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Effect of Patrick Step Up Exercise on Strength of VMO in Patients After Total Knee Arthroplasty

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ABSTRACT

Background: The Patrick Step Up exercise enhances knee extensor strength, particularly terminal extension. Vastus medialis oblique (VMO) muscle aids knee extension and patellar stabilization. This exercise targets quadriceps within a closed kinematic chain, crucial for post-total knee arthroplasty (TKA) rehabilitation due to post-op strength reduction.
Methodology: Ten participants were randomly assigned to two groups. Experimental: Patrick Step Up exercise. Control: Traditional VMO strengthening. Goniometry measured knee extension, KOOS assessed outcomes.
Results: ROM analysis: Group A (Patrick Step Up) showed significant ROM reduction, raising joint mobility questions. Group B also exhibited ROM reduction. KOOS: Group A had notably higher KOOS scores, aligning with exercise impact on patient-reported knee function and quality of life.
Conclusion: The study advances post-TKA exercise understanding, highlighting Patrick Step Up's potential benefits in enhancing patient-reported knee function and quality of life. Further research should explore tailored interventions for optimized rehabilitation.

Keywords: Osteoarthritis of knee, VMO strength, Patrick step up exercise, Extensor lag, Goniometry measurements, KOOS.

INTRODUCTION

Osteoarthritis is a common, degenerative, and debilitating disease worldwide. The prevalence suggests approximately 80% of those with OA undergo movement impairments and 25% cannot perform daily activities. The most affected joints are the Knee and hip joints among all other synovial joints because the hip and knee joints are large weight-bearing joints that translate force from HAT (head, arm, and trunk) to the lower extremity during daily activities which leads to a higher degree of disability in respect to reduced mobility and limitations with activities of daily living, which again leads to a substantial and persistent reduction in physical functioning[1]. Osteoarthritis is the eighth leading cause of disability worldwide and the knee joint is one of the most common joints.

Despite remarkable advancements in surgical and prosthetics placement techniques, numerous patients present with a limited range of motion (ROM), pain, limited physical function restoration, and impaired quality of life. Excessive mechanical stress and overloading on the knee joint will affect muscles around the joint. A study by Nichole M. L mentioned that early disuse of the VMO indicates general quadriceps weakness. Because the importance of VMO is evident, it is necessary to improve the strength of VMO [3].

Total knee arthroplasty (TKA) is the procedure that is most effective for patients who suffer from end-stage debilitating knee arthritis, demonstrating excellent outcomes and pain reduction. Despite these positive outcomes, the strength of the quadriceps can often fail to recover to levels of healthy, age-matched cohorts' years after surgery. This can lead to profound functional disadvantages such as impairments with balance, walking speed, stair climbing, and increased fall risk. In addition to this, almost 50% of patients report impairments in physical function 1 year after TKA. The weakness of the quadriceps can manifest as a limitation in active extension (quadriceps lag). This is characterized as a patient's inability to actively move a joint to its passive limit, which contrasts with a flexion contracture in which patients exhibit pathological limitations in active and passive knee extension. This cut-off was based on a study demonstrating a require 60% increase in the force of quadriceps contraction from -15 to 0 degrees of extension, and as such is most sensitive for quadriceps weakness [6]. As many older adults undergo Orthopedic surgery to regain mobility, total knee arthroplasty (TKA) has become one of the most common procedures. Its incidence is 150 to 200/100,000 inhabitants in Western countries worldwide, more than 500,000 total knee joints are implanted every year [8].
Effective post-TKA rehabilitation is important for the restoration of structural and functional ability[2]. The post-surgical physiotherapy and exercise-based interventions promote re-training and functional improvement [9]. The weakness and delayed activation of the quadriceps has been recognized as the major cause of activity limitations after TKR. The post-operative Quadriceps strength is reduced to as much as 60% when compared to the pre-operated strength. Therefore, Quadriceps activation is an important consideration for rehabilitation following total knee arthroplasty. A worldwide accepted protocol for post-operative rehabilitation for total knee replacement is lacking [4]. The progression of loss of quadriceps strength gets worse after TKA, and strength may not recover completely even years after surgery which ultimately affects knee function [10]. The quadriceps muscle leads to knee extension and is the main active stabilizer of the knee; its correct function strongly influences patients' return to daily activities after total knee arthroplasty [10].
The quadriceps muscles have an important role in stabilizing the knee joint during the stance phase of gait. The VMO which stands for "Vastus Medialis Oblique." is one of the most crucial quadriceps muscles and the most responsible to maintain knee stability. Clinically therapists use the last 15-degree knee extension exercise and high sitting knee extension exercise for strengthening VMO but there were other exercises for VMO strengthening [3]. Vastus medialis oblique muscle serves to extend the knee as well as acts as a major stabilizer for the patella [5].
The Patrick Step Ups is a simple body resistance exercise which is a good general lower-body conditioning exercise that focuses on terminal knee extension. For this exercise patient stands on a stack of weight plates, stepper, or low plyobox after that he/she puts the heel of the non-targeted foot on the floor and then comes to starting position. The main benefit of this exercise is that it is a closed kinematic chain exercise which moves the knee through a range of motion that strengthens the VMO (vastus medialis oblique) muscle which is particularly important for knee rehabilitation. This exercise is proven to be one of the injury mitigations for runners and athletes. it can be useful to introduce it in rehabilitation protocol just to add diversity to the squatting movement pattern. It is one of the tertiary exercises as it creates little to no fatigue.
The main idea of using Patrick Step Ups for post-TKA patients is to add diversity to traditional treatment as it is one of the closed kinematic chain exercises. It might also effectively work to facilitate the last-

degree knee extension. The need of this study is to find out the effect of Patrick Step Ups in improving the strength of VMO and to find out the effect of Patrick step-up exercise in comparison to traditional exercise in improving the strength of VMO in post-TKR patients.

MATERIALS & METHODS

The study was done as per the ethical guidelines formulated by the institutional ethical committee of Khyati college of physiotherapy, Ahmedabad, Gujarat. Total ten patients were selected for the study as per the selection criteria. Purpose of the study, procedure of exercise and benefits were explained to all the participants, prior to the study and a written consent has obtained. Participants were divided in to two groups of 5 each, Group A- was given Patrick Step Ups and Group B was given last degree extension exercise.

Inclusion Criteria:

- Male/female patients between the age group of 50-70.
- Duration of TKR; minimum 10 days.
- Patient having Extensor lag post TKR.

Exclusion Criteria

- Patients having OA of Knee but did not go for TKR
- Patients having psychological, neurological, cardiac, vascular, and sensory problems.
- Patients who are not willing to participate in the study.

Patrick step ups exercise:

The Patrick steps up exercise is the tertiary squatting exercise which is a form of closed kinematic chain exercise for extensor lag and it helps to improve VMO strength.

Procedure: Start with both feet on top of a step/box. Next, slowly lower the unaffected leg down forward off the step/box to lightly touch the heel to the floor. Then return to the original position with both feet on the step/box. The frequency of the exercise was 2 sets; 8 to 10 repetitions for each set.

Common Mistakes:

- Moving too fast. Doing this exercise quickly will take away from the control needed from the hip and knee to perform it effectively therefore taking away from the adaptations from performing it.
- Touching the floor with the toes and creating momentum. Again, this reduces the stress from the exercise and prevents any meaningful adaptation.

Last degree extension exercise:

Patient in supine lying position. Keep a bolster or foam roller under the affected knee, after that ask patient to do terminal extension of knee actively. Same like experimental group, the frequency of the exercise was 2 sets; 8 to 10 repetitions for each set.

The duration of the treatment was 8 days for both the groups. The rehabilitation protocol for post TKA was continued for all ten participants. The basic assessment and examination were taken before and after the treatment for all the participants of both the groups. Goniometry measurement for last degree knee extension and Knee injury and osteoarthritis outcome score (KOOS) were used as a main outcome measure of the study.

STATISTICAL ANALYSIS

The study's demographic information, including age and gender distribution in both Group A and Group B, was summarized using descriptive statistics like means, standard deviations, frequencies, and percentages. These statistical measures offered an overview of the participants' profiles and helped in understanding the composition of the two groups.

Comparison of Knee Extension Range of Motion.

A statistical technique known as an independent sample t-test was utilized to compare the range of motion (ROM) during the final degree of knee extension between Group A and Group B. The purpose of this analysis was to ascertain whether any

noteworthy differences existed in knee extension ROM between the two groups.

Assessment of Changes in ROM Before and After Intervention:

Changes in knee extension ROM within both Group A and Group B were evaluated using paired samples analysis. By comparing measurements taken before and after an intervention, this analysis aimed to identify any significant alterations in knee extension ROM within each group.

Comparison of Functional Ability Using KOOS:

To gauge the functional ability of patients, an independent samples t-test was employed to compare Group A and Group B. The objective of this analysis was to determine whether there were noteworthy differences in functional ability between the two groups.

RESULT

The descriptive analysis of the study includes an overview of the participants' age and gender distribution in both Group A and Group B. In Group A, the participants consisted of 3 males and 2 females, resulting in a male-to-female ratio of 3:2. On average, the participants in Group A were approximately 57.8 years old. In Group B, the gender distribution indicated 1 male participant and 4 female participants, resulting in a male-to-female ratio of 1:4. The average age of participants in Group B was approximately 56.8 years.

ROM: The mean ROM of last degree knee extension for participants in Group A was 7.4, with a standard deviation of 0. 89443.The mean ROM for participants in Group B was 15.2, with a larger standard deviation of 5.31037(Table 1).

Equal Variances Assumed t-test: The p-value is 0.012, and the t-value is -3.239 (Degrees of Freedom = 8). This suggests a statistically significant difference in ROM between Group A and Group B (Table 2).

Equal Variances Not Assumed t-test: The p-value is 0.029, and the t-value is -3.239 (Degrees of Freedom = 4.227). Again, this indicates a statistically significant difference in ROM (Table 2).

Group Statistics					
	Group	**N**	**Mean**	**Std. Deviation**	**Std. Error Mean**
ROM (Last degree knee extension)	A	5	7.4	0.89443	0.4
	B	5	15.2	5.31037	2.37487

Table 1

Independent Samples Test					
		t-test for Equality of Means			
		Sig. (2-tailed)	**Mean Difference**	**Std. Error Difference**	**95% Confidence Interval of the Difference**
					Lower
ROM (Last degree knee extension)	Equal variances assumed	0.012	-7.8	2.40832	-13.35359
	Equal variances not assumed	0.029	-7.8	2.40832	-14.34744

Table 2

Both Group A and Group B (Table 3 & 4) showed a decrease in ROM from pre-test to post-test measurements. For Group A, the mean difference in ROM between pre-test and post-test was 8.6 units, and this difference is statistically significant (p = 0.02). For Group B, the mean difference in ROM was 4.4 units, and this difference is marginally significant (p = 0.049).

Paired Samples Test					
		Paired Differences			
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference
					Lower
Group A	Pre - Post	8.6	5.12835	2.29347	2.23231
Group B	Pre - Post	4.4	3.50714	1.56844	0.04532

Table 3

Paired Samples Test					
		Paired Differences	t	Df	Sig. (2-tailed)
		95% Confidence Interval of the Difference			
		Upper			
Group A	Pre - Post	14.96769	3.75	4	0.02
Group B	Pre - Post	8.75468	2.805	4	0.049

Table 4

The results suggest that for both groups, there is an observed decrease in ROM after the intervention. Group A's decrease was larger and statistically significant, while Group B's decrease was smaller and marginally significant. The clinical significance of these differences should be considered alongside their statistical significance.

KOOS:

The p-value from both versions of the t-test is less than 0.05, indicating that there is a statistically significant difference in KOOS scores between Group A and Group B. The mean difference of 0.25 suggests that participants in Group A, who followed the Patrick Step Up exercise, had higher KOOS scores compared to participants in Group B, who underwent the traditional VMO strengthening protocol (Table 5).

The Confidence Interval further supports the conclusion that Group A had significantly better KOOS scores (Table 6).

The findings suggest that the Patrick Step Up exercise might have a positive impact on patients' knee function and overall well-being as reflected by higher KOOS scores. These results are noteworthy as the KOOS assesses various dimensions of knee health, including pain, symptoms, and quality of life, which are critical outcomes in post-TKA rehabilitation.

Group Statistics					
	Group	**N**	**Mean**	**Std. Deviation**	**Std. Error Mean**
KOOS	A	5	0.702	0.12637	0.05652
	B	5	0.452	0.12538	0.05607

Table 5

Independent Samples Test

		t-test for Equality of Means			
		Sig. (2-tailed)	**Mean Difference**	**Std. Error Difference**	**95% Confidence Interval of the Difference**
					Lower
KOOS	Equal variances assumed	0.014	0.25	0.07961	0.06642
	Equal variances not assumed	0.014	0.25	0.07961	0.06641

Table 6

DISCUSSION

The present study aimed to explore the effects of Patrick step up exercise interventions on both the range of motion (ROM) of last-degree knee extension and the Knee Injury and Osteoarthritis Outcome Score (KOOS) among patients following total knee replacement (TKR). The findings provide valuable insights into the impact of these interventions on knee joint function and patient-reported outcomes, while also contributing to the existing body of knowledge in this field. Previous studies have highlighted the significance of exercise interventions in post-TKR rehabilitation. Notably, Artz et al. (2015) conducted a systematic review and meta-analysis, underscoring the effectiveness of physiotherapy exercise following total knee replacement. Their findings echoed the importance of tailored exercise programs in improving patient outcomes, which aligns with the objectives of our study.

Range of Motion (ROM) Analysis:

Our analysis of ROM data indicated intriguing outcomes within each group. In Group A, participants experienced a significant decrease in ROM following the intervention, with a mean difference of 8.6 units. This result raises questions about the mechanism behind the decrease in joint mobility post intervention, like the observations made by Artz et al. (2015) and

their emphasis on assessing the clinical relevance of observed changes in joint function. Group B also exhibited a reduction in ROM, though with a smaller mean difference of 4.4 units. These findings underscore the complexities of exercise interventions and their potential implications for joint mobility, echoing the caution expressed by Moore et al. (2020) in evaluating treatment outcomes using functional assessments in knee osteoarthritis patients.

KOOS Analysis:

The analysis of KOOS data offered intriguing insights into the effects of the exercise interventions on patient-reported outcomes. Group A, which engaged in the Patrick Step Up exercise, demonstrated significantly higher mean KOOS scores (0.702) compared to Group B (0.452), which followed traditional VMO strengthening protocols. This finding is consistent with the conclusions drawn by Artz et al. (2015), who emphasized the positive impact of exercise interventions on patient-reported outcomes.

The higher KOOS scores in Group A suggest that the Patrick Step Up exercise may have a positive impact on patient-reported knee function and quality of life, reinforcing the notion that tailored exercise interventions can yield meaningful improvements in patient outcomes, as highlighted by Morelli et al. (2021) in their systematic narrative update on muscle group function post-TKR.

Clinical Implications: The study's outcomes hold important clinical implications. The ROM reductions observed in both groups post intervention underscore the need for careful monitoring and evaluation of exercise interventions. Although the clinical significance of these ROM changes requires further exploration, they prompt considerations about exercise program design and participant selection.

The higher KOOS scores in Group A align with the objective of post-TKR rehabilitation: improving patient well-being and functional status. These findings support the integration of the Patrick Step Up exercise into rehabilitation programs to potentially enhance knee joint function and alleviate symptoms in post-TKR patients.

Limitations of this study include the relatively small sample size, which may impact the generalizability of the findings. Further research with larger cohorts is recommended to strengthen the reliability of the results. Moreover, investigating the long-term effects of the interventions and exploring potential mechanisms driving the observed changes in both ROM and KOOS scores would provide a more comprehensive understanding of the interventions' impact.

CONCLUSION

In conclusion, this study contributes to the evolving knowledge of exercise interventions in post-TKR rehabilitation. The findings highlight the potential benefits of the Patrick Step Up exercise in enhancing patient-reported knee function and quality of life, as reflected by higher KOOS scores. As the field of post-TKR rehabilitation advances, future research should continue to explore tailored interventions that optimize patient outcomes and inform evidence-based rehabilitation protocols.

Declaration by Authors

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