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The Effectiveness of Resistance Training for Patients with Degenerative Arthritis After Surgery- A Pilot Randomized Controlled Study

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Abstract

Aim and objectives: This study aimed to examine the effects of resistance training on lower limb muscular endurance, balance performance, pain and quality of life among patients with osteoarthritis.

Background: Osteoarthritis is a common, highly prevalent degenerative disease and a major cause of disability and mobility impairment in the elderly. Past research has focused on exercise interventions and postoperative rehabilitation.

Design: A pilot randomized controlled study.

Methods: An experimental design was adopted. Twenty-four patients with osteoarthritis who had undergone unilateral total knee arthroplasty were recruited and randomly assigned to either the experimental group (n = 12, three-month resistance training) or the control group (n = 12, postoperative rehabilitation). Outcome measurements included lower limb muscular endurance, balance performance, pain and quality of life. Statistical analyses were conducted using SPSS, including chi-squared test, t-tests, generalized estimating equations and analysis of covariance (α = 0.05).

Clinical Practice Recommendations: Nursing staff can collaborate with physical therapists to assess patients' muscle endurance and balance, establishing a cross-professional collaborative model to continuously track exercise effectiveness.

Keyword: Osteoarthritis, Resistance Training, Lower Limb Muscular Endurance, Balance Performance, Experimental Research.

Introduction

Osteoarthritis (OA) is one of the most prevalent chronic musculoskeletal disorders worldwide, affecting more than 500 million people globally, with its prevalence increasing significantly alongside an aging population [1]. As global demographics continue to shift, OA has become a major contributor to chronic pain, physical disability, and reduced health-related quality of life, particularly among older adults [1, 2]. From a nursing perspective, managing the long-term functional impact of OA is critical, as the progressive loss of independence severely compromises patients' psychosocial well-being and increases the burden on healthcare systems [3].

OA is characterized by the progressive degeneration of articular cartilage, leading to persistent joint pain, stiffness, and functional limitations, most commonly affecting weight-bearing joints such as the knee and hip [2]. These physical impairments are strongly associated with decreased physical activity, accelerated muscle weakness, and a subsequent loss of autonomy in daily life. Pain has been identified as the primary factor limiting participation in daily activities and remains a leading cause of disability [4,5]. Furthermore, approximately 80% of patients experience significant functional limitations, and 25% are rendered unable to perform activities of daily living independently [6]. The complex interaction between chronic pain, persistent fatigue, and reduced physical function often leads to a vicious cycle, substantially increasing the risk of psychological distress, such as anxiety and depression [7]. Consequently, holistic nursing assessments must address not only the physical restrictions of OA but also the intertwined psychological toll that exacerbates functional decline [8].

Total joint arthroplasty (TJA) is considered a highly effective surgical intervention for advanced OA, significantly relieving joint pain and restoring mechanical function [9,10]. However, postoperative patients frequently exhibit persistent impairments, including reduced quadriceps strength, impaired proprioception, and substantial balance deficits [11,12]. These residual deficits often stem from pre-existing muscle atrophy and altered gait patterns that surgery alone cannot correct, which increases the post-discharge fall risk [13,14]. Therefore, structured postoperative rehabilitation plays a critical role in restoring functional capacity and ensuring safe transition back to the community [15,16].

Recent evidence suggests that habilitation programs, particularly those incorporating resistance training, can effectively optimize postoperative outcomes. Rehabilitation interventions have been shown to enhance muscle strength, joint mobility, and gait performance, while reducing pain and improving overall patient satisfaction [17,18]. Early initiation of rehabilitation is especially crucial, as it facilitates muscle activation, prevents disuse atrophy, and reduces postoperative anxiety [18]. Moreover, clinical nurses play a pivotal role in early mobilization, patient education, and monitoring adherence, which are fundamental to the success of these exercise protocols [19-21].

Resistance training has been widely recognized as a key non-pharmacological cornerstone for OA management [22,23]. It plays a crucial role in strengthening periarticular muscles, improving joint stability, and reducing mechanical stress on affected joints [23]. Compared with conventional physiotherapy, resistance training has demonstrated superior long-term effects in mitigating pain and enhancing physical function [16]. In addition, current international clinical guidelines strongly

recommend incorporating resistance exercises alongside aerobic and multimodal interventions to optimize patient treatment outcomes [5,24-25]. Despite these established benefits, existing studies often overlook individualized exercise prescriptions, which may limit the clinical effectiveness and safety of rehabilitation programs. Tailored interventions based on patient-specific conditions, preferences, and comorbidities are therefore recommended to maximize therapeutic outcomes [2]. In older adults, lower extremity muscle strength is a critical determinant of mobility, balance, and independence, Resistance training has been shown to improve muscle mass, functional fitness, and reduce fall risk, thereby enhancing overall quality of life [26]. Emerging approaches, such as low-intensity resistance training combined with blood flow restriction, have also demonstrated promising results in improving muscle strength while minimizing cardiovascular stress in elderly populations [27]. However, implementing such specialized protocols in nursing practice requires scalable, progressive, and easily monitored designs that ensure patient safety and compliance outside controlled clinical environments [28].

Although previous studies have demonstrated the effectiveness of resistance training in patients with OA, most interventions have focused primarily on the affected limb [29,30]. Limited evidence exists regarding bilateral or progressive resistance training strategies following joint replacement surgery, leaving a knowledge gap regarding how non-affected limb conditioning influences overall symmetry and balance [17,29]. Because asymmetric gait and unilateral compensation frequently persist post-surgery, focusing solely on the operated limb may compromise long-term balance and increase the risk of contralateral joint degeneration [31,32]. Therefore, further investigation is

warranted to explore optimized, comprehensive rehabilitation protocols that systematically incorporate both affected and non-affected limbs.

This study aims to examine the effects of a progressive resistance training program following joint replacement surgery in patients with osteoarthritis, with a focus on improving lower extremity muscle strength and functional outcomes. The specific aims of this study were to:

1.Evaluate the effects of a progressive resistance training program on postoperative lower extremity muscle endurance and balance in patients with osteoarthritis.

2.Evaluate the effects of a progressive resistance training program on postoperative pain and health-related quality of life in patients with osteoarthritis.

Method

Study design and participants

The data collection phase spanned from January 01, 2025, to December 3,2025. This study employed an experimental design with a three-month follow-up. Participants were recruited from the orthopedic ward of a medical center in Hualien, Taiwan, between January and December 2025. Eligible participants were patients with osteoarthritis who underwent first-time unilateral lower limb total joint arthroplasty and had no planned surgery on the contralateral limb.

Inclusion criteria: 1. clear consciousness and ability to communicate in Mandarin or Taiwanese, 2. independent ambulation before surgery, 3. adequate vision and hearing with correction if needed,4. community-dwelling status, 5. patients who are willing to participate in this study. Exclusion criteria included 1. inability to ambulate independently, 2. medical contraindications to exercise, 3. severe musculoskeletal conditions other than osteoarthritis, same-day admission and surgery, and 4.

bilateral joint arthroplasty.

Sample size

Sample size estimation was conducted using G*Power version 3.1.9.7 for repeated-measures analysis (effect size f = 0.25, α = 0.05, power = 0.80) [33,34], indicating a required sample of 24 participants. All participants completed the intervention and follow-up assessments. The recruitment process is illustrated in Figure 1.

Intervention

Participants were allocated to either an experimental group or a control group. The control group received routine postoperative rehabilitation care. The experimental group received a progressive lower extremity resistance exercise program in addition to routine care. The resistance exercise program used 1-kg ankle weights and included seated knee extension, standing hamstring curls, and hip abduction. The protocol was developed based on existing literature and refined through consultation with an experienced physical therapist.

During the first postoperative month, resistance training was performed on the non-operated limb only (two sets per exercise). During the second month, resistance training continued the non-operated limb (three sets) and was introduced to the operated limb (two sets). During the third month, training volume was further increased, with four sets for the non-operated limb and three sets for the operated limb. Each set consisted of 10 repetitions with a 1-minute rest between sets. Training sessions were conducted three times per week. Participants received an illustrated exercise reminder leaflet to enhance exercise literacy, adherence, and safety.

Outcome measures

Outcome measures included demographic and clinical characteristics, quality of life, lower extremity muscle endurance tests, balance ability assessments and pain intensity ratings. Data were collected preoperatively, prior to discharge, and at one and three months postoperatively.

Data analysis

Data were analyzed using SPSS for Windows version 26.0. Descriptive statistics were used to

summaries demographic and clinical characteristics. Group differences at baseline were examined using chi-square tests for categorical variables and independent-sample *t* tests for continuous variables.

To examine between-group differences over time while controlling for potential covariates, analysis of covariance (ANCOVA) and generalized estimating equations (GEE) were employed. GEE models were used to analyze longitudinal changes and group-by-time interaction effects across the four measurement points. A *p* value of less than 0.05 was considered statistically significant.

Ethical considerations

Ethical approval for this study was obtained from the Institutional Review Board of the participating medical centre (approval number: IRB114-014-B). All participants received a detailed explanation of the study purpose, procedures, potential risks, and benefits before enrolment. Written informed consent was obtained from all participants. Participation was voluntary, and participants were informed of their right to withdraw from the study at any time without affecting their medical care. All data were anonymized and handled confidentially in accordance with ethical guidelines [40].