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Effect of total knee replacement surgery and postoperative 12 month home exercise program on gait parameters

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ABSTRACT

Objective: To evaluate the effects of surgery and a postoperative progressive home exercise program on gait parameters among individuals operated with total knee arthroplasty.
Design: Single blinded randomized controlled trial.
Subjects: 108 patients (84 females, 24 males, mean age 69 years).
Interventions: Patients were equally randomized into an exercise group (EG) and control group (CG). The 12-months progressive home exercise program starting two months postoperatively was compared to usual care.
Methods: Gait analysis was performed using the Gaitrite electronic walkway system. In addition, knee extension and flexion strength were measured by a dynamometer preoperatively, and pain on visual analog scale (VAS) at two months and 14 months postoperatively.
Results: At the 12–month follow-up, maximal gait velocity ($p = 0.006$), cadence ($p = 0.003$) and stance time ($p = 0.039$) showed a greater increase among EG than CG. All the other gait parameters improved among both groups, but with not statistically discernible difference between groups. Weak correlations were found between changes in maximal gait velocity and the knee extension ($r = -0.31$, $p = 0.002$), flexion strength ($r = 0.28$, $p = 0.004$) and pain during loading ($r = -0.27$, $p = 0.005$) values.
Conclusion: The intervention produced statistically significant changes in maximal gait velocity, cadence and stance times in the exercise group compared to controls. Although the average change was small it is of importance that biggest changes occurred in those with low performance.

1. Introduction

Total knee arthroplasty (TKA) is an effective treatment to reduce pain and subjective disability in patients with osteoarthrosis of the knee, but several studies have shown that muscle strength deficiency [1–3] and functional limitations may persist for several years after the operation [4–6].

The radiological degree of severity of knee arthrosis has an influence on gait and compensatory mechanisms during walking [7,8]. Gait velocity among individuals with knee arthrosis has been established to be slower than among healthy controls at same age [8,9–12]. Among individuals with knee arthrosis average gait velocity is 23%, cadence 33% lower and step length 13% shorter than among healthy controls [13]. Furthermore, despite having the same gait velocity, the duration of the support phase of the gait cycle becomes slightly longer among knee OA individuals than healthy controls [12,14,15].

Previous investigations have explored TKA and its influence on gait. Kramers-de Quervain et al. [16] stated that gait velocity and cadence were significantly improved two years after TKA surgery. Thewlis et al. [17] found that the detected gait asymmetries before the TKA, were no longer identified at six months postoperatively. Rehabilitation protocols for patients after TKA are often institution specific and no universally accepted protocol exists [18]. In a systematic review by Pozzi et al. [18], it was concluded that optimal physical therapy protocols after TKA should include progressive strengthening and intensive functional exercises either through land-based or aquatic programs. Studies included in the review used intervention durations from 4 to 12 weeks and

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to our knowledge studies investigating the long-term training effects on gait parameters in patients after TKA do not exist.

The primary aim of this study was to examine the effect of a one year progressive postoperative home exercise program on gait parameters among individuals with TKA starting 2 months postoperatively. In addition, the associations between the maximal gait velocity and the changes in knee muscle strength and pain were studied. Another purpose was to examine changes in gait velocity and cadence in the early postoperative phase.

2. Subjects, evaluation and intervention

The study was carried out in the Central Finland Central Hospital. The subjects were recruited from patients selected for TKA during a preoperative orientation visit to the clinic. The inclusion criteria were 1) diagnosed knee OA, 2) primary arthroplasty of the knee in question, and 3) age over 18 years. The exclusion criteria were 1) other surgery for lower limbs planned to be carried out within 12 months, 2) dementia, 3) other serious co-morbidities preventing active training, and 4) difficulty in visiting a physiotherapist due to long travelling distance. Conventional medial parapatellar approach was used in all operations in this study. Tourniquet was used routinely in all TKA operations. No mini invasive, subvastus, midvastus, lateral (Keplish) or any kind of mini-invasive approaches were used. Of the total of 301 patients, 191 were excluded (Fig. 1) and 108 volunteer patients were randomized into either the exercise group (EG, n = 53) or control group (CG, n = 55), using a computer-generated randomization list. The mean age (range) of the participants was 69.3 years (58–78) (Table 1).

The gait analysis and clinical measurements were performed before the TKA, two months after the operation at the time when the exercise intervention started, and at 12 months thereafter. All the assessments were performed by two physiotherapists blinded to the treatment group assignment. The patients filled in a questionnaire concerning their demographic and clinical characteristics at the same time points. The study plan was approved by the ethics committee of the Central Finland Health Care District and the patients gave their written consent prior to participation in the study.

Gait analysis was performed using Gaitrite electronic walkway system v3.8 (GAITrite Gold, CIR system, PA, USA), which has been stated to be a valid and reliable tool for measuring selected spatial and temporal parameters of gait [19–21]. The overall dimensions of the walkway were 12 m × 90 cm with the active sensor area of 366 cm × 61 cm containing 13824 sensors activated by mechanical pressure. The sample rate of the Gaitrite was 80 Hz. The data were collected from self-selected normal and fast gait velocities; gait velocity, cadence, step time, cycle time, swing time, stance, single support, double support, step length, stride length, base of support and toe in/out.

2.1. Methods

The isometric knee flexion and extension strength levels were measured using a fixed dynamometer (Ds Europe, mod. 546QTD strain gauge, Milan, Italy) [22]. During the measurements, the participants were seated with the knee and hip joints at 70° flexion, and a security strap was placed over the pelvis. After three submaximal repetitions for warm-up, three maximal muscle contractions were performed with a one-minute rest period following each effort. If the third performance improved by more than 5% from the best result, an additional trial was performed. The best result of each measurement was used in the final analysis.

Knee pain was measured with the visual analog pain scale (VAS). For pain intensity, the scale is anchored by “no pain” (score of 0 mm) and “worst possible pain” (score of 100 mm) [23].

3. Measures of pathology and symptom

3.1. Early rehabilitation

The postoperative hospital stay was about one week. On discharge from the hospital, all patients received advice concerning the application of cold packs and a written exercise program which included active and passive knee range of motion exercises,

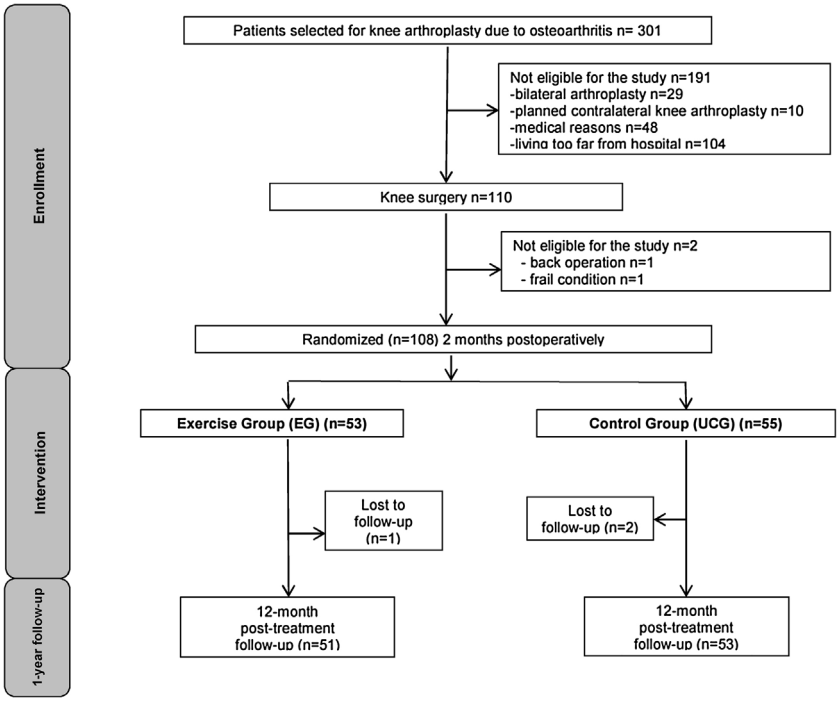

Fig. 1. Knee arthroplasty study flowchart.