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Shaji John Kachanathu
College of Applied Medical Sciences, King Saud University, Riyadh, KSA

Herlin Kaur
Department of Physiotherapy, Manav Rachna International University, Fardabad, India

Mohan Natho
College of Applied Medical Sciences, King Saud University, Riyadh, KSA

Shibili Nuhmani
Department of Physiotherapy, Jamia Hamdard, New Delhi, India

Correspondence:
Shaji John Kachanathu
Department of Rehabilitation Health Sciences, College of Applied Medical Sciences, King Saud University, P.O Box: 10219 Riyadh, Zip: 11433, Kingdom of Saudi Arabia (KSA)
Tel: +966534781109
Fax: +966014355883
E-mail: johnsphysio@gmail.com

The effect of open and closed kinematics chain exercises in the management of meniscal injuries

Shaji John Kachanathu, Herlin Kaur, Mohan Natho, Shibili Nuhmani*

Abstract

Objective: Meniscal injuries are very common in sports. Open Kinematics Chain (OKC) and Closed Kinematics Chain (CKC) exercises are used often in clinical settings to treat patients with meniscal injuries. In the present era demands early intervention and recovery, thus this study was intended to find out effectiveness of OKC and CKC in the improvement of strength and balance for the management of meniscal injuries. **Methods:** A total 20 patients with mean age of 21.2±2.3 years of meniscal injuries were participated in this study. The patients were randomly divided into two groups, group A and group B, n=10 in each group. Group A and B were under gone OKC and CKC exercises respectively. Total duration of the study was for 2 weeks. Study outcomes such as muscle strength and static balance were assessed by spring balance test and standing stork test respectively, at base line and after 2 weeks of post-exercise regime. **Results:** In groups A and B, who received OKC and CKC respectively, showed significant improvements in strength and balance. However when both the groups were compared CKC demonstrated better improvements over OKC. CKC was effective in improving strength of hamstrings and balance whereas, not shown significant result in improving the strength of quadriceps. **Conclusion:** Study concluded that OKC and CKC interventions are effective in the management of meniscal injuries. CKC is more effective in improving hamstrings strength than strength of quadriceps.

Keywords: Meniscal Injuries, OKC, CKC, Strength, Balance.

Introduction

Meniscal injuries are very common in sports and are more common in all sports that require twisting movements and sudden changes of direction, especially the various football codes, basketball, netball and alpine skiing. Meniscal injuries, particularly sports-related injuries, usually involve damage due to rotational force. A common mechanism of injury is a varus or valgus force directed to a flexed knee. When the foot is planted and the femur is internally rotated, a valgus force applied to a flexed knee may cause a tear of the medial meniscus. A varus force on a flexed knee with the femur externally rotated may lead to a lateral meniscus lesion. The medial meniscus is attached more firmly than the relatively mobile lateral meniscus, and this may result in a greater incidence of medial meniscus injury.[1]

Understanding of the importance of the menisci in the biomechanics of the knee has progressed steadily since 1968. The exact function of that structure (meniscus) is still a matter of some conjecture. At that time, it was common to remove the entire substance if any doubt existed regarding the integrity of the meniscus.[2]

Today, it is known that the menisci are not optional or expendable structures; they have an integral role in normal knee joint mechanics. Although the exact incidence and prevalence of meniscal injury are unknown, it is a fairly common sports-related injury among adults. Although less common in adults, knee meniscal injuries do occur in individuals who are skeletally immature. Meniscal injuries are rare in children younger than 10 years with morphologically normal.[3] Meniscal injuries are more common in males, which may be a reflection of males being more involved in aggressive sporting and manual activities that predispose to rotational injuries of the knee. Meniscal injuries usually are associated with pain that results in gait deviation and loss of time from work and/or sport.[4]

An Open Kinematics Chain (OKC) is performed when the limb is not fixed and allowed to move freely through space. It helps in decreasing the joint compression. Closed Kinematics Chain (CKC) is performed when the limb is fixed or maintains contact with a ground reactive force. It helps in decreasing joint translation and increased functionality.[5] OKC and CKC are used often in clinical settings to treat patients lower extremity injuries. This study is intended to find out effectiveness of OKC and CKC exercise training in the management of meniscal injuries.

Materials and Methods

Twenty patients with meniscal injuries were enrolled in this study with mean age of 21.2±2.3 years from various hospitals, Delhi NCR region. Prior to being enrolled in the study, all participants were advised of potential study risks and obtained written consent form. Patients were selected based on following inclusion criteria, aged between 17-25years, diagnosed with meniscal injury of grade-I and grade-II and within the duration of sub-acute stage. Patients were excluded based on grade-III meniscal injury, acute stage of meniscal injury and other exercise contraindicated patients. After considering about the inclusion criteria the patients were randomly divided into two Groups, group A and group B (n=10) in each group. Group A and B were under gone OKC and CKC exercises respectively. Both groups were treated with short wave diathermy for 20 minutes post exercise. Each group exercise sessions was consisted a total duration of 30 minutes per session, 1 session per day and 5 sessions per week for total period of 2 weeks. 10 minutes warm-up of walking was allowed prior to the exercises. Exercises were observed properly and were corrected in case of any discrepancy in an effort to ensure consistent performance of the exercise. They were also instructed to avoid any other form of lower extremity exercise and not to increase the intensity or frequency of activity during the study period.

Study outcomes such as muscle strength and static balance were assessed by Spring Balance Test (SBT) and Standing Stork Test (SST) respectively, at base line and after 2 weeks of post-exercise regime. Strength of 'Hamstrings' and 'Quadriceps' muscle groups were measured with the help of SBT and three trials were taken at time of measurement and an average value was calculated. SST was used to measure the static balance, during the test each subject was asked to stand on his affected leg with his eyes closed, both the hands placed on his waist and unaffected leg flexed and touching the affected one. Reading was taken three times with the help of stop watch. Then the average value was calculated.

Table 1.1: OKC and CKC exercise regimes

S#	Open Chain Kinematics Exercises	Closed Chain Kinematics Exercises
1.	Hamstring Curls (Fig. 1.1)	Unilateral Closed Chain Extension (Fig. 1.5)
2.	Gravity Assisted Supine Wall Slide (Fig. 1.2)	Resisted Mini Squats (Fig. 1.6)
3.	Resisted Step Ups (Fig. 1.3)	Unilateral Closed Chain Flexion.
4.	Chair Scoots (Fig. 1.4)	Half Squats.

Fig. 1.1: Hamstrings Curls,

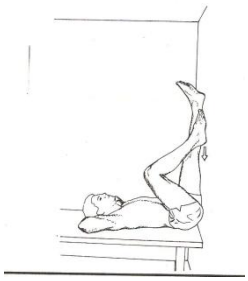

Fig. 1.2 Gravity Wall Slide

Fig. 1.3: Resisted Step Ups

Fig. 1.4: Chair Scoots

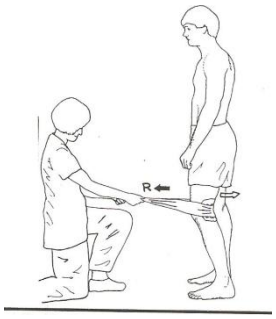

Fig.1.5: Unilateral CKC Extension

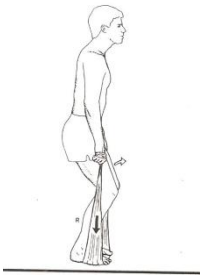

Fig. 1.6: Resisted Mini Squats

Results

Statistical analysis was performed by using the software package SPSS 16.0. The mean and standard deviation of all the variables were analyzed. The unrelated t-test analysis was done for both the groups for strength and balance (Table1.2).

Table 1.2: Balance and Strength of Hamstrings between Groups A (OKC) and B (CKC)

Outcomes	**Duration**	**Group- A (n=10)**	**Group-B (n=10)**	**Unrelated T-test**	**p-Value**
Balance	Baseline	13.73±1.08	13.08±1.13	0.91	p>0.05
	2weeks	21.41±0.8	27.28±0.5	4.47	p>0.05
	Difference	7.68	14.2	3.56	
Strength (Quadriceps)	Baseline	57.43±2.37	61.79±3.1	0.12	p>0.05
	2weeks	86.31±2.8	97.96±3.2	1.221	p>0.05
	Difference	28.88	36.17	1.101	
Strength (Hamstring)	Baseline	34.12±2.39	34.63±2.04	0.32	p>0.05
	2weeks	39.46±3.5	59.96±2.35	1.63	p>0.05
	Difference	5.34	20.33	1.31	

Discussion

Open and Closed kinematics exercises are important components of musculoskeletal and sports rehabilitation programs of lower extremity. Present study efforts were made to examine the efficacy of OKC and CKC exercises as a method of improving strength and balance in patients with meniscus injuries. The results demonstrated that in groups A and B, who received OKC and CKC respectively, showed significant improvements in strength and balance. However when both the groups were compared CKC demonstrated better improvements over OKC. CKC was effective in improving strength of hamstrings and balance whereas, not shown significant result in improving the strength of quadriceps. Thus OKC and CKC exercises interventions were effective in the improvement of strength and balance in patients with meniscal injuries.

OKC and CKC exercises effective in the improvement of strength and balance, however controversies exist regarding the onset of open kinetic chain (OKC) exercises.[6] Clinical and biomechanical studies have shown that non-weight bearing exercises may promote greater anterior tibial translation at specific angles of knee flexion, thereby increasing the graft tension.[7, 8]

CKC was effective in improving strength of hamstrings and balance. This was supported by previous studies observations that CKC or weight bearing exercises are widely used protocols because of their known effects of articular compression and knee stabilization.[7, 9]

However when both the groups were compared CKC exercise group demonstrated better improvements over OKC exercise group as eccentric loading is more in CKC than in OKC. After obtaining the results of CKC, it can be said that it is highly effective in improving strength of hamstrings and balance in patients with meniscus injuries. But it did not show significant result in improving the strength of quadriceps as that for hamstrings as eccentric loading in greater for Hamstrings than in Quadriceps. The results obtained in this study are similar to those of the previous studies performed on CKC and OKC exercises, subjects in both the groups were almost similar in terms of their age, strength and balance at their baseline. Bynum et al. (1995) performed a clinical trial comparing outcomes after ACL reconstruction with patellar tendon grafts after 19 months of healing and patients were randomized to rehabilitation programs that consisted of either OKC or CKC exercises.[10] The CKC group had a faster return to sport. This study may account for the faster return to previous level of activity of the CKC group.

CKC was not effective in improving strength of quadriceps. Studies have shown that quadriceps strengthening in OKC exercises can provide an improved muscle torque without damaging the normal laxity of the knee joint as well as favoring a return to pre-injury levels.[11-13]

Escamilla et al.1998 and Fleming et al. 2005 demonstrated that it is possible to perform OKC exercises for quadriceps strengthening without overloading the graft by providing a restricted ROM, that is, performing quadriceps activation between 90° and 45° of knee flexion.[14, 15]

Mikkelsen et al.2000 also demonstrated the benefits of quadriceps strengthening in OKC exercises in an initial postoperative stage when compared with a specific CKC exercise program.[13] The authors added weight bearing exercises without increasing anterior knee laxity. However, this study assessed patients with patellar tendon graft reconstruction. The intersegment forces at the knee indicate that the CKC exercises produce lower anterior shear load on the tibia, increase the tibiofemoral compressive forces, enhance muscle co-contraction, and decrease patellafemoral compressive forces near extension, all factors thought to protect the graft and restore knee function. Application of a compressive load to the tibiofemoral joint, such as that produced by weight bearing, strains the ACL, suggesting that the compressive load does not strain shield the ligament as previously thought. The effects of these exercises on graft healing, knee function, and patient satisfaction must be assessed through prospective randomized clinical trials. The two studies directly comparing OKC and CKC protocols provide different conclusions: one suggests an OKC program produces an increase in joint laxity and patellofemoral problems whereas the other does not.[10] Knee function and patient satisfaction were better in CKC.[13]

The results of this study are in agreement with the result of other studies OKC and CKC showed significant improvements in strength and balance. However CKC demonstrated better improvements over OKC. CKC was effective in improving strength of hamstrings and balance whereas, not shown significant result in improving the strength of quadriceps.

Conclusion

Study concluded that OKC and CKC interventions are effective in the management of meniscal injuries. Both the interventions are showed gradual improvements in strength and balance over a period of 2 weeks. CKC is more effective in improving hamstrings strength than strength of quadriceps.

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