

## Application of Case Management Model Combined with Proprioceptive Training in Rehabilitation of Knee Arthroplasty Patients

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### Abstract

**Objective** To investigate the application effect of case management model construction combined with proprioceptive training in the rehabilitation of knee replacement patients. **Methods** Seventy-six patients who underwent unilateral knee replacement surgery for the first time at the Department of Orthopedics, Hai'an Hospital of Traditional Chinese Medicine from July 2019 to December 2021 were selected as research subjects. Patients were randomly divided into a control group and an observation group. The control group received conventional nursing care, while the observation group received intervention with case management model combined with proprioceptive training in addition to the conventional care. The time to first ambulation, length of hospital stay, and hospitalization costs were compared between the two groups; the VAS pain scores at rest and during activity were compared before and after intervention; the HSS scores were compared preoperatively and at 1 week, 3 weeks, and 1 month postoperatively. **Results** The observation group had shorter time to first ambulation, shorter hospital stay, and lower hospitalization costs compared with the control group; the VAS pain scores at rest and during activity in the observation group were lower than those in the control group; the HSS scores of the observation group were higher than those of the control group preoperatively and at 1 week, 3 weeks, and 1 month postoperatively; the differences were statistically significant ( $P < 0.05$ ). **Conclusion** The combination of case management model construction and proprioceptive training can effectively promote postoperative rehabilitation in knee replacement patients, alleviate pain, enhance knee function, and improve walking ability, while reducing hospital stay and hospitalization costs.

## Full Text

# Application of Case Management Model Combined with Proprioceptive Training in the Rehabilitation of Knee Arthroplasty Patients

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## Abstract

**Objective:** To explore the efficacy of implementing a case management model combined with proprioceptive training in the rehabilitation of knee arthroplasty patients. **Methods:** Seventy-six patients who underwent primary unilateral knee arthroplasty at the Department of Orthopedics, Hai'an Hospital of Traditional Chinese Medicine between July 2019 and December 2021 were selected as study participants. Patients were randomly divided into a control group and an observation group. The control group received conventional nursing care, while the observation group received additional intervention combining case management with proprioceptive training based on the control group's regimen. The time to first ambulation, length of hospital stay, and hospitalization costs were compared between the two groups. Pain scores at rest and during activity (VAS) were compared before and after intervention. HSS scores were compared preoperatively and at 1 week, 3 weeks, and 1 month postoperatively. **Results:** The observation group demonstrated significantly shorter time to first ambulation, shorter hospital stay, and lower hospitalization costs compared to the control group ( $P < 0.05$ ). VAS scores at rest and during activity were significantly lower in the observation group. HSS scores in the observation group were significantly higher than those of the control group at all time points: preoperatively, 1 week postoperatively, 3 weeks postoperatively, and 1 month postoperatively ( $P < 0.05$ ). **Conclusion:** The combination of case management model and proprioceptive training effectively promotes postoperative rehabilitation in knee arthroplasty patients by alleviating pain, enhancing knee function, and improving ambulatory capacity, while concurrently reducing both hospitalization duration and costs.

**Keywords:** Case management model; Proprioceptive training; Knee arthroplasty; Rehabilitation

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## Introduction

Total knee arthroplasty represents a primary surgical intervention for end-stage knee osteoarthritis, effectively reducing knee pain and improving joint mobility [1]. However, patients undergoing knee arthroplasty frequently exhibit compromised lower limb proprioception and joint stability, which adversely affect knee function and increase fall risk [2]. Consequently, optimizing the utilization of

limited medical resources to accelerate knee function recovery and facilitate patients' return to normal life constitutes a critical priority in postoperative care. Previous research has demonstrated that proprioceptive training can enhance periarticular muscle strength, improve balance function in the affected knee, and elevate quality of life for arthroplasty patients [3,4]. Case management model represents an innovative workflow that enables comprehensive patient needs assessment, multidisciplinary collaboration, and continuous care delivery, thereby augmenting rehabilitation opportunities [5]. This study investigates the rehabilitative outcomes of implementing a case management model combined with proprioceptive training in knee arthroplasty patients.

## Methods

**Study Population** Seventy-six patients undergoing primary unilateral knee arthroplasty were enrolled, including 44 females and 32 males aged 58-82 years with a mean age of  $(67.56 \pm 11.68)$  years. Inclusion criteria comprised: (1) clinical indication for unilateral knee arthroplasty, and (2) informed consent with good compliance. Exclusion criteria included: (1) concurrent surgical procedures during knee arthroplasty, and (2) communication or consciousness disorders. Participants were randomly allocated to either the control group (n=38) or observation group (n=38) based on the odd/even terminal digit of their medical record number. The two groups demonstrated no statistically significant differences in gender, age, disease duration, or surgical site ( $P > 0.05$ ), establishing comparability. This study protocol received approval from our hospital's ethics committee.

**Interventions Control Group:** Patients received conventional postoperative rehabilitation including: (1) limb elevation and continuous cryotherapy with bio-ice packs for 24 hours on the operative day with monitoring for frostbite; (2) ankle pump exercises (20 repetitions, 4 times daily); (3) isometric quadriceps and hamstring training (20 repetitions, 4 times daily); (4) straight leg raises to  $45-60^\circ$  (20 repetitions, 4 times daily); (5) knee flexion/extension exercises including thigh-hugging flexion, side-lying gravity-eliminated movements, and bedside dangling; and (6) ambulation training with a walker. All exercises progressed gradually in intensity without increasing patient pain.

**Observation Group:** In addition to conventional care, patients received case management combined with proprioceptive training.

*Case Management Model:* (1) A multidisciplinary rehabilitation team was established comprising one orthopedic specialist nurse, one operating room specialist nurse, four charge nurses, and two physicians, led by the orthopedic specialist nurse. Project plans were developed with clearly defined responsibilities. The specialist nurse formulated and implemented the case management protocol after competency verification. (2) Individualized rehabilitation manuals and patient databases were created [6]. (3) Implementation included: **Preoperative:** Charge nurses conducted specialized assessments focusing on pain, VTE risk,

and knee function. Patients viewed exercise instruction videos with QR codes shared with family members to enhance compliance. Specialist nurses conducted 20-minute interviews to evaluate functional expectations and psychological status while verifying health education effectiveness. **Intraoperative:** Operating room nurses provided specialized surgical coordination and interventions for psychological support, pain management, and DVT prophylaxis. **Postoperative (Day 0):** Charge nurses coordinated with operating room staff for proper limb positioning, cryotherapy, massage, and ankle pump exercises, with specialist nurse evaluation of performance. **Postoperative Days 1-3:** Supervised ankle pumps, passive knee flexion/extension, isometric contractions, proprioceptive training, and 50-meter walker-assisted ambulation, with daily specialist nurse assessment and corrective feedback. **Postoperative Days 4-7:** Progressed to straight leg raises, thigh-hugging flexion, side-lying exercises, bedside dangling, proprioceptive training, and 150-meter ambulation, with in-hospital patient exchange sessions, video presentations, and outcome sharing to promote mutual motivation. **Postoperative Days 8-12:** Advanced to prone active knee flexion/extension, handrail-assisted squats, and lunge exercises with proprioceptive training and targeted individualized guidance. **Discharge:** Comprehensive discharge instructions were provided with evaluation of rehabilitation knowledge, compliance, outcomes, and satisfaction. Extended care included home visits at 3 weeks post-discharge assessing wound status, pain, medication adherence, and knee function, with one-month follow-up appointments. A quality control team comprising the department chief, head nurse, and specialist nurse provided ongoing monitoring and feedback for continuous improvement.

*Proprioceptive Training Methods:* (1) Supine air cycling with progressive speed increases; (2) Balance training on balance boards progressing from eyes-open bilateral stance to eyes-closed bilateral and unilateral stance; (3) Bilateral and unilateral partial squats; and (4) Gait pattern training including forward steps, backward steps, turning, and lateral step-together movements [7]. All exercises were performed once daily for 20-30 minutes.

**Outcome Measures** Primary outcomes included: (1) time to first ambulation, hospitalization duration, and costs; (2) pain at rest and during activity assessed using the Visual Analogue Scale (VAS) ranging from 0 (no pain) to 10 (severe pain), with scores of 1-3 indicating mild pain, 4-6 moderate pain, and 7-10 severe pain; (3) knee function evaluated using the Hospital for Special Surgery (HSS) knee score (0-100 points) encompassing pain (30 points), ambulatory function (22 points), range of motion (18 points), muscle strength (10 points), flexion deformity (10 points), and stability (10 points), with higher scores indicating better function (Cronbach's  $\alpha = 0.824$ ) [8]; and (4) comfort level assessed using Kolcaba's General Comfort Questionnaire (GCQ) evaluating physiological, psychological, sociocultural, and environmental dimensions, with scores <60 indicating low comfort, 60-90 moderate comfort, and >90 high comfort [9].

**Statistical Analysis** SPSS 22.0 software was utilized for statistical analysis. Continuous variables were expressed as mean  $\pm$  standard deviation ( $\bar{x}\pm s$ ), with paired t-tests for intergroup comparisons of comfort levels. Categorical data were described using percentages. Statistical significance was defined as  $P<0.05$ .

## Results

**2.1 Hospitalization Outcomes** The observation group exhibited significantly shorter time to first ambulation, reduced hospital stay, and lower hospitalization costs compared to the control group ( $P<0.05$ ).

**2.2 Pain Assessment** No significant differences existed between groups in VAS scores at rest or during activity before intervention ( $P>0.05$ ). Following intervention, the observation group demonstrated significantly lower VAS scores at rest and during activity compared to the control group ( $P<0.05$ ).

**2.3 Knee Function Evaluation** Preoperative HSS scores showed no significant intergroup differences ( $P>0.05$ ). Postoperatively, the observation group achieved significantly higher HSS scores at 1 week, 3 weeks, and 1 month compared to the control group ( $P<0.05$ ).

**2.4 Comfort Level Comparison** The observation group reported significantly higher comfort levels compared to the control group ( $P<0.05$ ).

## Discussion

Total knee arthroplasty constitutes a high-risk orthopedic procedure, with patients frequently experiencing postoperative proprioceptive decline and reduced accuracy—critical factors for maintaining knee stability. Xu et al. [10] demonstrated that proprioceptive training significantly enhances balance and coordination in knee arthroplasty patients, improving quality of life in middle-aged and elderly populations. While conventional rehabilitation primarily focuses on pain relief and range of motion improvement, proprioceptive deficits and balance deterioration increase fall risk among elderly patients [11], compromising quality of life. Consequently, proprioceptive training has assumed increasing clinical importance. Current conventional rehabilitation protocols inadequately meet patient needs, necessitating more effective nursing models to optimize postoperative outcomes.

Case management model represents a patient-centered, personalized comprehensive nursing approach facilitating healthcare collaboration and continuous care delivery [12]. In this study, the observation group receiving case management combined with proprioceptive training demonstrated significantly improved HSS scores at 1 week, 3 weeks, and 1 month postoperatively. Application of case management throughout the perioperative period enabled comprehensive assessment, collaborative development of individualized rehabilitation plans with

orthopedic surgeons, and creation of personalized rehabilitation manuals. Early, structured mobilization and ambulation not only enhanced patient confidence but also increased comfort levels, as evidenced by significantly improved GCQ scores in the observation group.

Both groups received conventional joint mobility and muscle strength training; however, the observation group's additional proprioceptive training resulted in superior knee function at all postoperative time points and enhanced stability during standing and ambulation. The proprioceptive training protocol—comprising air cycling, balance training, partial squats, and gait pattern exercises—was simple, practical, and feasible for early postoperative implementation. This training strengthened periarticular musculature, improved neuromuscular excitability, and enhanced joint stability [13], enabling patients to maintain balanced states during standing and walking while substantially reducing fall risk.

In summary, the integration of case management model with proprioceptive training represents a novel collaborative healthcare approach that effectively promotes postoperative rehabilitation in knee arthroplasty patients by alleviating pain, enhancing knee function, and improving ambulatory capacity. This intervention merits broader clinical implementation.

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