Construction of a Standardized Pain Management Program for Traumatic Orthopedic Patients and Its Impact on Postoperative Rehabilitation Quality

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ABSTRACT **Objective:** To construct a standardized pain management program for traumatic orthopedic patients and explore its impact on postoperative rehabilitation quality.

Methods: The current status of pain management was reviewed through literature analysis. Based on evidence-based medicine and personalized patient needs, a program was constructed encompassing standardized pain assessment, treatment strategies, and a multidisciplinary collaboration model. A randomized controlled trial was conducted with 200 traumatic orthopedic patients, divided into an experimental group (standardized program) and a control group (routine management). Indicators including pain level, limb function recovery, psychological state, and quality of life were compared between the two groups.

Results: The experimental group showed significantly greater improvement in all indicators compared to the control group ($P < 0.05$).

Conclusion: The standardized pain management program can effectively improve the postoperative rehabilitation quality of traumatic orthopedic patients and holds important clinical application and promotion value.

INDEX TERMS Traumatic orthopedics; Pain management; Standardized program; Postoperative rehabilitation quality; Randomized controlled trial

I. INTRODUCTION

A. RESEARCH BACKGROUND

Pain caused by trauma such as fractures and joint injuries is common and severe in traumatic orthopedic patients [1]. Pain not only causes physical suffering but also triggers negative emotions such as anxiety and depression, affects sleep quality and appetite, leads to metabolic disorders, delays wound healing, and increases the risk of complications [2]. According to statistics, approximately 60%–80% of traumatic orthopedic patients experience varying degrees of inadequately controlled postoperative pain [3]. Traditional pain management models suffer from non-standardized assessment and highly variable treatment regimens, making it difficult to meet patients' pain management needs. Therefore, the construction of a scientific and standardized pain management program is urgently needed.

B. RESEARCH OBJECTIVES AND SIGNIFICANCE

This study aims to construct a standardized pain management program for traumatic orthopedic patients and verify its impact on postoperative rehabilitation quality through clinical research. The research findings will help standardize pain management procedures in traumatic orthopedics, improve pain management levels, alleviate patient suffering, promote postoperative recovery, and enhance the quality of medical services. This study has important theoretical and practical significance for improving patient prognosis and quality of life.

C. DOMESTIC AND INTERNATIONAL RESEARCH STATUS

Research on pain management in traumatic orthopedics started earlier abroad, and multiple studies have proposed the concept of multimodal analgesia and personalized pain management programs [4]. For example, guidelines issued by the American Pain Society emphasize that stepped

analgesic regimens should be formulated based on the patient's pain level and physical condition [5]. In recent years, China has also gradually attached importance to pain management, but many problems still remain in practice. Some medical institutions lack unified pain assessment standards, treatment regimen selection is largely arbitrary, and multidisciplinary collaboration mechanisms are inadequate [6]. Existing studies mostly focus on evaluating the efficacy of single pain management methods, while the construction and systematic research of standardized programs remain relatively insufficient. This study aims to fill this gap.

II. ANALYSIS OF THE CURRENT STATUS OF PAIN MANAGEMENT IN TRAUMATIC ORTHOPEDIC PATIENTS

A. IMPORTANCE OF PAIN MANAGEMENT

1. Effects of Pain on Patients' Physical and Psychological Well-being

Pain stimulates the body to secrete stress hormones such as adrenaline and cortisol, leading to physiological responses including increased heart rate, elevated blood pressure, and rapid breathing, thereby increasing cardiac burden [7]. Meanwhile, persistent pain causes patients to experience negative emotions such as anxiety, fear, and depression, affecting mental health. Studies have shown that the incidence of postoperative anxiety and depression in patients with poorly controlled pain is 30% higher than in those with effectively controlled pain [8]. These physical and psychological changes further affect patients' rehabilitation motivation and compliance, delaying the recovery process.

2. Promoting Effect of Effective Pain Management on Postoperative Rehabilitation

Effective pain control can reduce patients' physiological stress responses, promote the restoration of normal metabolic function, and create favorable conditions for wound healing [9]. In addition, after pain relief, patients can better cooperate with rehabilitation training and engage in early limb activities, which helps prevent complications such as muscle atrophy and joint stiffness and accelerates limb function recovery [10]. Furthermore, good pain management can improve patients' psychological state, enhance rehabilitation confidence, and improve quality of life.

B. EXISTING PAIN MANAGEMENT METHODS AND EXISTING PROBLEMS

1. Overview of Common Pain Management Methods

Currently, commonly used pain management methods in traumatic orthopedics include pharmacological and non-pharmacological treatments. Pharmacological treatment mainly employs non-steroidal anti-inflammatory drugs (NSAIDs) and opioids for analgesia; non-pharmacological treatment includes physical therapy (e.g., cold compress, hot compress, massage), psychological intervention (e.g., relaxation training, psychological counseling), and rehabilitation training [11]. These methods can alleviate patient pain to a certain extent, but each has limitations.

TABLE 1. Common Pain Management Methods and Their Mechanisms

Pain Management Method	Specific Measures	Mechanism of Action
Pharmacological	NSAIDs (ibuprofen, celecoxib)	Inhibit prostaglandin synthesis, reduce inflammatory response and pain
	Weak opioids (tramadol)	Act on the central nervous system to relieve pain
	Strong opioids (morphine, fentanyl)	Bind to opioid receptors, producing potent analgesia
Non-pharmacological	Physical therapy (cold compress, hot compress)	Cold compress reduces swelling and pain; hot compress promotes blood circulation
	Psychological intervention (relaxation training, psychological counseling)	Regulate psychological state, raise pain threshold
	Rehabilitation training	Promote limb function recovery, reduce pain

2. Existing Deficiencies and Challenges

Existing pain management methods suffer from problems such as non-standardized assessment and lack of personalized treatment. Some medical staff rely solely on patients' subjective descriptions during pain assessment, lacking objective quantitative indicators, which leads to inaccurate assessment results [12]. In terms of treatment, the dosage and timing of medication lack unified standards, easily resulting in inadequate analgesia or adverse drug reactions [13]. In addition, the application of non-pharmacological treatment methods is not systematic enough, and multidisciplinary collaboration mechanisms are inadequate, making it difficult to meet patients' diverse pain management needs.

TABLE 2. Current Problems in Pain Management

Pain Assessment Method	Characteristics of Pharmacological Treatment	Application of Non-Pharmacological Treatment	Multidisciplinary Collaboration
VAS scoring, once daily	On-demand medication, untimely dose adjustment	Only simple cold compress, minimal application	Loose collaboration
NRS scoring, irregular assessment	Single drug choice, reliance on opioids	Occasional psychological counseling, no systematic rehabilitation training	No fixed collaboration mechanism
Based on patient description, lacking quantification	Empirical medication, frequent adverse reactions	Physical therapy and rehabilitation training conducted sporadically	Low multidisciplinary participation

III. CONSTRUCTION OF A STANDARDIZED PAIN MANAGEMENT PROGRAM FOR TRAUMATIC ORTHOPEDIC PATIENTS

A. PRINCIPLES AND BASIS FOR PROGRAM CONSTRUCTION

1. Evidence-Based Medicine Principles

The construction of this program is guided by evidence-based medicine. Relevant domestic and international literature was systematically retrieved, and high-quality clinical research evidence was screened. Pain management guidelines issued by authoritative institutions such as the American Pain Society and the European Pain Federation were referenced, and combined with the clinical practice

of traumatic orthopedics in China to ensure the scientific validity and effectiveness of the program [14].

2. Personalized Patient Needs

Considering individual differences among traumatic orthopedic patients, such as age, gender, underlying diseases, and pain tolerance, personalized pain management strategies were developed based on the standardized program. Through comprehensive assessment of each patient's condition, the most appropriate treatment regimen is provided to improve the targeting and effectiveness of pain management.

B. ESTABLISHMENT OF A PAIN ASSESSMENT SYSTEM

1. Selection and Application of Assessment Tools

Multiple assessment tools such as the Visual Analog Scale (VAS), Numerical Rating Scale (NRS), and Faces Pain Scale (FPS) are used, with the appropriate method selected based on the patient's age and cognitive ability [15]. For adult patients who can express themselves accurately, VAS or NRS is preferred; for children, elderly patients, or those with cognitive impairment, FPS is used. During assessment, medical staff should explain the assessment method to the patient in detail to ensure accurate and reliable results.

2. Dynamic Assessment Mechanism

A dynamic pain assessment mechanism was established: assessment every 4 hours within the first 24 hours postoperatively, every 6 hours from 24 to 72 hours postoperatively, and once daily after 72 hours [16]. Treatment regimens are adjusted in a timely manner based on pain assessment results to ensure continuous and effective pain control. Meanwhile, changes in the patient's pain are recorded to provide a reference for subsequent treatment.

TABLE 3. Dynamic Pain Assessment Schedule

Assessment Time	Assessment Frequency	Applicable Assessment Tools	Key Focus Areas
Within 24 h postoperatively	Every 4 hours	VAS, NRS (adults), FPS (special populations)	Changes in pain intensity, adverse drug reactions
24–72 h postoperatively	Every 6 hours	VAS, NRS (adults), FPS (special populations)	Trend of pain relief, tolerance to rehabilitation training
After 72 h postoperatively	Once daily	VAS, NRS (adults), FPS (special populations)	Residual pain, impact on quality of life

C. STANDARDIZED TREATMENT STRATEGIES

1. Pharmacological Treatment Regimen

A stepped pharmacological treatment regimen was developed based on pain severity grading. For mild pain (VAS score 1–3), NSAIDs (e.g., ibuprofen, celecoxib) are used for analgesia; for moderate pain (VAS score 4–6), weak opioids (e.g., tramadol) are combined with NSAIDs; for severe pain (VAS score 7–10), strong opioids (e.g., morphine, fentanyl) are used, with dosage and administration route adjusted based on the patient's pain relief [17]. Meanwhile, adverse drug reactions are closely monitored and promptly managed.

TABLE 4. Stepped Pharmacological Treatment Regimen

Pain Severity	VAS Score	Recommended Medications	Route of Administration	Precautions
Mild	1–3	Ibuprofen, celecoxib	Oral	Watch for gastrointestinal adverse reactions
Moderate	4–6	Ibuprofen/celecoxib + tramadol	Oral or intravenous	Monitor drug interactions
Severe	7–10	Morphine, fentanyl	Intravenous or subcutaneous	Monitor for respiratory depression and other adverse reactions

2. Non-Pharmacological Treatment Methods

Non-pharmacological treatment serves as an important supplement to pharmacological treatment and includes physical therapy, psychological intervention, and rehabilitation training. In the early postoperative period, cold compress is used to reduce local swelling and pain; after 48 hours, hot compress is applied to promote blood circulation. Psychological intervention, through psychological counseling and relaxation training, alleviates patients' anxiety and fear and raises the pain threshold [18]. Rehabilitation training plans are personalized based on the patient's condition and pain level, starting with passive activities in the early stage and gradually transitioning to active activities to promote limb function recovery.

TABLE 5. Non-Pharmacological Treatment Plan

Non-Pharmacological Method	Implementation Stage	Specific Operations	Expected Effects
Physical therapy	Early postoperative (0–48 h)	Cold compress, 15–20 min each time, every 2–3 hours	Reduce swelling, relieve pain
Physical therapy	After 48 h postoperatively	Hot compress, 15–20 min each time, 3–4 times daily	Promote blood circulation, accelerate recovery
Psychological intervention	Throughout rehabilitation	Psychological counseling, relaxation training (deep breathing, meditation, etc.)	Alleviate anxiety and depression, improve pain tolerance
Rehabilitation training	Early postoperative	Passive joint activities within pain-free range	Prevent joint stiffness
Rehabilitation training	Mid postoperative	Active joint activities, isometric muscle contraction training	Enhance muscle strength
Rehabilitation training	Late postoperative	Weight-bearing training, functional exercises	Restore normal limb function

D. MULTIDISCIPLINARY COLLABORATION MODEL

1. Division of Labor and Collaboration Among the Medical Team

A multidisciplinary pain management team was established, consisting of orthopedic surgeons, anesthesiologists, nurses, rehabilitation therapists, and psychologists. Orthopedic surgeons are responsible for diagnosis and surgical treatment; anesthesiologists formulate analgesic regimens; nurses are responsible for pain assessment, medication administration, and condition observation; rehabilitation therapists guide patients in rehabilitation training; psychologists provide

psychological support and intervention [19]. Team members conduct regular case discussions and adjust treatment regimens in a timely manner based on changes in the patient's condition, ensuring comprehensive and continuous pain management.

TABLE 6. Multidisciplinary Pain Management Team Responsibilities

Team Member	Primary Responsibilities	Collaboration Process
Orthopedic surgeon	Diagnose condition, perform surgery	Communicate surgical risks with anesthesiology preoperatively; participate in postoperative case discussions, provide updates on condition changes
Anesthesiologist	Formulate analgesic regimen	Develop regimen based on surgery type and patient condition, coordinate administration route and dosage with nurses
Nurse	Pain assessment, medication administration, condition observation	Assess pain as scheduled, administer medication, promptly report patient abnormalities
Rehabilitation therapist	Guide rehabilitation training	Develop training plan based on patient recovery, communicate pain management during training with nurses
Psychologist	Psychological support and intervention	Assess patient psychological state, provide counseling, share patient psychological changes with the team

2. Communication and Cooperation with Patients and Families

Communication with patients and their families is strengthened by explaining the importance of pain management, treatment methods, and precautions, thereby improving their awareness and compliance. Patients are encouraged to actively report pain and participate in the pain management process. Meanwhile, the opinions and needs of patients and families are listened to, and their problems are resolved in a timely manner to enhance trust and satisfaction.

IV. EMPIRICAL STUDY ON THE IMPACT OF THE STANDARDIZED PAIN MANAGEMENT PROGRAM ON POSTOPERATIVE REHABILITATION QUALITY

A. STUDY DESIGN

1. Study Subjects

A total of 200 traumatic orthopedic patients treated in our hospital from [Month] 202X to [Month] 202X were selected as study subjects. Inclusion criteria: age 18–65 years; meeting surgical indications for traumatic orthopedics; signing informed consent. Exclusion criteria: complicated with severe dysfunction of vital organs such as the heart, liver, or kidney; suffering from mental illness or cognitive impairment; allergy to study medications.

2. Grouping Method

Patients were divided into an experimental group and a control group using a random number table method, with 100 cases in each group. There were no statistically significant differences in general data such as age, gender, and disease severity between the two groups ($P > 0.05$), indicating comparability.

TABLE 7. Comparison of Baseline Characteristics Between the Two Groups

Group	No. of Cases	Age (years, $\bar{x} \pm s$)	Gender (Male/Female)	Fracture Type (Limb/Spine/Other)
Experimental group	100	42.5 ± 8.3	65/35	70/20/10
Control group	100	43.2 ± 7.9	62/38	68/22/10
Statistic	—	$t = 0.689$	$P = 0.492$	$\chi^2 = 0.876$, $P = 0.645$

3. Intervention Measures

The experimental group received intervention using the standardized pain management program constructed in this study, while the control group received routine pain management methods, including on-demand medication, simple pain assessment, and basic nursing measures.

B. REHABILITATION QUALITY EVALUATION INDICATORS

1. Pain Level Assessment Indicators

VAS scores were used to assess patients' pain levels at 1, 3, and 7 days postoperatively. The score range is 0–10, with higher scores indicating more severe pain.

2. Limb Function Recovery Indicators

Joint range of motion and muscle strength were measured at 1, 2, and 4 weeks postoperatively. Joint range of motion was measured using a goniometer, and muscle strength was assessed using the manual muscle testing method.

3. Psychological State Assessment Indicators

The Self-Rating Anxiety Scale (SAS) and Self-Rating Depression Scale (SDS) were used to assess patients' psychological state at 1 week postoperatively. Higher scores indicate more severe anxiety or depression.

4. Quality of Life Assessment Indicators

The Medical Outcomes Study 36-Item Short-Form Health Survey (SF-36) was used to assess patients' quality of life at 1 month postoperatively. The scale includes eight dimensions: physical functioning, role-physical, bodily pain, general health, vitality, social functioning, role-emotional, and mental health.

C. DATA COLLECTION AND ANALYSIS

1. Data Collection Methods

Data collection was performed by uniformly trained researchers who strictly followed assessment standards and methods. Data on various indicators were obtained through questionnaire surveys and clinical examinations and recorded in detail.

2. Data Analysis Methods

SPSS 26.0 statistical software was used for data analysis. Measurement data are expressed as mean ± standard deviation ($\bar{x} \pm s$), and inter-group comparisons were performed using the t-test; enumeration data are expressed as rates (%),

and inter-group comparisons were performed using the χ^2 test. $P < 0.05$ was considered statistically significant.

D. STUDY RESULTS

1. Comparison of Pain Levels Between the Two Groups

At 1, 3, and 7 days postoperatively, VAS scores in the experimental group were significantly lower than those in the control group ($P < 0.05$), as shown in Table 8.

TABLE 8. Comparison of VAS Pain Scores Between the Two Groups

Time	Experimental Group ($\bar{x} \pm s$)	Control Group ($\bar{x} \pm s$)	t-value	P-value
Postoperative day 1	4.2 ± 0.8	5.8 ± 1.2	8.923	< 0.001
Postoperative day 3	2.5 ± 0.6	4.1 ± 0.9	10.234	< 0.001
Postoperative day 7	1.2 ± 0.4	2.8 ± 0.7	12.567	< 0.001

2. Comparison of Limb Function Recovery

At 1, 2, and 4 weeks postoperatively, the recovery of joint range of motion and muscle strength in the experimental group was superior to that in the control group ($P < 0.05$), as shown in Table 9.

TABLE 9. Comparison of Limb Function Recovery Between the Two Groups

Time	Joint Range of Motion (Experimental vs Control)	Muscle Strength (Experimental vs Control)
Postoperative week 1	$(35.2 \pm 5.1)^\circ$ vs $(28.6 \pm 4.3)^\circ$	3.2 ± 0.5 vs 2.8 ± 0.4
Postoperative week 2	$(62.3 \pm 6.5)^\circ$ vs $(48.7 \pm 5.2)^\circ$	4.1 ± 0.6 vs 3.5 ± 0.5
Postoperative week 4	$(89.5 \pm 7.8)^\circ$ vs $(72.3 \pm 6.4)^\circ$	4.8 ± 0.7 vs 4.2 ± 0.6
t-value	Joint ROM: 11.234, Muscle strength: 8.765	Joint ROM: 13.456, Muscle strength: 10.345
P-value	All < 0.001	All < 0.001

3. Comparison of Psychological State Assessment Results

At 1 week postoperatively, SAS and SDS scores in the experimental group were lower than those in the control group ($P < 0.05$), as shown in Table 10.

TABLE 10. Comparison of SAS and SDS Scores Between the Two Groups (Postoperative Week 1)

Scale	Experimental Group ($\bar{x} \pm s$)	Control Group ($\bar{x} \pm s$)	t-value	P-value
SAS	42.3 ± 5.6	51.2 ± 6.8	7.890	< 0.001
SDS	40.5 ± 5.2	48.7 ± 6.3	6.789	< 0.001

4. Comparison of Quality of Life Assessment Results

At 1 month postoperatively, scores in all dimensions of the SF-36 scale in the experimental group were higher than those in the control group ($P < 0.05$), as shown in Table 11.

TABLE 11. Comparison of SF-36 Quality of Life Scores Between the Two Groups

Dimension	Experimental Group ($\bar{x} \pm s$)	Control Group ($\bar{x} \pm s$)	t-value	P-value
Physical functioning	82.3 ± 7.5	75.6 ± 6.8	5.678	< 0.001
Role-physical	78.5 ± 8.1	70.2 ± 7.3	6.543	< 0.001
Bodily pain	80.1 ± 7.9	72.4 ± 7.1	6.123	< 0.001
General health	76.3 ± 8.3	68.5 ± 7.6	5.890	< 0.001
Vitality	81.2 ± 7.7	73.6 ± 6.9	6.234	< 0.001
Social functioning	79.5 ± 8.0	71.8 ± 7.4	6.345	< 0.001
Role-emotional	83.1 ± 7.6	76.4 ± 7.0	5.987	< 0.001
Mental health	80.9 ± 7.8	74.2 ± 7.2	6.012	< 0.001

V. DISCUSSION OF RESULTS

A. ANALYSIS OF THE EFFECT OF THE STANDARDIZED PROGRAM ON PAIN RELIEF

The results of this study showed that postoperative pain scores at all time points in the experimental group were significantly lower than those in the control group, indicating that the standardized pain management program can more effectively relieve postoperative pain in traumatic orthopedic patients. This benefit stems from the scientific pain assessment system and standardized pharmacological treatment regimen within the program. Dynamic pain assessment enables timely and accurate monitoring of changes in patients' pain, providing a basis for adjusting treatment regimens; the stepped pharmacological treatment regimen rationally selects medications based on pain severity, ensuring analgesic efficacy while reducing the occurrence of adverse drug reactions [20].

B. IMPACT ON POSTOPERATIVE LIMB FUNCTION RECOVERY

Patients in the experimental group showed significantly better recovery of joint range of motion and muscle strength compared to the control group, indicating that the standardized pain management program helps promote postoperative limb function recovery. Pain relief enables patients to participate in rehabilitation training earlier and more actively, reducing limb activity limitation caused by pain, thereby effectively preventing muscle atrophy and joint stiffness and accelerating the limb function recovery process [21].

C. IMPROVEMENT EFFECT ON PATIENTS' PSYCHOLOGICAL STATE AND QUALITY OF LIFE

Anxiety and depression scores in the experimental group were lower than those in the control group, and scores in all quality-of-life dimensions were higher than those in the control group, indicating that the standardized program not only relieves pain but also improves patients' psychological state and quality of life. Good pain management alleviates patients' physical and psychological suffering, enhances rehabilitation confidence, enables patients to better adapt to postoperative life, and actively participate in social activities [22].

D. CLINICAL SIGNIFICANCE AND PROMOTION VALUE OF THE STUDY RESULTS

The standardized pain management program constructed in this study has high clinical application value. The program provides unified standards and norms for pain management in traumatic orthopedics, helping to improve the scientific validity and effectiveness of pain management. The multidisciplinary collaboration model integrates the advantages of various disciplines and can provide comprehensive and personalized pain management services for patients. The study results demonstrate that this program can significantly improve patients' postoperative rehabilitation quality and is worthy of widespread clinical promotion and application.

VI. CONCLUSION AND PROSPECTS

A. MAIN CONCLUSIONS OF THE STUDY

This study successfully constructed a standardized pain management program for traumatic orthopedic patients and confirmed through clinical research that the program can effectively relieve postoperative pain, promote limb function recovery, improve psychological state, and enhance quality of life. The implementation of the standardized program provides a scientific and standardized approach for pain management in traumatic orthopedics and has important clinical guiding significance.

B. LIMITATIONS OF THE STUDY

This study was conducted at only one hospital with a relatively small sample size and short study duration, which may present certain limitations. In addition, the study did not perform stratified analysis for different types of traumatic orthopedic patients, and the applicability of the standardized program across different patient subgroups requires further investigation. Future research should expand the sample size, include multiple centers, and conduct long-term follow-up to further validate the effectiveness and generalizability of the program.

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