescue analgesia as needed), standardized anticoagulant therapy, and a stepwise functional exercise program guided by rehabilitation therapists (ankle pump exercises started 6 hours after surgery; straight leg raising and continuous passive movement training started on the first postoperative day, gradually transitioning to walking with a walking aid).

(2) On the basis of the standardized ERAS nursing protocol, the TEAS group received TEAS dur-

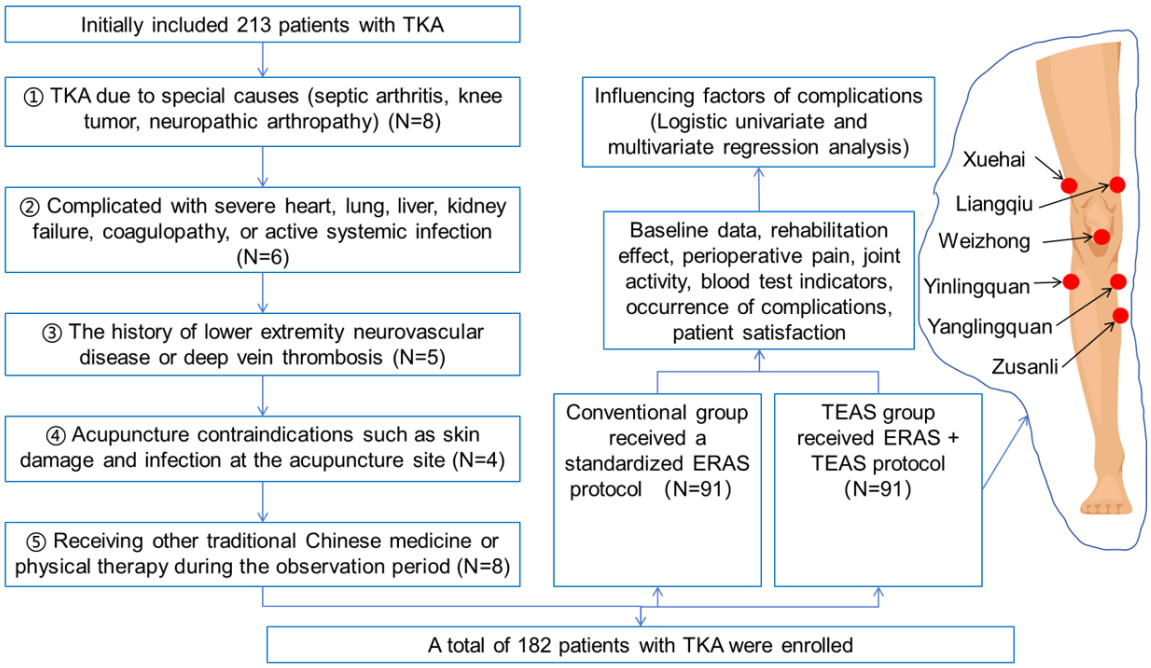

Figure 1. Screening of subjects and flow chart of the study. Note: TKA: total knee arthroplasty; TEAS: transcutaneous electrical acupoint stimulation; ERAS: enhanced recovery after surgery.

ing the perioperative period. Treatment instrument: Neuromuscular electrical stimulator (KT-90A). Main acupoints: Zusanli (ST36), Xuehai (SP10), Liangqiu (ST34), Yanglingquan (GB34), Yinlingquan (SP9), and Weizhong (BL40) on the affected side, with locations determined according to WHO standards. Operation procedure: After routine disinfection of the skin at the acupoints, electrode patches are applied. The stimulation waveform is set to a dense-sparse wave of 2 to 100 Hz, and the intensity is set to the maximum current intensity that does not cause the patient discomfort such as pricking pain or numbness (approximately 8 to 16 mA). Each session lasted 30 minutes. Treatment started 1 day before surgery (once) and was administered once daily from the first postoperative day until discharge, with an average treatment cycle covering the critical postoperative rehabilitation window. All TEAS procedures were performed by qualified attending physicians.

Indicators of observation

(1) Baseline data: Age, gender, affected side, body mass index (BMI), type 2 diabetes mellitus (T2DM), hypertension, preoperative joint range of motion, operation duration, and intraoperative blood loss.

(2) Rehabilitation effect: The rehabilitation effect of patients was evaluated by the length of hospital stay and the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) score [16]. The WOMAC consists of 24 items, assessing pain (5 items), stiffness (2 items), and joint function (17 items). Each item of the WOMAC is scored on a 5-point scale (0-4), with a total score ranging from 0 to 96. All patients' WOMAC evaluations were conducted by uniformly trained rehabilitation physicians through face-to-face interviews at admission and discharge, with the assessment process taking approximately 10 to 15 minutes. Higher scores indicate more severe joint pain, stiffness, and dysfunction, which is defined as poorer knee function.

(3) Perioperative pain: The Visual Analogue Scale (VAS) was used to evaluate resting pain 1 day before surgery and 1, 3, and 5 days after surgery. The VAS consists of a 10-cm straight line (marked at 1-cm intervals), with a score of 0 at the start indicating no pain and a score of 10 at the end indicating unbearable severe pain. Patients marked the corresponding position on the VAS line according to their pain perception, and the distance from the marking point to the start was measured as the patient's

VAS score. The higher the score, the greater the pain intensity.

(4) Joint mobility: A protractor was used to measure the maximum active flexion angle of the knee at 1 and 3 days after surgery and before discharge.

(5) Blood test indicators: Levels of serum inflammatory mediators, including Interleukin-6 (IL-6), C-reactive protein (CRP), and the coagulation index D-dimer, were collected 1 day before surgery and 1 day before discharge.

(6) Occurrence of complications: Postoperative complications were graded according to the Clavien-Dindo Classification System.

(7) Patient satisfaction: On the day of discharge, research nurses used a standardized satisfaction questionnaire to assess patients' satisfaction with the overall rehabilitation process. The questionnaire was a single-item, 4-level assessment with specific options: "very satisfied", "relatively satisfied", "generally satisfied", and "not very satisfied". Patients independently selected the option that best matched their true feelings during hospitalization and postoperative rehabilitation.

(8) Influencing factors of complications: According to the occurrence of postoperative complications, subjects were divided into a complication group and a non-complication group. Univariate analysis was used to initially screen potential influencing factors of postoperative complications, and multivariate Logistic regression was used to determine the independent influencing factors of complications after TKA.

Statistical analysis

SPSS 26.0 software was used for data analysis. Measurement data with a normal distribution were expressed as mean ± standard deviation. The t-test was used to compare single-time-point data between groups, and repeated-measures analysis of variance was used to compare data at multiple time points. Data with a skewed distribution were presented as median and interquartile range, and inter-group comparisons were analyzed using the rank-sum test. Categorical variables were expressed as n (%), and the χ^2 test was used for inter-group comparisons. The rank-sum test was used for data with a rank distribution. Logistic regression analysis was used to explore the association between TEAS and postoperative complications in elderly TKA patients after adjusting for confounding factors. A *P*-value <0.05 was considered statistically significant.

Results

Clinical characteristics

As shown in **Table 1**, baseline characteristics including age, gender, affected side, BMI, T2DM, hypertension, preoperative range of motion, operative duration and intraoperative blood loss were comparable between the conventional group and the TEAS group (all P> 0.05).

Effect of postoperative rehabilitation outcomes

As presented in **Table 2**, baseline knee function was similar between the two groups at admission (P>0.05). After intervention, the TEAS group had a significantly shorter length of hospital stay and better knee function at discharge compared with the conventional group (both P<0.05).

Perioperative pain

Resting pain VAS scores at different perioperative time points in the two groups are summarized in **Table 3**. Repeated-measures ANOVA revealed a significant main time effect for pain scores (F=141.306, P<0.001), indicating gradual pain relief over time in all patients. There were also significant main group effect (F= 93.333, P<0.001) and time-group interaction effect (F=18.537, P<0.001), suggesting distinct postoperative pain change trajectories between the two groups.

Range of motion

Early postoperative maximum active knee flexion range of motion in the two groups is shown in **Table 4**. Significant main effects of time (F=2006.191, P<0.001), group (F=67.792, P< 0.001), and time-group interaction (F=3.110, P=0.046) were observed. The significant interaction indicated different recovery patterns of knee range of motion between the two groups.

Inflammatory and coagulation markers

As shown in **Table 5**, preoperative serum IL-6, CRP and D-dimer levels were within normal or

Table 1. Clinical characteristics

Characteristics	Conventional group (N=91)	TEAS group (N=91)	χ^2/t	*P*
Age (years)	67.92±4.23	68.57±4.52	0.999	0.319
Gender			0.206	0.650
Male	38 (52.1%)	35 (47.9%)		
Female	53 (48.6%)	56 (51.4%)		
Affected side			0.354	0.552
Left	44 (52.4%)	40 (47.6%)		
Right	47 (48.0%)	51 (52.0%)		
BMI (kg/m^2)	26.38±2.50	27.00±2.60	1.629	0.105
T2DM			0.421	0.516
Yes	25 (46.3%)	29 (53.7%)		
No	66 (51.6%)	62 (48.4%)		
Hypertension			0.200	0.655
Yes	39 (48.1%)	42 (51.9%)		
No	52 (51.5%)	49 (48.5%)		
Preoperative joint range of motion			0.108	0.743
<90°	33 (47.1%)	37 (52.9%)		
≥90°	58 (51.8%)	54 (48.2%)		
Operation duration (min)	196.09±30.91	202.70±32.93	1.397	0.164
Intraoperative blood loss (mL)	128.79±18.11	125.43±16.04	1.326	0.187

TEAS: transcutaneous electrical acupoint stimulation; BMI: Body Mass Index; T2DM: Type 2 diabetes.

Table 2. Effect of postoperative rehabilitation

Group	N	Length of hospital (d)	WOMAC	
			Admission	Discharge
Conventional	91	6.97±1.21	62.55±8.12	50.79±6.52*
TEAS	91	6.22±0.80	63.30±7.69	48.38±5.94*
Z/t		4.925	0.637	2.604
P		<0.001	0.525	0.010

Note: TEAS: transcutaneous electrical acupoint stimulation; WOMAC: Western Ontario and McMaster Universities Osteoarthritis Index, Compared with admission, *P<0.05.

Table 3. Perioperative pain score

Group	1 d before surgery	1 d after surgery	3 d after surgery	5 d after surgery
Conventional	4.18±1.09	6.16±1.30	5.46±1.20	4.62±1.00
TEAS	4.13±0.99	5.77±1.11	4.27±1.00	3.11±0.80
F_{time}=141.306		P<0.001		
F_{group}=93.333		P<0.001		
$F_{interaction}$=18.537		P<0.001		

TEAS: transcutaneous electrical acupoint stimulation.

slightly elevated ranges, with no significant between-group differences (all P>0.05), confirming comparable baseline inflammatory and coagulation status. Postoperatively (1 day before discharge), all patients exhibited typical postoperative inflammatory response and coagulation activation, with marked elevations in IL-6, CRP and D-dimer. However, these markers were significantly lower in the TEAS group than in the conventional group (all P<0.05).

Postoperative complications

All patients were followed up for 3 months postoperatively. In the conventional group, 28 patients developed complications, with an overall incidence of 30.8%; in the TEAS group, 15 patients had complications, with an incidence of 16.5% (**Table 6**). The TEAS group showed a significantly lower overall complication rate (P=0.023). No Grade IV or V complications occurred in either group. Grade I complications mainly included superficial wound infection requiring debridement and persistent postoperative nausea and vomiting needing symptomatic management. Grade II complications were dominated by urinary tract

Table 4. Postoperative range of motion of the patients

Group	1 d after surgery	3 d after surgery	Discharge
Conventional	42.5±7.8	68.2±9.3	92.6±7.1
TEAS	45.8±6.9	75.8±8.1	98.1±6.8
F_{time}=2006.191		P<0.001	
F_{group}=67.792		P<0.001	
$F_{interaction}$=3.110		P=0.046	

TEAS: transcutaneous electrical acupoint stimulation.

infection requiring antibiotic therapy and symptomatic anemia necessitating blood transfusion.

Patient satisfaction

As shown in **Table 7**, the rank-sum test indicated a significant between-group difference in patient satisfaction with rehabilitation outcomes (Z=-2.031, P=0.042). The rate of "very satisfied" patients was higher in the TEAS group (45.05% vs. 31.87%), while the dissatisfaction rate was lower (3.30% vs. 7.69%).

Univariate analysis of factors associated with postoperative complications

Univariate analysis (**Table 8**) showed significant differences in age, BMI, T2DM, intraoperative blood loss and treatment modality between patients with and without postoperative complications (all P<0.05). All other baseline indicators were well balanced between the two subgroups (all P>0.05).

Multivariate analysis of influencing factors for postoperative complications

Variables including age, BMI, T2DM, intraoperative blood loss and treatment modality were enrolled as independent variables, and 3-month postoperative complications were set as the dependent variable for multivariate Logistic regression analysis. Variable assignments are listed in **Table 9**. As shown in **Table 10**, age (OR=1.372), BMI (OR=1.591), T2DM (OR=2.844), intraoperative blood loss (OR=1.022) and treatment modality (OR=0.120) were independent influencing factors for postoperative complications in elderly TKA patients (all P<0.05).

Discussion

This study focused on the rehabilitation challenges faced by elderly patients following TKA and explored the clinical value of perioperative adjuvant TEAS. Although the widespread adoption of the ERAS concept has substantially optimized perioperative TKA management, elderly patients still suffer from suboptimal postoperative pain control, delayed early functional recovery, and elevated complication risks. These issues are attributable to age-related physiological decline, multiple comorbidities, and poor tolerance to analgesic medications in this population [17-19]. Such problems not only hinder postoperative recovery and patient satisfaction but also prolong hospital stays and increase medical resource consumption, posing a notable public health burden. Therefore, there is an urgent clinical demand for safe, effective non-pharmacological adjuvant therapies that can be incorporated into standardized ERAS protocols to achieve individualized and optimized rehabilitation for elderly TKA patients. The present findings demonstrated that TEAS combined with standard ERAS significantly shortened hospital stay, improved postoperative knee function and range of motion, alleviated pain and systemic inflammatory responses, and reduced postoperative complication rates in elderly TKA patients.

Compared with patients receiving ERAS alone, elderly TKA patients treated with combined TEAS and ERAS exhibited a shorter hospital stay, better knee function (assessed via WOMAC scores), and superior active knee flexion range of motion at discharge. Improvements in these key clinical outcomes indicate that TEAS facilitates accelerated postoperative rehabilitation, potentially through multiple underlying mechanisms. By stimulating specific acupoints such as Zusanli (ST36) and Xuehai (SP10) with low-frequency electrical pulses, TEAS can activate spinal supraspinal analgesic pathways, modulate the hypothalamic-pituitary-adrenal axis, and stimulate the endogenous opioid system, including enkephalin and β-endorphin release [20-22]. Effective pain relief markedly enhances patients' willingness and compliance with early rehabilitation training, such as straight leg raising and continuous passive motion initiated on postoperative day 1. Early standardized exercise has been well document-

Table 5. Inflammation and coagulation markers

Group	IL-6 (pg/mL)		CRP (mg/L)		D-dimer (mg/L)	
	1 day before surgery	1 day before discharge	1 day before surgery	1 day before discharge	1 day before surgery	1 day before discharge
Conventional	7.47±1.60	70.50±19.59	6.28±2.12	53.19±15.58	0.45±0.22	3.85±1.11
TEAS	7.72±1.60	54.11±15.32	6.64±1.90	38.24±11.58	0.43±0.20	3.06±0.97
t	1.078	6.287	1.207	7.345	0.670	5.089
P	0.283	<0.001	0.229	<0.001	0.504	<0.001

Note: TEAS: transcutaneous electrical acupoint stimulation; IL-6: Interleukin-6; CRP: C-reactive protein.

Table 6. Postoperative complications

Group	Grade I	Grade II	Grade III	Total incidence
Conventional	12 (13.19)	10 (10.99)	6 (6.59)	28 (30.77)
TEAS	8 (8.79)	5 (5.49)	2 (2.20)	15 (16.48)
X^2				5.146
P				0.023

TEAS: transcutaneous electrical acupoint stimulation.

Table 7. Patient satisfaction

Group	Very satisfied	Relatively satisfied	Generally satisfied	Not very satisfied
Conventional	29 (31.87)	39 (42.86)	16 (17.58)	7 (7.69)
TEASe	41 (45.05)	35 (38.46)	12 (13.19)	3 (3.30)
Z		-2.031		
P		0.042		

TEAS: transcutaneous electrical acupoint stimulation.

ed to promote local blood circulation, reduce swelling, and prevent joint stiffness and muscle atrophy. In a prospective interventional study, Chiu et al. [23] reported that acupuncture effectively relieved knee pain and lowered WOMAC scores in patients with knee osteoarthritis.

TKA inevitably triggers a systemic inflammatory response characterized by elevated proinflammatory mediators such as IL-6 and CRP. Excessive inflammation serves as a major contributor to postoperative pain and underlies postoperative fatigue, poor appetite, and delayed functional recovery. The present results showed that hospital discharge levels of IL-6 and CRP were significantly lower in the TEAS group than in the conventional group. In a meta-analysis of 20 randomized controlled trials, Zhang et al. [24] concluded that TEAS effectively reduced serum IL-6 and CRP levels in TKA patients. Reduced inflammatory burden alleviates surgical stress responses and relieves postoperative fever, fatigue and other discomforts, thereby facilitating early discharge and rehabilitation. Patients after TKA are also at risk of local hypercoagulability and microcirculatory disorders. The lower D-dimer levels observed in the TEAS group suggest that TEAS may regulate vasomotor function, mitigate hypercoagulability, and improve periarticular tissue perfusion and oxygen supply [25]. A favorable local microenvironment promotes surgical wound healing and reduces the risk of intra-articular hemorrhage and fibrous adhesion, which is critical for preserving and improving knee range of motion.

Postoperative complications are key determinants of rehabilitation progress, hospital stay, and long-term prognosis in elderly TKA patients. In this study, the overall postoperative complication rate was 30.8% in the conventional group, compared with 16.5% in the TEAS group. These results are comparable with previously published data. Ratnasamy et al. [26] reported an overall TKA complication rate of approximately 19.6% in general populations, whereas the risk increased to 33.3% in patients with systemic conditions such as Behçet's syndrome. Liu et al. [27] reported a postoperative complication rate of 25.3% in a retrospective cohort focusing on hyperamylasemia and pancreatitis after TKA. The relatively moderate-to-high complication rate in our conventional group may be attributed to our exclusive enrollment of elderly patients aged 60-80 years, who frequently have multiple underlying comor-

Table 8. Univariate analysis

Characteristics	Complication group (N=43)	Non-complication group (N=139)	χ^2/t	*P*
Age (years)	72.30±3.11	66.99±3.94	8.097	<0.001
Gender			0.389	0.533
Male	19 (26.0%)	54 (74.0%)		
Female	24 (22.0%)	85 (78.0%)		
Affected side			0.568	0.451
Left	22 (26.2%)	62 (73.8%)		
Right	21 (21.4%)	77 (78.6%)		
BMI (kg/m^2)	28.57±1.76	26.11±2.50	6.005	<0.001
T2DM			9.912	0.002
Yes	21 (38.9%)	33 (61.1%)		
No	22 (17.2%)	106 (82.8%)		
Hypertension			0.092	0.762
Yes	20 (24.7%)	61 (75.3%)		
No	23 (22.8%)	78 (77.2%)		
Preoperative joint range of motion			0.829	0.363
<90°	14 (20.0%)	56 (80.0%)		
≥90°	29 (25.9%)	83 (74.1%)		
Operation duration (min)	224.93±16.60	191.50±29.20	6.662	<0.001
Intraoperative blood loss (mL)	127.67±18.99	126.94±16.60	0.246	0.806

Note: BMI: Body Mass Index; T2DM: Type 2 diabetes.

Table 9. Assignment of variables

Variables	Assignment of value
Dependent variable	
Occurrence of complications	0: complication, 1: non-complication
Independent variables	
Age	Actual value
BMI	Actual value
T2DM	0: No, 1: Yes
Intraoperative blood loss	Actual value
Treatment methods	0: Conventional, 1: TEAS

Note: BMI: Body Mass Index; T2DM: Type 2 diabetes; TEAS: transcutaneous electrical acupoint stimulation.

bidities. Notably, the complication rate in the TEAS group was not only significantly lower than that in the conventional group but also lower than the baseline rate reported for general TKA populations, indicating that TEAS plus ERAS is particularly beneficial for reducing postoperative complication burden in high-risk elderly individuals. Perioperative TEAS was identified as an independent protective factor against postoperative complications.

Patient satisfaction was significantly higher in the TEAS group, with a larger proportion reporting "very satisfied" and fewer reporting "not very satisfied". This finding aligns with the superior performance of TEAS in pain management, functional recovery and complication prevention, further confirming that integrating TEAS into ERAS pathways improves subjective rehabilitation experience and overall medical satisfaction in elderly TKA patients, with positive clinical and humanistic value. Our finding that TEAS reduces postoperative pain is clinically meaningful. Notably, a Cochrane review reported only low-quality evidence supporting intra-articular morphine for pain control after knee arthroscopy, implying that non-pharmacological adjuvant strategies such as TEAS warrant greater clinical attention [28].

Although this study provides preliminary evidence for perioperative TEAS application in elderly TKA patients, several limitations should be acknowledged. This is a single-center retrospective study; therefore, selection bias and

Table 10. Multivariate analysis

Variables	β	SE	Wald χ^2	P	OR	95% CI
Age	0.316	0.079	16.083	<0.001	1.372	1.175-1.601
BMI	0.465	0.142	10.660	0.001	1.591	1.204-2.103
T2DM	1.045	0.523	3.997	0.046	2.844	1.021-7.925
Intraoperative blood loss	0.022	0.009	5.758	0.016	1.022	1.004-1.041
TEAS	-2.119	0.569	13.880	<0.001	0.120	0.039-0.366
Constant	-39.907	6.934	33.120	-	-	-

Note: BMI: Body Mass Index; T2DM: Type 2 diabetes; TEAS: transcutaneous electrical acupoint stimulation.

unmeasured confounding factors could not be completely eliminated, even after multivariate adjustment. Constrained by its retrospective design, this study only collected 3-month postoperative follow-up data, lacking long-term evaluation of knee function, prosthesis survival, and long-term complications. Future high-quality multicenter prospective randomized controlled trials are required to provide higher-level evidence for clinical application.

Conclusion

In elderly patients undergoing TKA, TEAS combined with ERAS effectively shortens hospital stay, improves early postoperative knee function and range of motion, attenuates postoperative pain and systemic inflammatory responses, and markedly reduces postoperative complication rates. Furthermore, this combined intervention enhances patient satisfaction with the rehabilitation process. Therefore, TEAS can be adopted as a safe and effective non-pharmacological adjuvant modality incorporated into the perioperative ERAS pathway for elderly TKA patients to optimize overall rehabilitation outcomes.

Disclosure of conflict of interest

None.

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