

## Comparative Study of Open Versus Closed Kinetic Chain Exercises in Patellofemoral Pain Syndrome- A Clinical Study



### Medical science

**KEYWORDS :** Patellofemoral Pain, open kinetic chain; closed kinetic chain; 1 R.M.

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### ABSTRACT

*Background: To define which rehabilitation methodology is best suited for patellofemoral pain syndrome as there is not much study to define in a comparative clinical set up with an O.K.C and C.K.C exercise with prolong follow up.*

*| Hypothesis: The long-term effect of closed kinetic chain training is significantly better compared to the effect of open kinetic chain in patellofemoral pain. | Study Design: Prospective randomized clinical trial. | Methods: 54 subjects were randomly divided into two groups, one group followed of open kinetic chain rehabilitation method and other one closed chain rehabilitation method for 12 week. Pre and post test result were compared with 4 defined functional test, results are statistically compared. | Results: At the end of Three month follow-up, all 4 tests (1- triple hop test, 2- flexion measurement test, 3- quadriceps girth, 4- V.A.S) were assessed in pre and post test result form and were compared statically. | Conclusions: On the basis of these results, it was noted that both open kinetic chain and closed kinetic chain programs lead to an equal long-term good functional outcome. | Abbreviation used- O.K.C (Open kinetic chain), C.K.C (closed kinetic chain), V.A.S (Visual pain analog scale), Quad.G. (Quadriceps girth), PFPS (Patellofemoral pain syndrome) R.M (Repetitive maximum) |*

### INTRODUCTION

Patellofemoral pain syndrome (PFPS) is often seen in physically active individuals and may account for almost 10% of all visits to a sports injury clinic. It is generally agreed that patellofemoral pain should be managed initially by conservative rather than operative means. The basis of conservative treatment is strengthening of the quadriceps and soft tissue stretching of quadriceps musculature, patellofemoral mechanism, and hamstring musculature. The most successful rehabilitation programs should emphasize progression without increasing symptoms. Keeping exercise intensity and patellofemoral stresses low and repetitions relatively high will help to achieve this goal. Today, little consensus exists regarding the most appropriate conservative treatment. Open kinetic chain (OKC – is a nonweight bearing exercise in which the kinetic chain of a limb is open or free to move i.e. the hand or foot can swing freely and is not pressed against the floor or any other surface) leg extension exercises have been the traditional means of strengthening the quadriceps. However, several authors have reported that these exercises exacerbate symptoms in many patellofemoral patients. The clinical use of closed kinetic chain (CKC- is a weight bearing exercise in which the kinetic chain of limb is closed i.e. the hand or foot cannot swing freely, such as when the foot is on the floor or some other surface) exercises has significantly increased during the past several years. One of the reasons these exercises have received increased attention within the rehabilitation community is that they simulate and replicate many functional movements. Because studies have shown that the major changes as a result of strength training are task specific, it may be better to incorporate the rehabilitation into task related practice. As such, specificity of training becomes a significant factor. In addition, several authors have demonstrated that PFPS patients may tolerate CKC exercises better than OKC exercises in functional ranges of motion because of lower patellofemoral joint stresses. Therefore, PFPS patients may tolerate CKC exercises better and, consequently, exhibit better functional results after such devised rehabilitation programs. Although these studies have documented the potentially deleterious effects of OKC exercises in patellofemoral patients, only a few clinical studies have been undertaken to scientifically prove this. Although these few studies are clinically important, they lack long-term follow-up. Indeed, Power et al stated that of utmost importance are clinical trials aimed at determining which treatment procedures are most effective in reducing the symptoms associated with patellofemoral pain with a long-term follow-up. In fact, despite the large amount of available literature concerning conservative

and operative management of PFPS, no controlled prospective long-term investigations are available to show which exercise protocol is most effective in reducing patellofemoral pain in the long term. Therefore, the purpose of this study was to determine, with a randomized prospective design, whether there is a difference in long-term patellofemoral complaints between an OKC and CKC exercise protocol. To our knowledge, this is the rare study to examine this, and we believe this information is essential for the patients as well for the physicians, physical therapists, and others involved in the treatment and rehabilitation of PFPS.

### MATERIALS AND METHODS

Initially a survey was conducted in the department of physical education and sports science Annamalai University- Tamil Nadu on amateur athletes, mainly to find the most common site affected in body region which came out to be knee after detail history and examination of knee it was found out that maximum individual with knee injury were suffering from patellofemoral syndrome. Individual with only unilateral patellofemoral syndrome without any other bony or soft tissue involvement are only incorporated into this study. A total of 54 were found to have patellofemoral pain syndrome, out of which 2 dropped out from test as they didn't reported for the treatment thus remaining 52 were divided into 2 group of 26 each in one group i.e. open kinetic chain exercise group and closed kinetic chain exercise group. Each group were evaluated on 4 functional test ( 1- triple hop , 2- flexion movement , 3- quadriceps girth , 4- V.A.S ) and all this functional test were compared with the result of pretest ( value recorded before the start of treatment) and posttest ( Value recorded at the end 12 week O.K.C exercise and C.K.C exercise protocol). Thus comparing the effective exercise among these two.

### TREATMENT

Prior to the beginning of the OKC and CKC exercise program, a 1-repetition maximum (1 RM- is the maximum amount of force that can be generated in one maximal contraction) was determined. On that information, patients were instructed to train at 60% of the 1 RM. A new 1 RM was established at the end of a month of training, after which every one month the new RM was set. Each exercise in both training groups was repeated for 3 sets of 10 repetitions. The patient rested 1 minute after the conclusion of each set. In the OKC exercise posture to be maintained for 6 seconds with a 3-second rest between repetitions. Each exercise in the CKC protocol was performed dynamically

with a 3-second rest between repetitions. The exercise protocols were as follows:

Therapeutic OKC Exercise Program

- Maximal static quadriceps contractions (quadriceps setting) with the knee in full extension.
  - Short arc movements from 10° of knee flexion to terminal extension
  - Straight leg raisings with the patient in the supine position.
  - Leg extension seated / leg curl in prone
- Therapeutic CKC Exercise Program
- Seated leg press.
  - Squat and lunge
  - Step up and down exercise.

In both training protocols, the patients were instructed to perform the conventional static stretches of lower limb after each training session. All subjects were instructed to perform 3 repetitions of a 30-second static stretch of these muscle groups

OUTCOME ASSESSMENTS

Subjective Assessment. VAS Pain Scale measured

From 0 (no pain) to 10 (worst pain possible)

*Functional Assessment.* Three additional functional evaluations were performed, flexion movement of knee joint for flexibility of hamstring and quadriceps, triple hop test prior to the triple hop performance, the patients were instructed to stand on their injured legs and had to jump 3 times along a straight line, in this no approach run is allowed individual will stand and jump. The total distance was measured in centimeters which were converted to meters, and in addition, the patients were instructed to score their pain and discomfort after this test on a 0-10 VAS scale (subjective) at the last quadriceps girth were taken each of these functional test were compared before the start of exercise treatment and after finishing the 6 month exercise treatment.

RESULTS

26 patients each were randomly allocated into 2 different groups as open kinetic chain exercise and closed kinetic chain exercise. Demographic data of both these group is shown in Table 1.

Both these group were compared by using independent t-test and found comparable without having any significant variation. The four functional parameter were checked prior to the rehabilitation (exercise treatment). after completing the 12 week of rehabilitation protocol both these group were checked to find the post rehabilitation assessment parameter , intra group pre and post test were compared using paired t-test and found significant improvement ( alpha as .05 and 95% coefficient), in all parameter of O.K.C and C.K.C rehabilitation method. Can be seen table2.

TABLE1 OPEN KINETIC CHAIN GROUP CLOSED KINETIC CHAIN

	MEAN	STANDARD DEVIATION(S.D)
HEIGHT	169.88	3.32
WEIGHT	69	3.10
AGE	24.03	3.37

  

	MEAN	STANDARD DEVIATION (S.D)
HEIGHT	171	4.56

WEIGHT	69.40	4.99
AGE	23.22	2.70

TABLE- 1- Independent t-test between these 2 group gives t-value equivalent to .25 which is non significant that means no variance difference between these group thereby can be compared for the clinical analysis.

TABLE -2

	MEAN	VARI- ANCE	t- SCORE	ALPHA SCORE
O.K.C TRIPLE HOP PRE TEST	5.02	1.92	1.70	< .05
POST TEST	5.40	.20		
C.K.C TRIPLE HOP PRE TEST	4.95	.06	1.70	<.05
POST TEST	5.87	.15		
O.K.C MOVE- MENT PRE TEST	128	24	1.70	<.05
POST TEST	132	4.3		
C.K.C MOVE- MENT PRE TEST	125.03	29.95	1.70	<.05
POST TEST	130.38	6.56		
O.K.C QUAD. G. PRE TEST	43.03	6.59	1.70	<.05
POST TEST	43.61	5.04		
C.K.C QUAD. G. PRE TEST	44.84	10	1.70	<.05
POST TEST	45.92	7.11		
O.K.C - V.A.S PRE TEST	7.26	.84	1.70	<.05
POST TEST	.38	.24		
C.K.C- V.A.S PRE TEST	7.19	.80	1.70	<.05
POST TEST	.38	.24		

Table 2- shows the intra group pre and post test were compared using paired t-test and found significant improvement (alpha as .05 and 95% coefficient), in all parameter of O.K.C and C.K.C rehabilitation method.

Variables	Mean	S.D	F	Significance
Open kinetic chain movement ( flexion )	132.03	2.08	7911.970	p < 0.05
Closed kinetic chain movement ( flexion)	130.38	2.56		
Open kinetic chain quadriceps girth	43.61	2.24		
Closed kinetic chain quadriceps girth	45.92	2.66		
Open kinetic chain triple HOP distance	5.40	0.44		
Closed kinetic chain triple HOP distance	5.87	0.39		
Open kinetic chain VAS pain scale	0.38	0.49		
Closed kinetic chain VAS pain scale	0.38	0.49		

**TABLE-3**

Table 3 – Inter group variable were compared using multivariate ANNOVA test, no significance were noted among O.K.C versus C.K.C.

**DISCUSSION**

From this study it appears that the long-term prognoses of PFPS patients who are managed conservatively with an OKC or CKC exercise protocol are relatively good. We believe the maintenance of the quadriceps strength is a notable finding because different authors have emphasized the importance of a good quadriceps function as a premise for a good functional result. Consequently, this leads to a situation in which at the 12 week follow-up, the overall outcomes of the patients are usually good but equal for both groups<sup>13</sup>. Though overall It was noted that mean of V.A.S, quadriceps girth, flexion movement, triple hop test were noted better in C.K.C exercise group.

**CONCLUSION**

Overall, the results of the present study revealed that both groups demonstrated maintenance of good subjective and overall functional outcome at the 12 week follow-up. Moreover, comparisons at the 12 week follow-up showed that in the majority of the examined parameters, there were no significant differences between both groups. Hence, on the basis of these results, we conclude that both groups have an equal long-term, relatively good functional outcome. We frequently encountered in the literature that OKC exercises are absolutely to be avoided in the

treatment of PFPS is not founded. We therefore do not advocate replacing the traditional OKC exercises with CKC exercises but rather suggest a combined use of both types of exercises. Though more long term study in larger group are required to ascertain the better correlation among the patellofemoral pain syndrome rehabilitation.

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