

Comparative Effects of Daily Adjustable Progressive Resistance Exercises Technique & Close Kinetic Chain Exercises on Extensor Lag in Post-Operative Knee Stiffness

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ABSTRACT

Background: Post-operative knee stiffness is caused by arthrofibrosis and functional limitation. Extensor lag is commonly prevalent after knee surgery. There are different approaches to treat this condition. Close kinetic chain exercises are hypothesized as one of effective treatment. DAPRE technique has remarked effects.

Aim: To determine effects of DAPRE technique and close kinetic chain exercises on pain intensity, ROM, function, strength among post-operative knee stiffness.

Study Design: Randomized control trial.

Methodology: Total of 22 patients with post-operative knee stiffness were recruited and divided in two groups. One group received DAPRE technique and other group received close kinetic chain exercises were participated by using a Non-probability convenience sampling technique.

Results: The result showed statistically significant difference in both groups in terms of NPRS, WOMAC index, ROM and strength with P-value less than 0.05.

Conclusion: It was concluded that Close kinetic chain exercises was more effective than the Daily adjustable progressive resistance exercises on extensor lag for post-operative knee joint stiffness to improving the pain, physical function, range of motion and strength.

Keywords: Knee Stiffness, Extensor Lag, Kinetic Chain Exercise, DAPRE and Resistance Exercises.

INTRODUCTION

Quadriceps lag occurs when a patient is unable to fully extend their knee via muscle contraction but can be passively extended by the therapist. Knee discomfort is linked to weak quadriceps, which causes increased loading at the knee, resulting in joint deterioration.¹ Quadriceps strength can deteriorate even after a successful knee repair. Quadriceps lag (Q-lag) is the latency in the active extension caused by muscle weakness. It is defined as the patient's inability to extend the knee to the last 15 degrees of extension².

The deficiency or weakness in extensors was explained as incapacity to achieve/gain normal extension of knee joint actively without any assistance or passively. Though, knee extension can be done passively. In the malformation of stiffness or its deformity, knee extension performing passively was also absent. In spite of having a range of motion of greater than 90 degrees, they were divided and classified into good and fair group or categories cause of the presence of a stiffness deformity or extensor lag³. Open kinetic chain (OKC) and closed kinetic chain (CKC) exercises are two types of lower limb training programs. The OKC physical activity involves moving the extremity's distal end to a somewhat firm or permanent ground. A closed kinetic chain workout for the lower leg can reduce slippage and improve core flexibility by causing quadriceps and hamstring co-activation, however this will raise intra-articular tension⁴. PRE programme is a popular strengthening strategy that gradually increases the intensity eventually. That revitalizing vigor is more than that which is associated with normal development and growth. PRE provides enough resistance that only a few integer (typically 8–12) of repetition may be performed before exhaustion occur, allowing us to progressively raise the number of resistance as our force develops, and permitting the training plan to last for a long time so that we can reap the benefits⁵. A DAPRE treatment that concentrates on or aims to improve quadriceps knee stability in

order to improve normal walking sequence, shifts and functional mobility. During first 7 weeks after the TKA, the person improved markedly in both functional performance and quadriceps motor activity. Patient was able to resume normal tasks of daily life without discomfort. The findings suggested that starting a DAPRE programme early was safe and enabling better functioning and muscle strength for such patients⁶.

The DAPRE protocol exhibited numerically significant improvements in resilience attaining in aspects of one repetition maximum. Prior methods do not use the core principle of continuous intense exercise to the extent that the daily adaptable advanced resisting activity approach does. Personal variances in the amount at which a person attains body ability are accommodated by the daily adaptive resistant linear program, which gives an empirical way for raising tension in line to muscle improvements⁷. The knee extension CKC effort also can be used to test and restore lower limb function. In general, the CKC movement is described as being more specific, efficient, and secure than that of the OKC routine. Muscle-strength evaluation as in connected loop may be a reliable measure of physical capabilities since CKC training appears to emulate daily demands in comparison with the open-chain strength assessment. CKC movement represents a strong association with functional performance. Considering whether CKC muscle force produced at a low isokinetic speed represent a relationship to functional activity could be of any help in developing evaluation-based protocols.⁸ Studies represented effect of DAPRE and CKC in different studies in post-operative knee stiffness, my studies will fill this gap

The objective of the study was to determine effects of DAPRE technique and close kinetic chain exercises on pain intensity, ROM, function, strength among post-operative knee stiffness.

METHODOLOGY

Non- probability convenient sampling approach was accustomed to recruit the individuals for the study and after that randomization process was done by sealed envelope to divide the subjects into

Received on 05-01-2022

Accepted on 15-06-2022

Group-A and Group-B. The study area was Pakistan Society for Rehabilitation of the Disabled (PSRD) Lahore Pakistan. Sample size was calculated by epi-tool. In this study, 22 participants were selected as per criterion for inclusion and exclusion. 11 participants were in group-1 and 11 participants in group-2. Both male and female, age 30-60 years with Post-operative knee stiffness (patients with 1-6 month stiffness), patients having extensor lag and willing to participate in research were included. Patients with pre-operative knee stiffness, severe cardiopulmonary disease, undergoing chemotherapy, acute inflammatory muscular pathology and TKR & hip pathology and replacement were excluded.

Group A: 11 participants received Conventional physiotherapy treatment in addition to DAPRE technique. Four sets of strength training were done utilizing a leg extension machine in the DAPRE approach. Ten and then six rotations were done against 1/2 and 3/4 of the previously specified working weight in the very first two sets of training. The amount of load a patient takes during a single practice is referred to as working weight. On the third set, the subject did as many repetitions as feasible with the entire working weight. The modified working weight for the final set is based on the number of repetitions accomplished during the third set. Patients took a one-minute break during each set.⁸

6 weeks (3 sessions per week)

- Hot pack: 7-10 min

- Stretching of calf and hamstring muscle: 5-10 min

Treatment time for each session was approximately 20-30 minutes.

Group B: 11 participants received conventional physiotherapy treatment in addition to close kinetic chain exercises. Close kinetic chain exercises for extensor lag is towel press, and 1) Wall slide with weight (Standing upright against the wall also with the head, shoulders, spine, and pelvis flat. Step out approximately 24 inches first from wall with both feet, keeping your upper body against it. Slowly lower the back until it is slightly just above regular sitting posture. Hold for 5 seconds before returning.), 2) Step exercise (Utilizing a 5cm high wooden box, the participants did step training. In order to accentuate the actions of the quadriceps, subjects were told to keep their back straight and guarantee that their heel was the last one to depart and back to the floor.), 3) Squat exercises (Slowly bending both of knees into a squatting position and hold for 5 seconds. Back should be straight and the heels firmly on the floor. Slowly move up by straightening the knees. The chair back is just for balance only) And 4) Quadriceps Setting Exercise (The patient sat in a chair, back supported, knees straight, and heel on the ground. They pressed their heels to the ground and their thighs on the chair's seat. The patient was maintained in this position for a count of five before resting.)⁹

Perform 3 sets of 5 repetitions for each exercise.

Treatment time was 20-30 minutes and three sessions per week applied on alternate day for up to 6 weeks.

6 weeks (3 sessions per week)

- Hot pack: 7-10 min

- Stretching of calf and hamstring muscle: 5-10 min.

Pre-interventional readings were taken at baseline & post intervention readings at 6th week. Numeric Pain Rating Scale for pain, the Western Ontario and McMaster University Osteoarthritis Index (WOMAC) for functional disability, Universal Goniometer for range of motion of knee joint and Sphygmomanometer for

hamstring and quadriceps strength were used as a data collection tools.

Statistical analysis: Data was analyzed by using SPSS v.25. The feature frequency %, mean, and standard deviation were utilized to show categorical and demographic data. The level of significance accepted as $P < .05$. Numeric variables were defined as mean \pm standard deviation. The data's normality was evaluated using the Shapiro-Wilk test of normality and uniformity. If Value of the Shapiro-Wilk Test > 0.05 , the data would be normal and parametric tests of analysis would be used. A significant difference was defined as one with a p-value < 0.05 . The following tests were used: Differences between pre- and post-treatment values: within the same group, analyzed by using the paired t-test Differences between the groups: between the groups, analyzed by using Independent samples t-test.

RESULTS

Total 22 patients, 11 in DAPRE technique group and 11 in CKC exercise group. In group 1, the patients mean age were 41.47 years and in group 2, mean age were 39.45 years. 7 males and 4 females were get the DAPRE Technique while 6 males and 5 females were receive the CKC exercises. DAPRE technique with mean value of 75.91 kg for weight and CKC exercises group have mean value 71.82 kg for weight. DAPRE technique with mean value of 170.41cm for height and CKC exercises group have mean value of 168.79cm for height. DAPRE technique with mean value of 170.41cm for height and CKC exercises group have mean value of 168.79cm for height. DAPRE technique with mean value of 25.44 kg/m² for BMI and CKC exercises group have mean value 24.84 kg/m² for BMI. Groups were homogenous at baseline and not statistically significant in all the parameters including NPRS, WOMAC, Quadriceps strength and ROMs with p value > 0.05 as shown in table-1.

Table-1: Baseline measurement of outcome variables

Variable	DAPRE technique	CKC Exercises	P value
Mean \pm SD		Mean \pm SD	
NPRS	5.55 \pm 0.82	5.55 \pm 0.69	1.00
WOMAC	59.64 \pm 5.44	57.55 \pm 6.15	0.41
Quadriceps strength	56.55 \pm 9.27	56.91 \pm 7.71	0.92
Knee flexion	83.45 \pm 15.55	87.10 \pm 14.39	0.58
Knee extension	19.18 \pm 4.21	18.36 \pm 3.71	0.63

After the analysis, it was found that within group analysis showed a statistically significant ($p < 0.001$) improvement in all the outcome measures including NPRS, WOMAC, Quadriceps strength and ROMs over a period of 9 weeks in both DAPRE group and CKC exercises group. The between-groups analysis showed statistically significant differences in NPRS, Quadriceps strength, ROM and WOMAC with p-values of 0.00 and 0.00 respectively as shown in table-2. Significant differences were also present in Knee ROMs having p-values < 0.05 (flexion=0.001, extension=0.001) at end of the treatment. The results of this study states that using close kinetic chain exercise is more effective than DAPRE in terms of outcome measures.

Table-2: Between Group Comparison of NPRS, WOMAC Quadriceps Strength & ROM

Variable	DAPRE Technique		CKC Exercise		P-value
	Pre-treatment	Post-treatment	Pre-treatment	Post-treatment	
NPRS	5.55 \pm 0.82	4.45 \pm 0.69	5.55 \pm 0.69	2.27 \pm 0.65	0.00*
WOMAC index	59.64 \pm 5.4	50.00 \pm 7.71	57.55 \pm 6.15	38.00 \pm 9.59	0.004*
Quadriceps strength	56.55 \pm 9.2	75.2 \pm 11.7	56.91 \pm 7.71	87.45 \pm 11.04	0.02*
Range of motion					
Flexion	83.5 \pm 15.5	96.6 \pm 14.8	87.10 \pm 14.4	109.18 \pm 7.99	0.02*
Extension	19.2 \pm 4.21	13.9 \pm 4.44	18.4 \pm 3.71	6.88 \pm 2.27	0.00*

*Statistically significant

DISCUSSION

This study aimed primarily to evaluate Comparative effects of Daily Adjustable Progressive Resistance Exercises technique and Close kinetic chain exercises on extensor lag in post-operative knee stiffness in terms of reducing pain, reducing functional disability, improving range of motion and strength. Results indicated significant improvement in both groups receiving intervention regarding all outcome measures. However, mean change in values of close kinetic chain exercises is more improved as compared to DAPRE group.

Previous study conducted by Matthew C Morrissey in which results indicate that the difference in knee discomfort between groups trained utilizing leg extension with the lower limb distally fixed versus non distally fixated from week 2 to week 6 following ACL repair surgery was not significant (CKC versus OKC training).¹⁰ Now current study says that CKC exercises are effective in reducing knee pain and extensor lag among post-operative knee stiffness patients than that of open kinetic chain exercises. A particular rehabilitation regimen is required for successful ACL reconstruction in order to reduce discomfort and swelling, reclaim effective extent of mobility during everyday activities and sports, and reclaim previous health. During CKC exercises, the knee should be kept in < 60 degrees of flexion, and also OKC workouts with knee angles > 40 degrees of flexion are indicated to reduce ACL strain during quadriceps muscle strength training¹¹.

Another study conducted by B.Sankarmani in which the results reveal that the ckc training of the knee extensors and jumping function have a substantial positive association. Benefits of CKC exercise session are finer, according to that data. Both groups improved their performance, but the closed kinetic chain exercise training group had a greater result.¹² Now current study also supports that the CKC workouts had greater effects on functional improvement, muscle strength than the open kinetic chain exercises. Jakob Kristensen conducted a randomized control trial study. The purpose of this project was also to contrast the outcomes of two distinct resistance-training regimes that are currently utilized in therapy, group 1 DAPRE and group 2 functional strength training (FST). Results reveal that both the DAPRE and FST groups saw significant gains in lower limb strength and power. There's no discernible change in power between the groups. Despite variances in programme design, short-term strengthening session during recovery could result in gains in strength and power. Conclude, however, that three weeks of workout is inadequate to detect significant variation among regimes¹³. Current study report that DAPRE technique was less effective than the close kinetic chain exercises in gaining strength and improving knee function during six week of rehabilitation. Mehmet Uçar conducted a study in which OKC and CKC workouts were used to compare the outcomes following knee ligament (ACL) recovery. Results of that research demonstrate that both groups' VAS pain scores dropped following treatment, with the CKC group's decrease being substantially greater than that of OKC group¹⁴. The current study favors the previous study that pain scale dropped more in CKC group as compared to progressive resistance training. Also there was greater increase in knee flexion in CKC group after 6 week rehabilitation program.

Limitations: This study lacked genetic workup among patients in order to find the genetic cause with limited resources and financial constrains.

CONCLUSION

It was concluded that close kinetic chain exercises was more effective than the Daily adjustable progressive resistance exercises on extensor lag for post-operative knee joint stiffness to

improving the pain, physical function, range of motion and strength.

Authors' Contribution: ST&RN: Conceptualized the study, analyzed the data, and formulated the initial draft, **HA&MB:** Contributed to data collection, **KI, SS&WL:** Proof read the final draft and analyzed data.

Conflict of interest: None

Funding: None

REFERENCE

1. Thakur R, Mande M, Mitra M. Effectiveness of Quadriceps Strengthening Exercises in Reducing Extensor Lag, Pain and Improving Functional Activity in Patients of KneeOsteoarthritis. Website: www.ijpot.com. 2017;11(2):18.
2. McGinn TL, Etcheson JI, Gwam CU, George NE, Mohamed NS, Mistry JB, et al. Short-term outcomes for total knee arthroplasty patients with active extension lag. *Annals of Translational Medicine*. 2018;6(11).
3. Sud A, Chaudhry A, Mehtani A, Tiwari A, Sharma D. Functional outcome following quadriceps tendon lengthening in congenital dislocation of the knee, with special reference to extensor weakness. *Strategies in trauma and limb reconstruction*. 2009;4(3):123-7.
4. Chang W-D, Huang W-S, Lee C-L, Lin H-Y, Lai P-T. Effects of open and closed kinetic chains of sling exercise therapy on the muscle activity of the vastus medialis oblique and vastus lateralis. *Journal of physical therapy science*. 2014;26(9):1363-6.
5. Scholtes VA, Becher JG, Janssen-Potten YJ, Dekkers H, Smallegenbroek L, Dallmeijer AJ. Effectiveness of functional progressive resistance exercise training on walking ability in children with cerebral palsy: a randomized controlled trial. *Research in developmental disabilities*. 2012;33(1):181-8.
6. Ardali G. A daily adjustable progressive resistance exercise protocol and functional training to increase quadriceps muscle strength and functional performance in an elderly homebound patient following a total knee arthroplasty. *Physiotherapy theory and practice*. 2014;30(4):287-97.
7. Sharma S, Singh P, Sharma S. A study to compare the Delorme and DAPRE strength training regimens. *Physiotherapy and Occupational Therapy Journal*. 2014;7(4):189.
8. Kovalski JE, Heitman RJ, Andrew DP, Gurchiek LR, Pearsall AW. Relationship between closed-linear-kinetic-and open-kinetic-chain isokinetic strength and lower extremity functional performance. *Journal of Sport Rehabilitation*. 2001;10(3):196-204.
9. Lee NK, Kwon JW, Son SM, Kang KW, Kim K, Hyun-Nam S. The effects of closed and open kinetic chain exercises on lower limb muscle activity and balance in stroke survivors. *NeuroRehabilitation*. 2013;33(1):177-83.
10. Morrissey MC, Drechsler WI, Morrissey D, Knight PR, Armstrong PW, McAuliffe TB. Effects of distally fixated versus nondistally fixated leg extensor resistance training on knee pain in the early period after anterior cruciate ligament reconstruction. *Physical Therapy*. 2002;82(1):35-43.
11. Risberg MA, Lewek M, Snyder-Mackler L. A systematic review of evidence for anterior cruciate ligament rehabilitation: how much and what type? *Physical Therapy in Sport*. 2004;5(3):125-45.
12. Blackburn JR, Morrissey MC. The relationship between open and closed kinetic chain strength of the lower limb and jumping performance. *Journal of Orthopaedic & Sports Physical Therapy*. 1998;27(6):430-5.
13. Kristensen J, Burgess S. A comparison of two 3-week resistance training programmes commonly used in short-term military rehabilitation. *BMJ Military Health*. 2013;159(1):35-9.
14. Uçar M, Koca I, Eroglu M, Eroglu S, Sarp U, Arik HO, et al. Evaluation of open and closed kinetic chain exercises in rehabilitation following anterior cruciate ligament reconstruction. *Journal of physical therapy science*. 2014;26(12):1875-8.