The Effect of Early Progressive Isotonic Exercise Therapy on Static Balance Control of Patients with Total Knee Replacement

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ABSTRACT

Purpose: Knee osteoarthritis (OA) is believed to be an important risk factor for falling. Total knee replacement (TKR) is a commonly used choice when other methods are not satisfactory. Proprioception impairment, risk of falling and balance disorder are within the main complications of this method. While multiple protocols have been suggested for TKR, efficacy of early isotonic exercise therapy aimed at improving body balance after TKR has not been thoroughly investigated.

Methods: In this quasi-experimental study, twenty female patients with severe OA, sampled by non-randomized convenient method were randomly and equally in number assigned into either "routine"or "early isotonic exercise" groups. The subjects were undergone TKR surgery. The rehabilitation process (being the same for both groups until the second week) was initiated the day after surgery and lasted for 6 weeks. From the second week, the experimental group received progressive, isotonic exercises, in addition to the routine rehabilitation protocol. Static balance was assessed prior to surgery and after the rehabilitation process in both groups by Sharpened Romberg tests.

Results: In both groups, static balance was significantly enhanced after surgery and rehabilitation (P=0.000). Prior to surgery the groups were indifferent according to their static balance scores (P=0.423) but, after surgery and rehabilitation, the patients receiving early isotonic exercise in addition to routine physical therapy, were significantly in better balance condition comparing the control group (P=0.000).

Conclusion: Routine physical therapy with and without early isotonic exercise therapy enhances static balance but, the balance improvement was more pronounced with this type of exercise. Early administration of isotonic exercise therapy in addition to the routine physical therapy program may enhance balance and thus prevent fall in patients with TKR.

1. Introduction

The knee joint plays an important role in weight bearing and is thus susceptible to osteoarthritis (OA) [1]. Knee OA is believed to be an important risk factor for falling [2]. Various drug-based and non-medical treatments have been applied which are mainly symptomatic and do not provide a total cure [3]. Total knee replacement (TKR) is a commonly used choice when other methods are not satisfactory [4]. Proprioception impairment, pain, slow walking, difficulty in walking up and down the stairs, risk of falling

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and balance disorder in the first weeks after the surgery are the main complications of this method [5, 6]. Proprioceptive deficits have been strongly associated with degenerative changes in OA [4]. TKR procedure, used as a treatment, will itself affect proprioceptive function of the knee [5] although slow recovery after TKR has been reported. Almost half of the patients with history of falling experience other fallings within the first year after TKR [2].

Rehabilitation is crucial after TKR to regain range of motion, alleviate pain, overcome muscle inhibition and enhance proprioception and balance control [4]. Advancement in surgical procedures has encouraged physical therapists to design early and intensive rehabilitation protocols. Early rehabilitation has received increasing attention in the last decade. Reduced time to return to work and normal daily activities and patient satisfaction have been the main outcomes of early rehabilitation after total hip replacement [7, 8] but, no study was available on the efficacy of early intensive rehabilitation after TKR. While multiple protocols have been suggested for TKR rehabilitation [5, 9], efficacy of early intensive exercise therapy aimed at improving body balance after TKR has not been thoroughly investigated.

OA patients have shown to have knee muscles weakness [10] and muscular insufficiency has been associated with balance disorders in these patients [2]. The aim of this study was to investigate the effect of early progressive isotonic exercise therapy on static balance control of patients with total knee replacement. We hypothesized that early progressive isotonic exercises might enhance balance after TKR.

2. Materials & Methods

Twenty female patients with severe OA (grade 4 on Kellgren/Lawrence classification system) and candidate for unilateral TKR surgery, sampled by non-randomized convenient method were recruited into this quasi-experimental study. All subjects were informed about the content of the study and volunteered to participate by signing the informed consent form approved by the medical ethics committee of Shahid Beheshti University of Medical Sciences.

The inclusion criteria were as follows: 1) age between 60 and 75, 2) primary OA, 3) both knees candidate for TKR and 4) fixed prosthesis used for surgery. The subjects were excluded if: they had a prior TKR surgery or any deformity in lower extremities other than in the knees or any neurological or non-corrected visual deficit affecting their balance. Patients not attending all their therapeutic sessions would also be excluded from the study. The initial evaluation of the subjects, including demographic data, anthropometric characteristics and Sharpened Romberg test [11] (to evaluate static balance) was performed two days before surgery. The subjects were then undergone TKR surgery by the same surgeon and technique with fixed articular surface prosthesis.

The rehabilitation process (being the same for both groups until the second week) was initiated the day after surgery and lasted for 6 weeks. The routine physical therapy protocol used for both groups emphasized edema and pain control, range of motion regaining, ambulation, isometric exercises and gait training [4]. From the second week, the experimental group received progressive, isotonic exercises, three sessions a week for an hour per session in addition to the routine rehabilitation protocol. The isotonic exercises were as follows: 1) stationary bicycling, 2) going up and down the stairs and 3) weight lifting. The time duration of the first two exercises and the weight magnitude of the lifting task were increased weekly. The whole rehabilitation program was six weeks long and the evaluation process was repeated in the seventh week after surgery. Kolmogorov-Smirnov (K-S), paired and independent t-tests were used for statistical analysis of the data. The statistical significance level was set at $P<0.05$.

3. Results

The result of the K-S test was indicative of normal distribution of the data ($P>0.05$). Summary of the demographic data of the subjects has been presented in Table 1.

Independent t-test revealed a significant difference between the two groups after the interventions ($P=0.000$) while the Sharpened Romberg score of the groups were indifferent prior to the surgery and rehabilitation ($P=0.423$). After surgery and rehabilitation, the patients receiving progressive isotonic exercise in addition to standard physical therapy, were significantly in better balance condition comparing the control group. In both groups, paired t-test showed that static balance was significantly enhanced after surgery and rehabilitation since increments of the Sharpened Romberg score of both groups were statistically significant ($P=0.000$) (Figure1).

4. Discussion

The main purpose of this study was to investigate the effect of addition of early progressive isotonic exercises to routine physical therapy on balance of patients with TKR. The findings of this study showed that routine physical therapy, with and without early isotonic exer-

Table 1. Demographic data of the subjects.

Conditions	Group	Mean	SD	Max	Min
Age (year)	Control group	67.90	5.32	60	75
	Case group	69.40	5.73	62	77
Weight (kg)	Control group	74.40	13.03	57	60
	Experimental group	71.90	11.69	96	92
Height (centimeter)	Control group	162.40	5.96	153	172
	Experimental group	159.30	5.10	150	169
Length of foot (centimeter)	Control group	21.40	3.23	17	26
	Experimental group	21.50	1.50	18	23
Length of lower limb (centimeter)	Control group	77.60	4.88	69	83
	Experimental group	78.30	5.73	70	87
BMI (kg/m^2)	Control group	28	5	21	37
	Experimental group	30	5	23	37
Length of upper limb (centimeter)	Control group	69.00	1.88	67	73
	Experimental group	69.60	2.45	66	73
Duration of knee pain (year)	Control group	5.20	4.56	1	17
	Experimental group	5.60	5.18	1	18

PHYSICAL TREATMENTS

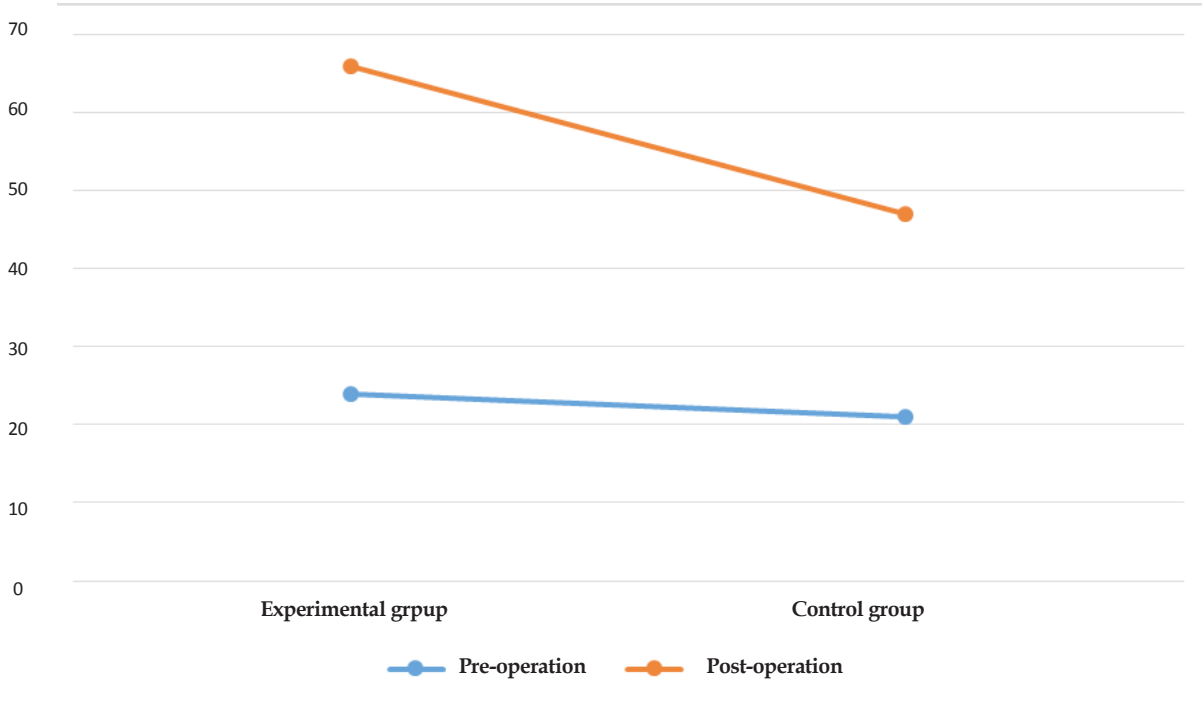

Figure 1. Descriptive values of Sharpened Romberg test results at different stages of evaluation.

PHYSICAL TREATMENTS

cise regimen, will improve static balance of severe OA patients. Routine physical therapy had previously shown to be effective in balance improvement after TKR [12-14]. Addition of early isotonic exercises to routine physical therapy led to better static balance abilities in patients with TKR. There is no definite agreement on the time of initiation of isotonic exercises necessary to enhance muscular strength and thereupon body balance. Different protocols have suggested to start these exercises from the third [4] to as late as 12 weeks after the surgery [9]. Since falling and balance loss are within major concerns in OA patients and after TKR and specially within the few days after surgery [4-6], it seems vital and worth exploring the most effective rehabilitation protocol yielding most possible balance improvement in the shortest time period.

Early progression of isotonic exercises is also beneficial by reducing the length of the rehabilitation process. While starting these exercise as late as the 6th or 12th week after surgery, the rehabilitation process will last even up to 26 weeks. This is so long and sometimes boring that many patients will not complete their rehabilitation program and thus get in difficulty with balance control, gait and activity daily living [4, 9, 14]. Rossi et al. [15] have shown the knee extensor muscles to be much weaker than pre-operation condition even sixty days after TKR. This emphasizes the need to accelerate the rehabilitation process to avoid consequences of muscle weakness. Making the length of the rehabilitation process short enough for the patients to afford the costs and also not to be so time consuming, may bring the chance that more patients get the most out of physical therapy and might reduce the risk of balance loss and surgery failure.

One concern on the early initiation of isotonic exercises might be the safety of the protocol. The patients in this study were not followed longer than two month after surgery and longer follow-ups are needed to ensure its safety but, it does not seem that this protocol might endanger the patients. A noticeable percent of TKR surgery failures occur within the first few months and no failure or adverse effects such as considerable pain or range of motion loss was noted in any of the patients. Although, to our knowledge, no study has directly studied the safety and possible side effects of early isotonic exercises yet, similar studies on total hip replacement have shown to be safe [16].

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