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Multivariate Analysis of Quadriceps Function and Morphology as Predictors of Physical Activity after Total Knee Arthroplasty

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Abstract

This single-center cohort study examined how certain preoperative factors — such as overall physical capability and the size and tissue composition of the quadriceps femoris — relate to physical activity (PA) levels measured 1 year after total knee arthroplasty (TKA). A total of 204 patients with knee osteoarthritis who underwent TKA were included and later divided into two groups based on whether their physical activity increased or decreased. Variables that showed notable differences between these groups (non-operative-side quadriceps strength, knee injury, and osteoarthritis outcome score (KOOS) Sport/Rec subscale, operative-side cross-sectional area (CSA) of the vastus medialis (VM), and operative-side computed tomography attenuation value (CTV) of the vastus lateralis (VL)) were entered into a multiple logistic regression analysis. Using the receiver operating characteristic (ROC) curve, researchers calculated the preoperative VM CSA cutoff value needed for patients to achieve adequate PA points at the one-year postoperative mark.The multivariate logistic regression analysis indicated that non-operative-side quadriceps strength, KOOS Sport/Rec score, operative-side CSA of the VM, and operative-side CTV of the VL were independently linked to higher physical activity following TKA. The ROC analysis produced a cutoff value of 10.2 cm².The results imply that the amount and condition of muscle tissue before surgery, especially in the vastus medialis, exert considerable influence on physical activity outcomes one year after TKA.

Keywords: Knee osteoarthritis, Muscle quantity, Muscle quality, Physical activity, Quadriceps femoris, Total knee arthroplasty

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Introduction

Knee osteoarthritis (KOA) is a common degenerative joint condition that primarily affects older individuals and is the leading contributor to mobility limitations in the adult population [1, 2]. The discomfort and movement restrictions associated with KOA tend to diminish both daily physical activity (PA) and general quality of life (QOL) [3]. Surgeons perform total knee arthroplasty (TKA) primarily to restore better physical function, encourage greater PA, raise health-related QOL, and help patients enjoy a longer span of healthy living [4-6]. For this reason, the extent of postoperative physical activity is considered an essential measure of success for patients undergoing TKA. Even so, roughly 10–33% of patients still face ongoing pain and struggle with routine tasks long after the procedure [7]. Muscle weakness appears to be a central reason for these difficulties; it is already widespread before surgery, tends to worsen afterward, and is strongly tied to reduced function and lower activity [8, 9].

As the chief extensor of the knee and its primary dynamic stabilizer, the quadriceps plays a decisive role in enabling patients to resume physical activity after TKA [10]. In people with knee osteoarthritis, quadriceps weakness often develops and can accelerate joint degeneration [11]. Research by Mizner *et al*. showed that the level of quadriceps strength present before the operation can forecast functional abilities — including performance on stair climbing and the timed "Up & Go" test — at the one-year follow-up after TKA [12]. Other earlier investigations likewise found that quadriceps strength on the unaffected side measured preoperatively could anticipate both the amount of PA and walking speed achieved after the replacement [13, 14]. Evaluations using computed tomography (CT) further reveal that the cross-sectional area (CSA) of the quadriceps at the mid-thigh reliably estimates overall skeletal muscle mass [15].

In contrast, the CT attenuation value (CTV) of the same muscle group at that level displays an inverse relationship with physical activity [16]. Because fat tissue registers negative values and muscle registers positive values on CT scans, the two can be clearly separated [17]. Notably, the buildup of fat inside the quadriceps seems to harm a person's capacity for physical activity and daily living tasks even more than an outright reduction in muscle volume [16]. It follows that lower preoperative values for quadriceps strength, CSA, and CTV could have an unfavorable impact on activity levels once the new joint is in place. Still, exactly which aspects of quadriceps quantity and quality before surgery most strongly shape PA recovery after TKA have not been clearly established.

The present study set out to uncover preoperative risk factors — focusing on physical function and the quantity and quality of the quadriceps femoris — that affect physical activity measured 1 year following total knee arthroplasty. The working hypothesis was that lower preoperative quadriceps strength, along with reduced operative-side CSA and CTV of the quadriceps, would be associated with a decline in postoperative physical activity.

Materials and Methods

Study design

This single-center cohort study recruited individuals with knee osteoarthritis (KOA) scheduled for primary total knee arthroplasty (TKA). From January 2019 to August 2023, a consecutive series of 247 patients were enrolled across the participating hospitals **(Figure 1)**. Patients were excluded if they had undergone revision TKA, presented with severe cognitive impairment, used a primary language other than Japanese, had received any other lower limb surgery, or withdrew from participation. After applying these criteria, 43 patients were removed, leaving 204 participants for final inclusion. These patients were categorized into two groups based on whether the score for item 4 of the Japanese version of the 2011 Knee Society Score (KSS) increased or decreased 1 year after the preoperative baseline. All participants provided written informed consent before enrollment. The study protocol received approval from the Ethics Review Committee of our institution (113,786).

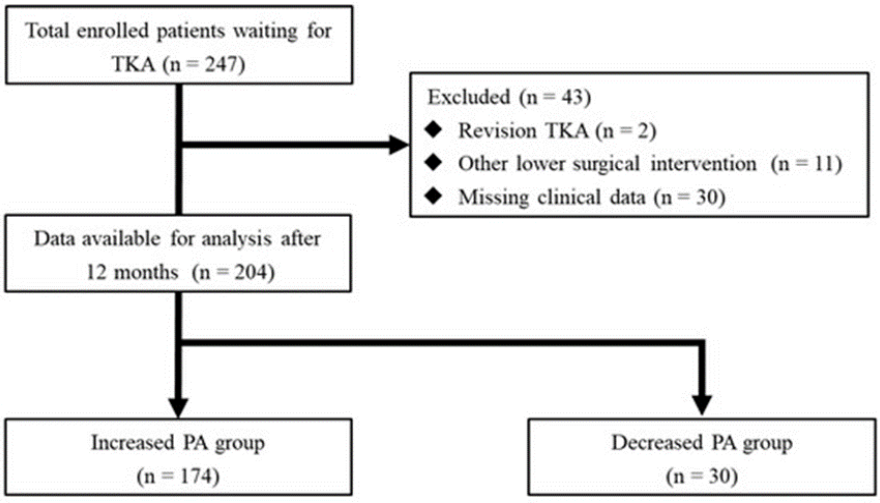

Figure 1. Flow chart of patient recruitment into this study.

Surgical technique and rehabilitation protocol

Two experienced orthopedic surgeons carried out all TKA procedures at the university hospital. The operations utilized either the subvastus or medial parapatellar approach, following the mechanical alignment technique. Rehabilitation commenced on the first postoperative day and allowed immediate full weight-bearing on the operated leg. The primary rehabilitation target was to enable independent walking with a cane by two weeks postoperatively. The program incorporated targeted exercises to enhance knee flexion and extension range, progressive lower-limb strengthening, gait retraining, and practice of essential activities of daily living (ADL).

Assessment variables

Collected clinical data encompassed basic demographic details (sex, age at surgery, height, weight, body mass index, history of contralateral TKA, surgical approach, Kellgren–Lawrence grade, 10 m gait time, range of motion (ROM) for knee flexion and extension, quadriceps muscle strength, one-leg standing time, and knee pain intensity measured on the numerical rating scale [NRS]); femorotibial angle; and scores from the knee injury and osteoarthritis outcome score (KOOS). Preoperative evaluation of skeletal muscle also involved measuring the cross-sectional area (CSA) and computed tomography attenuation value (CTV) for the vastus medialis (VM), vastus lateralis (VL), vastus intermedius (VI), and rectus femoris (RF).

Physical function tests

The 10 m gait time was recorded while patients walked at their preferred comfortable speed along a 14 m straight course, which included an extra 2 m at both the start and finish for acceleration and deceleration [18]. Timing was performed with a stopwatch, capturing only the central 10 m segment. Passive knee range of motion was assessed with a standard goniometer (Toudaisiki Goniometer; OG Wellness Co., Ltd., Okayama, Japan). Quadriceps and hamstring muscle strength were quantified using a handheld dynamometer (μTas F-1; ANIMA, Tokyo, Japan). Measurements were performed according to a previously validated protocol for quadriceps strength assessment [19]. Participants sat with the hip and knee flexed at 90°, and isometric knee extension force was recorded twice. The maximum value, reported in newtons, was retained for analysis. One-leg standing time was determined by measuring how long participants could hold the raised leg off the floor before it touched down due to loss of balance; the test was repeated twice with a 60 s upper limit, and the longer duration was used for statistical purposes. This measure served as an indicator of static postural stability [20]. Knee pain intensity was rated on the numerical rating scale (NRS) from 0 (no pain) to 10 (worst possible pain).

Patient-reported outcome measures

Participants completed the Japanese version of the Knee Society Score (KSS) on two occasions: once before surgery and again at the one-year follow-up [21]. All KSS questionnaires were filled out during hospital visits. Physical activity (PA) was quantified preoperatively and one year after TKA using item 4 of the KSS, which employs a 0–100-point scale where 100 represents the highest possible level of activity [22]. This instrument evaluates four domains — symptoms, patient expectations, satisfaction, and physical activity — in individuals who have undergone TKA [22].

In addition, the Knee Injury and Osteoarthritis Outcome Score (KOOS) was collected. This 42-item self-reported questionnaire specifically evaluates knee health across five subscales: pain (9 items), symptoms (7 items), activities of daily living (17 items), sports and recreation function (5 items), and knee-related quality of life (4 items). Respondents selected one of five Likert-scale options for each item. Subscale scores were then transformed to a 0–100 range, with 0 indicating extreme difficulties and 100 indicating no problems [23].

Skeletal muscle assessment

Evaluation of muscle size and tissue composition was conducted by quantifying cross-sectional area (CSA) and examining computed tomography attenuation values (CTV) on transverse CT slices **(Figure 2)**. Scans were obtained at the midpoint of the thigh, located exactly halfway between the top border of the patella and the groin fold (scan settings: 120 kV, 120 mA; rotation time of 1 s; field of view: 233 mm) [24]. Analysis was carried out using EV Insite imaging software (PSP Corporation, Tokyo, Japan). In every case, the outlines of the vastus medialis (VM), vastus lateralis (VL), vastus intermedius (VI), and rectus femoris (RF) were manually traced, followed by automatic computation of CSA and CTV for each muscle group [24]. While CSA reflected overall muscle volume along with surrounding intermuscular fat, CTV served as an indicator of muscle tissue integrity by revealing the extent of fat deposits within and between muscle fibers. On average, CTV readings for typical muscle tissue range from 40 to 100 Hounsfield Units (HU). Reduced HU levels indicated lower muscle density and, consequently, diminished muscle quality. The accuracy and usefulness of this CT measurement technique have been supported by prior investigations [25].

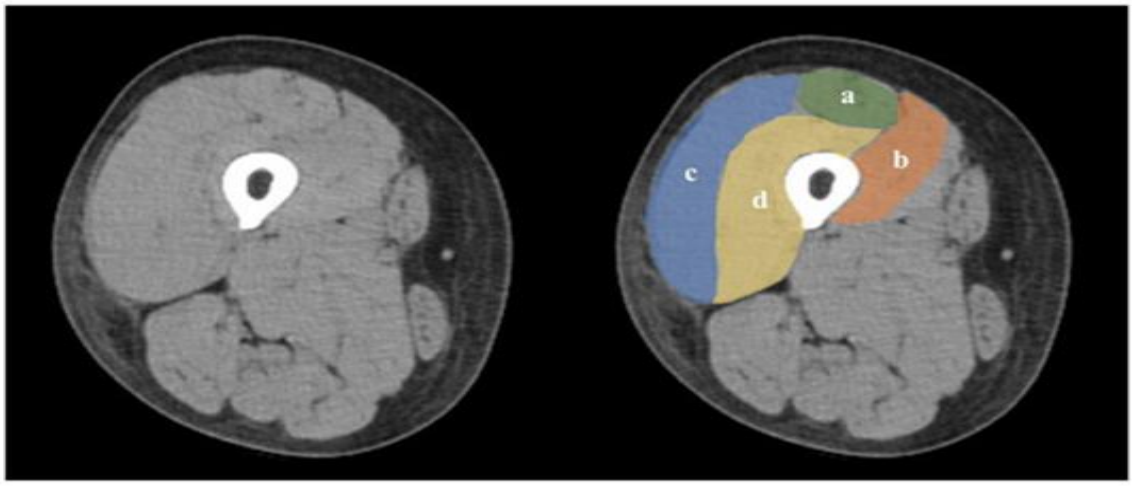

Figure 2. CT-based assessment of the quadriceps muscle group. Cross-sectional image at the mid-thigh level: a) rectus femoris, b) vastus medialis, c) vastus lateralis, and d) vastus intermedius. Abbreviation: CT = computed tomography.

Data analyses

Statistical power for the entire investigation was computed with GPower version 3.1.9.7 (Franz Paul, Kiel, Germany). Before data collection, a power calculation for univariate comparisons indicated that a minimum of 142 participants would be required, assuming a medium effect size (d) of 0.50, a significance level (α) of 0.05, and a desired power of 0.80. An additional a priori power analysis for the multiple logistic regression model determined that 129 patients would suffice, given an effect size (f^2) of 0.15, α of 0.05, power of 0.95, and four anticipated predictor variables [26].

Data distribution was examined via the Shapiro–Wilk test to check for normality, and variance equality was verified using the F-test when relevant. Between-group comparisons for variables meeting normality assumptions were performed with the Student's t-test or Welch's t-test. In contrast, non-normal data were analyzed using the Wilcoxon rank-sum test or Pearson's chi-square test. To pinpoint independent contributors to physical activity (PA) status one year after the procedure, multivariate logistic regression modeling was applied. The binary outcome of PA level at the one-year postoperative point served as the dependent variable, and factors that were statistically significant in the initial univariate tests were selected as candidate predictors. Lastly, the minimum preoperative CSA threshold of the vastus medialis (VM) needed to attain satisfactory PA scores at one year was derived from receiver operating characteristic (ROC) curve analysis. All computations were executed in SPSS Statistics (version 27.0.0.0; IBM, Armonk, NY, USA), and results were considered statistically significant at $P < 0.05$.

Results and Discussion

Table 1 displays the baseline characteristics of the enrolled participants. Within the study cohort of 204 individuals, 30 patients assigned to the decreased PA category showed a more pronounced decline in activity levels 1 year after TKA than preoperatively. In contrast, the increased PA category recorded a substantially higher activity score at the one-year mark compared with the decreased PA category (increased PA group: 68.6 ± 14.3 points; decreased PA group: 40.8 ± 7.7 points; $P < 0.001$) **(Figure 3)**.

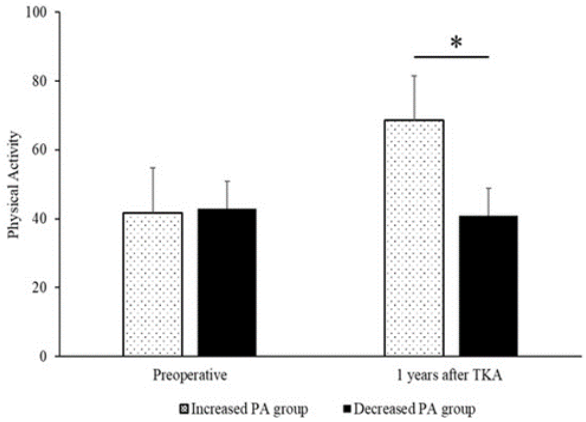

Figure 3. Preoperative versus one-year postoperative shifts in physical activity levels. Marked differences are evident between the two groups ($P < 0.001$). Abbreviation: TKA = total knee arthroplasty.

Table 1. Baseline characteristics of the study population.

Patient Demographics and Clinical Characteristics	
Variable	**Value**
Sex (male:female)	49:155
Age at surgery (years)	73.5 (8.5)
Height (cm)	155.0 (7.7)
Body weight (kg)	61.8 (10.1)
Body mass index (kg/m²)	25.7 (3.9)

History of contralateral TKA (yes/no)	48/156
Surgical Approach	
Approach Type	**Number (%)**
Subvastus approach	181 (88.7%)
Medial parapatellar approach	23 (11.3%)
Radiographic Severity (Kellgren–Lawrence Classification)	
Grade	**Number (%)**
Grade III	31 (15.2%)
Grade IV	173 (84.8%)

Abbreviations: BMI = body mass index; TKA = total knee arthroplasty.

Univariate testing highlighted meaningful differences in non-operative-side quadriceps strength, KOOS Sport/Rec subscale scores **(Table 2)**, operative-side CSA of the VM, and CTV of the VL **(Table 3)**. The subsequent multivariate logistic regression model **(Table 4)** revealed that non-operative-side quadriceps strength (odds ratio (OR): 1.011; 95% confidence interval (CI): 1.004–1.018; P = 0.001), KOOS Sport/Rec score (OR: 1.037; 95% CI: 1.003–1.073; P = 0.033), operative-side CSA of the VM (OR: 1.544; 95% CI: 1.124–2.119; P = 0.007), and operative-side CTV of the VL (OR: 1.222; 95% CI: 1.063–1.404; P = 0.005) emerged as significant independent predictors of achieving adequate physical activity one year after TKA. According to the ROC curve, a preoperative operative-side CSA value of 10.2 cm² for the VM represented the optimal cutoff for forecasting successful PA attainment at the one-year follow-up (sensitivity: 0.79; specificity: 0.67), with an area under the curve of 0.70 **(Figure 4)**.

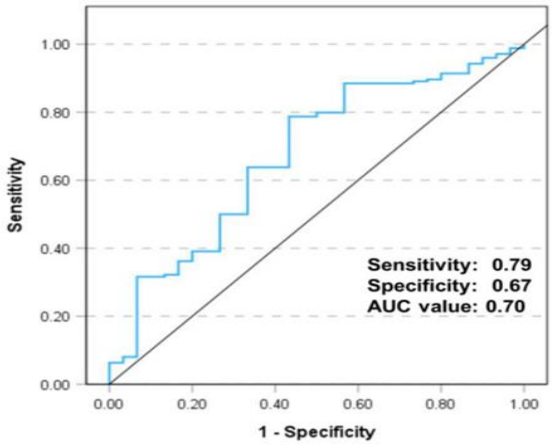

Figure 4. Determination of threshold values for CSA of the vastus medialis on the operative side. The receiver operating characteristic curve yields an area under the curve of 0.70 when distinguishing between increased and decreased physical activity at one year post-surgery. The best preoperative cutoff point for predicting adequate PA at one year was an operative-side VM CSA of 10.2 cm² (sensitivity: 0.79; specificity: 0.67). Abbreviations: CSA = cross-sectional area, VM = vastus medialis, PA = physical activity, and AUC = area under the curve.

Table 2. Preoperative variable comparison according to increased versus decreased physical activity at one year.

Variable	p-value	95% Confidence Interval	Lower PA Group (n = 30)	Higher PA Group (n = 174)
Clinical characteristics				
Sex (male:female)	0.496	−0.11, 0.23	6:24	43:131
Age at surgery (years)	0.921	−3.17, 3.51	73.0 (7.2)	72.8 (8.7)
Height (m)	0.103	−5.45, 0.50	152.9 (3.7)	155.4 (7.8)
Body weight (kg)	0.322	−5.96, 1.97	60.1 (10.3)	62.1 (9.6)
Body mass index (kg/m²)	0.948	−0.11, 0.23	25.7 (4.0)	25.7 (3.6)
Previous contralateral TKA	0.624	−0.21, 0.13	6	42
10-meter walking time (s)	0.672	−1.64, 2.51	13.5 (5.2)	13.1 (5.2)
Operated limb				
Knee flexion ROM (°)	0.390	−8.95, 3.51	108.0 (14.4)	110.7 (16.2)
Knee extension ROM (°)	0.831	−2.87, 2.31	−8.2 (7.1)	−7.9 (6.5)
Quadriceps muscle strength (N)	0.086	−49.46, 3.27	146.7 (53.7)	169.9 (69.7)
Single-leg stance duration (s)	0.263	−10.32, 2.83	18.3 (16.2)	22.0 (17.0)
Knee pain score	0.055	−1.23, 0.01	3.4 (1.9)	4.0 (1.5)
Femorotibial angle (FTA)	0.177	−3.53, 0.68	186.2 (5.3)	187.6 (5.4)
Non-operated limb				
Knee flexion ROM (°)	0.845	−4.34, 5.29	129.5 (11.5)	129.0 (12.5)
Knee extension ROM (°)	0.163	−0.52, 3.09	−1.3 (3.5)	−2.6 (4.8)
Quadriceps muscle strength (N)	<0.001	−87.49, −30.17	154.4 (68.3)	213.2 (74.4)
Single-leg stance duration (s)	0.657	−7.79, 11.92	33.5 (24.9)	31.4 (23.3)
Knee pain score	0.482	−0.57, 1.08	1.8 (2.1)	1.5 (1.8)

Femorotibial angle (FTA)	0.654	−0.21, 0.57	176.9 (1.5)	176.8 (1.4)
Patient-reported outcomes (PROMs)				
KOOS – Symptoms	0.882	−6.72, 7.81	49.5 (16.5)	48.9 (19.0)
KOOS – Pain	0.164	−13.05, 0.26	41.5 (19.1)	46.9 (19.6)
KOOS – Activities of Daily Living	0.639	−9.69, 5.96	50.2 (18.4)	52.1 (20.3)
KOOS – Sports/Recreation	0.010	−14.72, −2.04	13.8 (11.6)	22.1 (16.9)
KOOS – Quality of Life	0.806	−7.90, 6.15	26.0 (19.7)	26.8 (17.7)

Abbreviations: PA = physical activity, BMI = body mass index, TKA = total knee arthroplasty, FTA = femorotibial angle, PROMs = patient-reported outcome measures, KOOS = knee injury and osteoarthritis outcome score, ADL = activities of daily living, QOL = quality of daily life, Sport/Rec = sports and recreation function, and CI = confidence interval.

Table 3. Preoperative variable comparison according to sufficient versus insufficient physical activity at one year.

Variable	P-value	95% confidence interval	Lower PA group (n = 30)	Higher PA group (n = 174)
Operated limb				
Muscle cross-sectional area				
Vastus medialis (cm²)	< 0.001	−1.53, −0.30	10.4 (1.5)	11.6 (1.8)
Vastus lateralis (cm²)	0.619	−0.55, 0.33	19.1 (1.0)	19.2 (1.1)
Vastus intermedius (cm²)	0.491	−0.79, 1.65	17.0 (1.0)	17.1 (1.1)
Rectus femoris (cm²)	0.384	−0.21, 0.31	6.5 (0.5)	6.4 (0.7)
CT attenuation values				
Vastus medialis (HU)	0.065	−2.19, 0.07	43.5 (2.9)	44.5 (2.9)
Vastus lateralis (HU)	< 0.001	−3.23, −0.84	43.9 (3.3)	45.9 (3.0)
Vastus intermedius (HU)	0.491	−0.79, 1.65	47.8 (3.6)	47.4 (3.3)
Rectus femoris (HU)	0.384	−0.71, 1.83	48.0 (3.1)	47.5 (3.3)
Non-operated limb				
Muscle cross-sectional area				
Vastus medialis (cm²)	0.761	−0.34, 0.46	12.0 (1.1)	11.9 (1.0)
Vastus lateralis (cm²)	0.979	−0.63, 0.61	21.9 (1.7)	21.9 (1.6)
Vastus intermedius (cm²)	0.923	−0.29, 0.32	17.3 (0.8)	17.3 (0.8)
Rectus femoris (cm²)	0.945	−0.29, 0.31	7.0 (0.9)	7.0 (0.8)
CT attenuation values				
Vastus medialis (HU)	0.801	−0.62, 0.80	51.3 (2.2)	51.3 (1.7)
Vastus lateralis (HU)	0.915	−0.76, 0.68	51.3 (2.1)	51.4 (1.8)
Vastus intermedius (HU)	0.646	−0.75, 1.21	51.2 (2.9)	51.0 (2.5)
Rectus femoris (HU)	0.863	−0.77, 0.65	50.5 (1.8)	50.6 (1.8)

CI, confidence interval; PA, physical activity; HU, Hounsfield unit.

Table 4. Preoperative factors predicting increased physical activity one year after primary TKA.

Variable	P-value	Odds Ratio (OR)	95% CI (Upper)	95% CI (Lower)
Quadriceps strength on the non-operated side (N)	0.001	1.011	1.018	1.004
KOOS Sports and Recreation score	0.033	1.037	1.073	1.003
Cross-sectional area of the vastus medialis (operative limb)	0.007	1.544	2.119	1.124
CT attenuation value of the vastus lateralis (operative limb)	0.005	1.222	1.404	1.063

Abbreviations: KOOS = knee injury and osteoarthritis outcome score, CSA = cross-sectional area, CTV = computed tomography attenuation values, and Sport/Rec = function in sports and recreation.

The present investigation identified multiple preoperative factors associated with reduced physical activity (PA) 1 year after total knee arthroplasty (TKA). The outcomes provided partial confirmation of the initial hypothesis, which proposed that lower preoperative quadriceps strength, together with diminished operative-side quadriceps cross-sectional area (CSA) and computed tomography attenuation value (CTV), would be associated with a decline in postoperative PA. From a practical standpoint, the key message of this work is that enhancing the preoperative size of the vastus medialis (VM) and the tissue quality of the vastus lateralis (VL) may help elevate PA levels after TKA.

The data revealed that individuals with weaker quadriceps strength on the non-operated side were more likely to fail to show gains in PA at the one-year mark after TKA. This observation aligns with earlier reports [8, 13, 27] that likewise linked preoperative non-operated-side quadriceps strength to later functional performance. Prior research has also shown that quadriceps strength on the opposite leg before surgery can forecast postoperative PA, stair ascent capability, and walking velocity [13, 14]. In patients undergoing unilateral TKA, the unaffected leg often assumes a compensatory role during both rehabilitation sessions and routine activities. Those possessing greater quadriceps power on the non-operated side appeared better equipped to bear body weight while walking, negotiating stairs, or performing other demanding movements, thereby facilitating smoother recovery and superior mobility. These observations underline the value of preoperative exercise regimens that target both the involved limb and the contralateral leg to maximize overall postoperative progress.

Current findings demonstrated that preoperative CSA of the VM and CTV of the VL exerted a noticeable influence on PA after the operation. Furthermore, a preoperative CSA value of 10.2 cm^2 for the VM emerged as the critical threshold for forecasting better PA outcomes one year post-TKA. An earlier investigation reported markedly thinner VM muscle in individuals with advanced knee osteoarthritis compared with healthy controls [28]. Another study found elevated intramuscular fat levels in the VM in patients with early-stage knee osteoarthritis, compared with healthy controls [29]. With advancing age, accumulation of fat inside the quadriceps tends to precede any measurable reduction in muscle volume [16]. As a key component of the quadriceps complex, the VM plays an essential part in maintaining knee joint stability during dynamic tasks such as level walking, stair negotiation, and deep squatting [30, 31]. Consequently, greater fat infiltration within the VM may undermine knee stability and, in turn, restrict PA. Earlier work has indicated that resistance-based exercise programs can enhance both muscle volume and tissue composition [32, 33]. Moreover, intensive preoperative strength training has been shown to boost lower-extremity muscle force and knee range of motion, leading to shorter hospital stays and accelerated functional gains following TKA [34, 35]. Clinically, these insights stress the need for well-designed preoperative training protocols, and future research should examine whether such interventions can successfully reduce muscle fat content and increase volume after TKA. One previous report suggested that high-speed resistance training may outperform slower training in improving muscle quality [36]. Thus, incorporating high-velocity resistance training in the preoperative phase could yield benefits extending beyond simple muscle enlargement to include superior muscle composition.

This investigation also found that patients presenting with lower preoperative KOOS Sport/Rec scores had higher odds of limited PA improvement 1 year after TKA. The Sport/Rec subscale specifically gauges a person's capacity to perform demanding activities such as squatting, running, or jumping, all of which place substantial demands on knee strength and control [37, 38]. Lower scores on this subscale before surgery likely signal more severe restrictions in these challenging movements and point to greater overall knee impairment. Several systematic reviews have indicated that PA may begin to rebound within three months after TKA and often surpasses baseline levels by 6 to 12 months [39, 40]. Nevertheless, the majority of TKA recipients still display lower activity levels than age-matched healthy individuals even at the one-year follow-up [39-41]. Such persistent shortfalls may stem from the underlying condition of the replaced knee and from reduced strength, coordination, and general fitness of the contralateral limb. As a result, patients with poorer preoperative KOOS Sport/Rec scores may encounter greater difficulty regaining full mobility and achieving elevated PA during recovery.

Several limitations should be acknowledged in this study. First, PA was evaluated solely through patient-reported instruments, namely the KSS. Consequently, the activity data collected here may diverge from measurements obtained via objective devices such as tri-axial accelerometers or step counters. Second, because this was a single-center investigation, the results may not readily apply to other patient groups or different clinical environments. Larger multicenter trials will be necessary to validate these observations across varied populations and healthcare contexts. Finally, the analysis centered primarily on the quadriceps femoris. However, additional muscle groups around the knee, including the hamstrings, likely contribute meaningfully to joint stability, movement efficiency, and overall physical activity. As antagonists of the quadriceps, the hamstrings help counteract forward tibial shift and reduce stress on the new joint during gait and other movements. Although these surrounding muscles were not assessed, they may also have influenced postoperative PA and functional restoration.

Conclusion

Preoperative quadriceps strength on the non-operated side, operative-side CSA of the VM, CTV of the VL, and preoperative KOOS Sport/Rec scores emerged as meaningful predictors of attaining higher physical activity levels one year after TKA. Overall, these findings indicate that preoperative quadriceps strength, along with muscle quantity and quality—especially regarding the VM—has considerable significance for physical activity outcomes following TKA.

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Conflict of interest: None

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Ethics statement: This study was conducted in accordance with the Declaration of Helsinki and was approved by the Ethics Committee of Kanazawa University (113786, 18 August 2021).
Informed consent was obtained from all participants involved in the study.

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