Original Article

Physiotherapy and Occupational Therapy Journal
Volume 11 Number 2, April - June 2018
DOI: http://dx.doi.org/10.21088/potj.0974.5777.11218.1

Effect of Close Kinematic Chain Exercise and Open Kinematic Chain Exercise on Q- Angle and Navicular Drop

Shatrudhan Das[1], Niraj Kumar[2], Ekta Pandey[3]

Abstract

Introduction: The Q- angle is the angle formed by the encounter of two lines, one that starts at the anterior superior iliac spine and goes to center of the patella and another that goes from the tibial tuberosity to the center of the patella [1]. Many experts favor closed chain over open chain exercises. They do so under the assumption that they are safer and more functional. The terms open and closed kinematic chain have frequently led to polarizing and contradictory discussions both in scientific literature & in everyday practice of various therapists clinicians and trainers.Controversial arguments for and against open kinetic chain and closed kinematic chain exercise [4]. One of the methods currently used in clinical practice is measurement of the navicular drop. Depending of the foot size the dynamic navicular drop for healthy persons is on average 5.3 mm (±18mm) but can vary up to 15 mm in problematic cases [10]. *Need of the Study:* Compare the effectiveness of and close kinematic chain exercises Open kinematic chain exercises on Gluteus maximus, Q angle and navicular drop in the knee joint for improve the strength of Gluteus maximus muscle and quadriceps muscle. I want to diagnose & compare of Q angle and navicular drop at the fatigue level exercise. *Methods:* It is an experimental study design. Subjects were randomly assigned into two groups. A and B. Group A subjects received close kinematic chain and Group B open kinematic chain exercises at the fatigue level. *Conclusion:* In present study we found that both type of exercise protocols either close kinematic chain or open kinematic chain exercise are equally effective. Therefore data from present study support our null hypothesis. *Discussion:* This study was designed to obtain more thorough understanding of the effect of exercise induces fatigue in the CKC and OKC on the Q- angle, and navicular drop. The study is done to compare the CKC and OKC on Q- angle and navicular dropping after exercise and before exercise in the dominant lower extremity. Before implementing the experiment, the pre values of various ranges of the two group were compared between them using independent 't' –Test and the result shown to be non significant which forms the baseline of this study. *Study Limitations:* How-ever despite of best effort and state of the class facilities this study to had some limitations such as small sample size, gender limitations, non specific study population which provides just a glimpse of possibilities with more accurate and better rehabilitation outcomes. Future studies should include patient focused population, large sample size, specific study population i.e. athletes from various discipline of sports.

Keywords: Close Kinematic Chain Exercise (CKC); Open Kinematic Chain Exercise (OKC); Q- Angle and Navicular Drop.

Introduction

The Q- angle is the angle formed by the encounter of two lines, one that starts at the anterior superior iliac spine and goes to center of the patella and another that goes from the tibial tuberosity to the center of the patella [1]. It creates a lateral force vector on the patella and predisposes the patella to displacement during activation of the quadriceps. Normal value of the Qangle has been shown to vary between 10 and 14 for men and 14 and 17 for women [2].

Closed kinetic chain exercises allow functional muscle recruitment patterns to occur throughout multiple joints are frequently used in strengthening and functional rehabilitation of the lower limb. The squat is a closed kinetic chain exercise & is a complex movement involving the ankle, knee and hip joints [3].

Author Affiliation: [1,3]Lecturer [2]Associate Professor, Shri Guru Ram Rai Institute of Medical & Health Sciences, Patel Nagar, Dehradun, Uttarakhand 248001, India.

Reprint Request: Niraj Kumar, Associate Professor, Shri Guru Ram Rai Institute of Medical & Health Sciences, Patel Nagar, Dehradun, Uttarakhand 248001, India.
E-mail: drnirajkumar25@gmail.com

© Red Flower Publication Pvt. Ltd.

Many experts favor closed chain over open chain exercises. They do so under the assumption that they are safer and more functional. The terms open and closed kinematic chain have frequently led to polarizing and contradictory discussions both in scientific literature & in everyday practice of various therapists clinicians and trainers. Controversial arguments for and against open kinetic chain and closed kinematic chain exercise.

Muscle can be strengthened through resistance training which can be divided into OKC & CKC exercises. OKC exercise occurs when the movement allows the distal part of the limb to move freely while proximal part is fixed. CKC exercise is a movement wherein the distal part is fixed as when the sole of the foot makes contact with the ground or the exercise equipment with the distal part fixed movement at any one joint in the kinetic chain requires motion as well at the other joints in the kinetic chain [5].

Navicular drop is a commonly used clinical measure that response that represents a composite measure of foot pronation. In an effort to better understand the potential influence of static posture faults on dynamic knee function, we examined how subjects who were high or low on ND and QA may differ in their neuromuscular control strategies under functional, weight bearing conditions [8].

One of the methods currently used in clinical practice is measurement of the navicular drop. Depending of the foot size the dynamic navicular drop for healthy persons is on average 5.3 mm(±18mm) but can vary up to 15 mm in problematic cases. The NP has been suggested to be the most appropriate parameter for the assessment of foot pronation as it is a valid indicator of talonavicular motion and rear foot movement. The size of navicular drop appears to have important consequences for subjects who participaten in weight bearing sports such as running. Too much movement of the navicular (i.e. the foot collapse during loading place the subject in higher risk of developing injuries to the medial side of shin as well as the knee [10].

Need of the Study

Compare the effectiveness of and close kinematic chain exercises Open kinematic chain exercises on Gluteusmaximus, Q angle and navicular drop in the knee joint for improve the strength of Gluteus maximus muscle and quadriceps muscle.

I want to diagnose & compare of Q angle and navicular drop at the fatigue level exercise.

Aims and Objectives

To evaluate the effectiveness of close kinematic chain exercises of Quadriceps muscle, Gluteus maximus muscle and naviculardroping.

To evaluate the effectiveness of Open kinematic chain exercise of Quadriceps muscle, Gluteus maximus muscle and navicular dropping.

To compare the effect of open kinematic and close kinematic exercise of Q angle, Gluteus Maximus muscle and navicular drop.

Hypothesis

Null Hypothesis

There will be no significant difference on effectiveness in close kinematic chain exercise upon open kinematic chain exercise in increasing the navicular dropping.

Alternative Hypothesis

There would be a significant effect of close kinematic chain exercises over open kinematic chain exercises on the increasing the strength of Gluteus Maximus muscle and slight increasing the Q angle and no change the navicular dropping.

Review of Literature

Lephart SM, pincivero DM, Giraldo JL, Fu FH (2011) [15]

Conducted a study and concluded that combination of open and close chain exercises will ultimately be necessary to stimulate normal function and optimize the return to activities, especially in throwing, strinking, running and kicking sports. They also mentioned that the closed chain exercises enhance joint compression, activate knee and tibia coupled motions, control joint position and stimulate proprioception, closed chain exercises should therefore be utilized in knee, and hip rehabilitation for functional return to must athletic activities from all types of knee injuries.

Blasier RB, Carpenter JE, Huston LJ(1994) [16]

Sudied the comparison of two techniques i.e. OKC and CKC and that both OKC and CKC resistance exercise improved joint reposition sense in healthy subject and these exercises are designed for strengthening program to improve neuromuscular control may also be of benefit to individuals with knee proprioceptive deficits.

Yoo Jung Kwon, Soo Jin Park, John Jefferson, and Kyoung Kim, (2013) [17]

Compared the open kinematic chain exercises and close kinematic chain exercises and resulted that closed kinematic chain exercises had an important role in significantly improved dynamic balance of healthy adults, while OKC exercise produced a positive, but not significant improvement.

Tillman et al. (1995) [21]

Studied and concluded that an excessively large Q-angle can increase calcaneal eversion, thus positioning the subtalar joint in pronation. These changes would partially be respon-sible for the drop of foot's longitudinal arches. And compared the Q-angle value and the positioning of the subta-lar joint between genders and found a significant discrepancy only with regards to the Q-angle value (13.1±3.0^o in men *versus* 17.5±3.8^o in women).

Vanzeli, C.H.G., Reis, A.C.F., Pereira, A.G. et al. [22]

Studied and concluded that the inflammatory diseases such as infectious arthritis, rheumatoid arthritis, synovial diseases ranging from nonspecific synovitis, which can have numerous causes, including viral, until synovial tumors (e.g sinovyal sarcoma), passing through specific synovitis (e.g. pigmented villonodular synovitis), chondrocalcinosis (pseudo gout limestone) are the cause of biomechanical changes of the knee joint, which suggests a directed change at Q angle.

Andrews, Harrelson and Wilk, (2000) [24]

Studied and concluded that the Complications of lateral displacement occur more often in women and may be due to the slight increase in lateral traction exerted by the quadriceps mechanism. Dysfunction of the oblique vastus medial is, tense lateral structures, including the iliotibial band, patellar retinaculum and the greater subtalar pronation that results in increased Q angle value are responsible for lateral patellar displacement.

Methodology

A sample of 30 patients was taken part in this study and this study was done in SGRRIMHS/ SMIH department of physiotherapy at Patel Nagar Dehradun. It is an experimental study design. The duration of study 6 weeks. Random Sampling was done. Subjects were randomly divided into 2 groups. Inclusion no history of hip, knee and ankle joint pain presently or recently, Only males subjects taken with the age of 20-30 yr., no past history of pain & trauma as well as surgery, subjects should not be suffering any lower back pain, neuralgia, hip pain, knee pain, ankle pain, neuromuscular disorder. Subjects were excluded any stiffness around hip, knee and ankle joints, history of recent stress fracture or dislocation or subluxation around hip, knee and ankle joints, Any types of diseases around hip, knee and ankle joints, History of neuromuscular disorder, Hyper laxity of knee joint, non compliance with testing procedures and if the subject is unable to understand instruction or to provide informed consent. All subjects were given verbal instructions for the procedure and consent form was obtained from each one of them, prior to participation in the study. Goniometer used in each & every patients. Instrumentation for data collection includes Inchitap, observation couch, Quadriceps table, Marker, Foot supporter and scale.

Procedure

Each subject's descriptive data and information regarding thigh dominance, injury status and game history were recorded to satisfy the subject selection criteria. An objective examination was done to evaluate and observe knee, hip and ankle both statically and dynamically in relation to its role in the entire kinematic chain (CKC and OKC) for both the lower limb and looked for any asymmetry, deformity, atrophy etc. A physical examination was done which consisted of thorough evaluation of both hip, knee, and ankle range of motion.The Q angle, navicular drop and MMT of gluteus maximus muscle begins with the establishment of measurement reference point. These measurement were done into two phase fist pre exercise and second post exercise at fatigue level in closed kinematic chain and open kinematic chain (CKC and OKC).

MMT of Gluteus Maximus checked by comfortably in prone position with 90 degree knee bending and instructed to the subjects to elevate the thigh with bearable resistance (Figure 1).

The Q angle were measurement into two phase first was done the supine anatomical resting position and second was done standing anatomical resting position. In supine position, the subjects were lying on couch comfortably in anatomical resting position and marking the point on the ASIS , centre of patella and tibial tuberosity then line was drawn from centre of patella to ASIS and centre of patella to tibial tuberosity. After that formed the angle of these line and measured the angle by the help of goniometer (Figure 2). In standing position, bilateral standing anatomical resting position the measurement of Q angle procedure same as supine position (Figure 3).

Fig. 1: MMT OF Gluteus maximus (pre ex. and post ex.)

Fig. 2: Measure the Q angle in the knee joint supine position (pre ex. & post ex.)

Fig. 3: Measure the Q angle in the knee joint standing position(pre ex. and post ex.)

Navicular dropping measurement were done into two phase first high sitting and second was one leg standing anatomical resting position. In high sitting position, the subjects were sitting in high sitting with on the foot supporter in 90 degree knee bending then marked the point of navicular tuberosity and then checked the height from on the foot supporter ground level to navicular tuberosity by used of scale (Figure 4). In standing position, the subjects were standing on one leg on the foot supporter then marked the point of navicular tuberosity and then same as high sitting procedure (Figure 5).

Fig. 4: Measure the Nevicular drop in the high sitting position(pre ex. and post ex.)

Fig. 5: Measure the Nevicular drop in the unilateral standing position (pre ex. and post ex.)

Instructions to the Patient

1. Subjects were asked to be regular for the treatment sessions as deemed by the researcher.
2. Subjects were asked to report any discomfort during the study period and briefed about the use of safety switch.

Group A: Group A (15 patients) received Close Kinematic Chain (CKC)

Exercise Protocal: Exercise order use a certain pattern generator in the order of the fatigue level .Subjects must be comfortable with performing the exercises to prevent any potential variations. No time will be limit for the session of exercises and No limits of subject to performing the repetition of exercises. The exercises were doing in two group.

Close kinematic chain exercise/ squating exercise: these concentrate on a contraction of the Quadriceps muscle, Gluteus Maximus muscles, Hamstring muscles and lower back, leg muscle, upper part of the body straight line standing position in stabilization on the comfortable plane surface. In standing position, lower limb part of body on the plane surface on standing position. The upper extremity should be on the side of the body placed in straight line. Slowly the hip and knee moves downwards and upwards movements and maintaining straight line on the ground. Before these movement of the part were fixed and stabilized on the ground. These movements are doing as well as they should be fatigue (Figure 6).

Group B: Group B (15 patients) received Open Kinematic Chain Exercise (OKC).

Fig. 6: To perfume the close kinematic chain exercise

Open Kinematic Chain Exercise (OKC)

Weight lifting exercise: These concentric on a co-contraction of the Quadriceps muscles. Stabilize the above knee joint and hip joint and distal part of leg free. In high sitting position, Sitting on the quadriceps table at high sitting position where distal part of leg and leg free move with weight and proximal and above knee joint is stabilized. Upper extremities hand are griped the hand arm of quadriceps table at straight line position then doing the movement of leg with weight on full range of motion of knee joint (Figure 7).

Fig. 7: To perfume the open kinematic chain exercise

After completing the above mentioned task same procedure of measuring each variables were repeated and recorded and compared.

Data Analysis

Data was analyzed using SPSS (version13.0) software and the results of present study are as follows. On analyzing pre exercise and post exercise data of group which performed close kinematic exercises the mean & SD for GMMMT was 3.87±0.516 & 4.2±0.41 respectively and the group which performed open kinematic exercise the mean & SD was 4.06±0.45 and 4.5±0.51 for GMMMT respectively. Results were calculated by using 0.05 level of significance.

Results

On analyzing pre exercise and post exercise data of group which performed close kinematic exercises the mean & SD for GMMMT was 3.87±0.516 & 4.2±0.41 respectively and the group which performed open kinematic exercise the mean & SD was 4.06±0.45 and 4.5±0.51 for GMMMT respectively.

Table 1 showed that mean±SD of Q- angle was 16.2±4.28 (ST), 16.47±5.11 (SU) pre exercise & 15.47±3.50 (ST) ,15.53±3.71 (SU) post exercise in group performing close kinematic exercise.

Table 2 showed that in group performing open kinematic exercise the mean±SD of Q- angle was 14.4± 4.7 (ST), 15.13± 3.7 (SU) in pre exercise group & 14.6±1.9(ST), 15.3±2.4 (SU) in post exercise group.

Tables 1 & 2 showed that on analyzing the data obtained (from both the groups performing close kinematic or open kinematic exercise) for Navicular drop test, the results showed significant differences between pre and post exercise values in both groups.

Table 1: Mean, Standard Deviation of Close Kinematic Chain Exercise (pre and post exercise) on GMMT, Q-Angle, & Navicular Drop

Close Kinematic Exercise					
GMMMT (N=15)					
PRE	AVRG	SD ±	POST	AVRG	SD ±
	3.87	± 0.516		4.2	± 0.414
Q ANGLE (N=15)					
PRE	AVRG	SD ±	POST	AVRG	SD ±
ST	16.2	± 4.28	ST	15.47	± 3.50
SU	16.47	±5.11	SU	15.53	± 3.717
NAV DROP (N=15)					
PRE	AVRG	SD ±	POST	AVRG	SD ±
HST	5.13	± 0.638	HST	5.14	± 0.725
BLST	4.67	± 0.767	BLST	4.7	± 0.746
ULST	4.96	± 0.678	ULST	4.93	± 0.694
DS	4.94	0.70	DS	5.0	±0.797

Table 3 showed that to compare the changes (if any) in various parameters of pre and post exercise levels in test groups, Paired "t" test has

Table 2: Mean, Standard Deviation of Open Kinematic Chain Exercise (pre and post exercise) on GMMT, Q-Angle, and Navicular Drop

Open Kinematic Exercise					
GMMMT (N=15)					
PRE	**AVRG**	**SD ±**	**POST**	**AVRG**	**SD ±**
	4.06	± 0.45		4.5	± 0.45
Q ANGLE (N=15)					
PRE	**AVRG**	**SD ±**	**POST**	**AVRG**	**SD ±**
ST	14.4	± 4.7	ST	14.6	± 4.7
SU	15.13	± 3.71	SU	15.3	± 3.7
NAV DROP (N=15)					
PRE	**AVRG**	**SD ±**	**POST**	**AVRG**	**SD ±**
HST	5.22	0.51	HST	5.2	± 0.51
BLST	5.09	± 0.49	BLST	5.12	±0.49
ULST	5.21	±0.45	ULST	8.28	± 0.45
DS	5.29	± 0.51	DS	5.2	± 0.51

Table 3: T-test for closed kinematic chain and poen kinematic exercises (showing mean, SD, t-value and significance)

Close kinametic exercise					
GMMT (pre exercise GMMT-post exercise GMMT)					
	Mean	**SD**	**t-value**	**DF**	**Sig (2-tailed)**
Pre GMMT- Post GMMT	0.33	0.48	2.64	14	0.019
Q- ANGLE (Pr exercise-Post Exercise)					
	MEAN	**SD**	**t-value**	**DF**	**Sig (2-tailed)**
Pre ST-Post ST	0.73	3.4	0.82	14	0.422
Pre SU – Pro SU	0.93	4.1	0.86	14	0.402
Navicular Drop (Pre Exercise-Post Exercise)					
	MEAN	**SD**	**t-value**	**DF**	**Sig (2-tailed)**
Pre HST-Post HST	0.006	0.13	0.18	14	0.855
Pre BLST-Post BLST	0.033	0.13	0.92	14	0.371
Pre ULST- Post ULST	0.026	0.096	1.07	14	0.301
Pre DS- Post DS	0.06	0.105	2.2	14	0.045

Open kinematic exercise					
GMMT (pre exercise GMMT-post exercise GMMT)					
	Mean	**SD**	**t-value**	**DF**	**Sig (2-tailed)**
Pre GMMT- Post GMMT	0.46	0.51	3.5	14	0.004
Q- Angle (Pre xercise-Post Exercise)					
	Mean	**SD**	**t-value**	**DF**	**Sig (2-tailed)**
Pre ST-Post ST	0.13	4.4	0.11	14	0.90
Pre SU – Pro SU	0.20	3.7	0.20	14	0.83
Navicular Drop (Pre Exercise-Post Exercise)					
	Mean	**SD**	**t-value**	**DF**	**Sig (2-tailed)**
Pre HST-Post HST	0.01	0.20	0.25	14	0.86
Pre BLST-Post BLST	0.02	0.24	0.41	14	0.68
Pre ULST- Post ULST	3.06	11.8	1.0	14	0.33
Pre DS- Post DS	0.006	0.59	0.43	14	0.67

Table 4: Correlations Of Closed Kinematic Chain Of Pre And Post Exercise Level

			Pre-Exercise Level							Post-Exercise Level						
			GMMMT	ST	SU	HST	BLST	ULST	WPST	GMMMT	ST	SU	HST	BLST	ULST	WPST
Pre-Exercise Level		GMMMT	1.000	-.481	-.341	-.206	.030	.012	-.002	.448	-.347	-.350	-.190	-.002	-.016	-.016
	Q Angle	ST	-.481	1.000	.933**	.522*	.455	.383	.499	-.197	.560*	.468	.531*	.444	.446	.469
		SU	-.341	.933**	1.000	.482	.457	.371	.466	-.194	.615*	.578*	.495	.425	.426	.408
	Foot Arch	HST	-.206	.522*	.482	1.000	.927**	.926**	.933**	.019	.607*	.506	.995**	.956**	.945**	.933**
		BLST	.030	.455	.457	.927**	1.000	.967**	.961**	-.019	.422	.346	.935**	.985**	.980**	.963**
		ULST	.012	.383	.371	.926**	.967**	1.000	.949**	.058	.356	.268	.936**	.970**	.988**	.950**
		WPST	-.002	.499	.466	.933**	.961**	.949**	1.000	.117	.416	.304	.951**	.964**	.968**	.981**
Post-Exercise Level		GMMMT	.448	-.197	-.194	.019	-.019	.058	.117	1.000	-.019	-.116	.058	.058	.019	.039
	Q Angle	ST	-.347	.560*	.615*	.607*	.422	.356	.416	-.019	1.000	.936**	.580*	.479	.418	.423
		SU	-.350	.468	.578*	.506	.346	.268	.304	-.116	.936**	1.000	.470	.387	.321	.305
	Foot Arch	HST	-.190	.531*	.495	.995**	.935**	.936**	.951**	.058	.580*	.470	1.000	.964**	.956**	.943**
		BLST	-.002	.444	.425	.956**	.985**	.970**	.964**	.058	.479	.387	.964**	1.000	.987**	.976**
		ULST	-.016	.446	.426	.945**	.980**	.988**	.968**	.019	.418	.321	.956**	.987**	1.000	.977**
		WPST	-.016	.469	.408	.933**	.963**	.950**	.981**	.039	.423	.305	.943**	.976**	.977**	1.000

Correlations of Closed Kinematic Chain of Pre and Post Exercise Level

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

been performed and the results shows significant difference (p<0.05 and p<0.01) in each group.

Table 4 showed that the relationship between exercise type (CKC/OKC) and various parameters was examined by calculating Pearson correlation on pre and post exercise data of both the groups with significance level set at P<0.05 and the results obtained, shows no significant correlation between GMMMT & Q-angle in pre exercise levels of open kinematic chain exercise group. There is a significant correlation (95% at P<0.05) between Navicular drop and GMMMT in HST position. More significant correlation (99% at P<0.01) was found between GMMMT and BLST and ULST positions at pre-exercise levels. No significant relation was present between GMMMT & DS at pre-exercise level.

In group performing open kinematic chain exercise there is no significant relation was found between GMMMT and Q-angle. At pre exercise and post exercise levels Table 5 showed that there was no significant correlation present between Navicular drop and Q-angle at pre exercise level.

Table 5: Correlations of Open Kinematic Chain of Pre and Post Exercise Level

		Pre-Exercise Level							Post-Exercise Level						
		GMMMT	ST	SU	HST	BLST	ULST	WPST	GMMT	ST	SU	HST	BLST	ULST	WPST
GMMMT		1.000	.098	.243	.558*	.667**	.667**	.488	.443	.241	.377	.361	.598*	.562*	.451
Q Angle	ST	.098	1.000	.785**	-.029	.118	-.071	-.054	-.156	.670**	.393	.086	.173	-.097	-.002
	SU	.243	.785**	1.000	-.189	.187	.209	.208	.095	.455	.559*	-.015	.202	.148	.243
Navicular drop	HST	.558*	-.029	-.189	1.000	.670**	.501	.456	.529*	-.005	-.054	.837**	.731**	.494	.483
	BLST	.667**	.118	.187	.670**	1.000	.899**	.863**	.357	.134	.415	.516*	.835**	.701**	.866**
	ULST	.667**	-.071	.209	.501	.899**	1.000	.907**	.558*	.049	.435	.434	.750**	.720**	.892**
	WPST	.488	-.054	.208	.456	.863**	.907**	1.000	.466	-.087	.362	.313	.599*	.586*	.994**
GMMMT		.443	-.156	.095	.529*	.357	.558*	.466	1.000	-.188	-.080	.499	.405	.310	.480
Q Angle	ST	.241	.670**	.455	-.005	.134	.049	-.087	-.188	1.000	.631*	.040	.245	.087	-.092
	SU	.377	.393	.559*	-.054	.415	.435	.362	-.080	.631*	1.000	-.044	.298	.417	.345
Navicular drop	HST	.361	.086	-.015	.837**	.516*	.434	.313	.499	.040	-.044	1.000	.770**	.537*	.368
	BLST	.598*	.173	.202	.731**	.835**	.750**	.599*	.405	.245	.298	.770**	1.000	.753**	.623*
	ULST	.562*	-.097	.148	.494	.701**	.720**	.586*	.310	.087	.417	.537*	.753**	1.000	.585*
	WPST	.451	-.002	.243	.483	.866**	.892**	.994**	.480	-.092	.345	.368	.623*	.585*	1.000

Correlations of Open Kinematic Chain of Pre and Post Exercise Level

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

At post exercise level significant correlation (95% at P<0.05) was present between GMMMT and BLST & ULST positions for Navicular drop among the group performing open kinematic exercises. HST & DS positions for Navicular drop showed no significant correlation in this group.

In group performing close kinematic exercise, at pre exercise level GMMMT has no significant correlation with Navicular drop. But there is significant correlation (95% at P<0.05) between Q-angle (ST) and Navicular drop (HST) at both pre and post exercise levels.

Discussion

This study was designed to obtain more thorough understanding of the effect of exercise induces fatigue in the CKC and OKC on the Q- angle, and navicular drop. The study is done to compare the CKC and OKC on Q- angle and navicular dropping after exercise and before exercise in the dominant lower extremity. Before implementing the experiment, the pre values of various ranges of the two group were compared between them using independent 't' –Test and the result shown to be non significant which forms the baseline of this study.

Significant difference has been resulted from the fatigue induced by the exercise. This result is supported by the study done by Yoo Jung kwon and Soo et al. [1] john Jefferson et al. [2], and kyoungkim et al. who suggested that closed kinematic chain exercises had an important role in significantly improved dynamic balance of healthy adults, while OKC exercise produced a positive, but not significant improvement [5].

This result is also supported by Lephart SM, pincivero DM, Giraldo JL, Fu FH (2011): Their finding suggest that combination of open and close chain exercises will ultimately be necessary to stimulate normal function and optimize the return to activities, especially in throwing, strinking, running and kicking sports. This may form part of the ascending proprioceptive afferent fiber system [15].

As it is proven through various studies that efficient functioning of lower limb is being influenced by various factors such as muscle strength, fatigue level and several other biomechanical constrains. In present study we tried to see the effect of exercise (close and open kinematic) on various parameters such as Q-angle, navicular drop, and strength of gluteus Maximus muscle. The results obtained in this study are in compliance with results of various other studies stating the relations between different parameters [15].

The findings of our study are strongly supported by the results of study done by Hugo Machado et.al comparing the differences in Q-angle values in different positions and found significant differences in Q-angle measurements in supine and standing position.

As the data of present study shows that there is an increase in value of Q-angle from standing position to supine position in each group but when the value of Q-angle of two groups were compared the results showed significant differences between the groups.

The group that performed open kinematic exercises has lower mean value of Q-angle as in comparison to group that performed closed kinematic exercise. Depending upon these findings, open kinematic chain exercise protocol can be in-corporate while planning rehabilitation protocol for persons with knee injuries [6].

In a study done by Yoo JUNG Kwon et.al, depending on the findings, they suggested that an exercise protocol to restore or increase dynamic balance ability the close kinematic exercises are more effective as it involves more than one joint at same time and produces superior eccentric contraction and co-contraction of muscles with reduced shear forces over the joint and data obtained in our study also shows increased mean value of selected parameters at post exercise levels. In same study Yoo Jung Kwon et.al also mentioned that open kinematic exercises are more useful in isolating an individual muscle/muscle group as it produces less force over the involved joints this statement strongly proves the validity of lesser mean value in group performing open kinematic exercises [17].

The Q-angle values differs in accordance to gender and normal values for Q-angle have been noted to vary between 10^{o} to 14^{o} for men and 14^{o} to 18^{o} for women and an increase in pressure between patella and lateral femoral condyle during quadriceps muscle activity. In a study conducted by Y. Sokhangooei et. al. included subjects with Patellofemoral syndrome and evaluated the efficiency of closed kinematic chain and open kinematic chain exercises on different parameters such as pain, Q-angle and knee proprioception. In particular they found that the subjects with Patellofemoral syndrome have increased Q-angle. They included close kinematic chain exercises and open kinematic chain exercises and noted significant improvement in Q-angle and they stated that both open chain and closed chain exercises are equally effective. Hence the data from current study is in accordance to results of above mentioned study. But it becomes essential to mention that selection of exercise protocol should be done after a proper assessment of patient's condition and ability [24].

In a study titled "Flat Foot Deformity, Q-angle and Knee pain are interrelated in wrestlers" done by Amir Letafatkat et. al. it is mentioned that the flat foot deformity or excessive Navicular drop may result in patella lateral rotation and increase in Q-angle. Hence, making it necessary for a rehabilitation expert/ sport therapist to choose optimal rehabilitation protocol for the patient [19].

Conclusion

In present study we found that both type of exercise protocols either close kinematic chain or open kinematic chain exercise are equally effective. How-ever, various factors such position of lower extremity, type of exercise, directly or indirectly will affect the prognosis of certain conditions involving lower limb. Furthermore, data obtained from this type studies can be considered as reference values either for making diagnosis, planning a patient specific rehabilitation protocols or even to predict the outcome of any on going rehabilitation protocol. Hence data from present study support our null hypothesis.

Study Limitations

How-ever despite of best effort and state of the class facilities this study to had some limitations such as small sample size, gender limitations, non specific study population which provides just a glimpse of possibilities with more accurate and better rehabilitation outcomes. Future studies should include patient focused population, large sample size, specific study population i.e. athletes from various discipline of sports.

Refrences

1. Sanchez HM, Sanchez EGM, Barauna MA, Canto RST. Evaluation of Q angle in different static postures. Actaortopedicabrasileira .November 2014;22(6):325-9. URL: http://www.scielo.br/aob.
2. Laura H. Lathinghouse, Mark H. Trimble. Effect of isometric Quadriceps Activation on the Q angle in women before and after Quadriceps exercise: Journal orthopaedic and sports physical Therapy. 2000;30(4):211-16.
3. Wilson J, Ferris E, Heckler A, Maitland L, Taylor C. A structured review of the role of gluteus maximus in rehabilitation, New Zealand journal of physiotherapy 2005;33(3):95-100.
4. F. Mayer, A. Schlumberger, R. Vancinegel, Y. Henrotin, W. laube and D. Schmidtbleicher. Training and testing in open versus closed kinetic chain. 2003;11:181-87.
5. Yoo Jung kwon, Soojin park, John Jefferson, Kyoungkimpt. The effect of open and closed kinetic chain exercises on dynamic balance ability of normal healthy adults. Journal of physical therapy science. 2013 June;25(6):671-74.
6. Hugo Machado & Ebefafitness. The funcational impact of navicular drop.www. ebfafitness. com. 2015 May 22.
7. Sandra J Schultz, Christopher R carcia, Bruce M Gansneder and David H Perrin.The independent & interactive effect of navicular drop and quadriceps angle on neuromuscular response to wight bearing perturbation. Journal of athletic training. 2006;3:251-59.
8. McPoil TG, Cornwall MW, Medoff L, Vicenzino B, Forsberg K, Hilz D. The navicular drop test. J Foot Ankle Res. 2008;1:3
9. William M. Austin. Women in Sports, Q Angle, and ACL Injuries. Dynamic Chiropractic. 2003 Oct 6;21(21).
10. Simon L. kappel, Michael S. Rathleff Dan Hermann, ole simonsen, HenrikKarstoft and peter ahrendt: A Novel method for measuring in shoe navicular drop during gait. Sensors. 2012;12(9).
11. Grob K, Ackland, T kuster, MS manestar, M. filgueria: anatomy of Quadricepfemoris muscles; 2016 Jan 6, Wikipedia.
12. Boisen- molar, finn, simonsenerik-b, Tranum-jenson, Jorgen: anatomy of navicular bone from Wikipedia; the fee encyclopedia; 2017 Aug 16.
13. Anne Asher, CPT, Reviewed by Grant Hughes, MS. Open and closed kinetic chain: 2016 Sep 24.
14. Pamela K. Levangie, Cynthia C. Norkin. Text books of joint structure and function, 2010.
15. Lephart SM, Pincivero DM, Giraldo JL, Fu FH The role of proprioception in the management and rehabilitation of athletic injuries. Am J Sports Med. 1997 Jan-Feb;25(1):130-7.
16. Blasier RB, Carpenter JE, Huston LJ. Shoulder proprioception: effect of joint laxity, joint position, and direction of motion. Orthop Rev 1994:23:45-50.
17. Yoo Jung Kwon, Soo Jin Park, John Jefferson, and Kyoung Kim. The Effect of Open and Closed Kinetic Chain Exercises on Dynamic Balance Ability of Normal Healthy Adults. J Phys Ther Sci. 2013 Jun; 25(6): 671–674.
18. Wilson J, Ferris E, Heckler A, Maitland L, Taylor C. A structured review of the role of gluteus maximus

in rehabilitation. New Zealand Journal of Physiotherapy 2005;33(3):95-100.

19. Letafatkar A, Zandi S, Khodayi M, Vashmesara JB. Flat Foot Deformity, Q Angle and Knee Pain are Interrelated in Wrestlers. J Nov Physiother 2013;3:138. doi:10.4172/2165-7025.1000138.
20. Søren Spörndly-Nees, Brian Dåsberg, Rasmus Oestergaard Nielsen, Morten IlumBoesen, and Henning Langberg. The Navicular Position Test– A Reliable Measure of the Navicular Bone Position During Rest and Loading. Int J Sports Phys Ther. 2011 Sep; 6(3): 199–205.
21. Tillman et al. (1995): Tidy's physiotherapy e-book.
22. Vanzeli, C.H.G., Reis, A.C.F., Pereira, A.G. et al. Measurement the "Q" angle through the application of direct method and indirect method. J. Morphol. Sci., 2016;33(3):168-70.
23. Y. Sokhangooei Lathinghouse And Trimble. Effects of isometric quadriceps activation on the Q-angle in women before and after quadriceps exercise. J Orthop Sports Phys Ther. 2000 Apr;30(4):211-6.
24. Andrews, J.R., Harrelson, G.L., Wilk, K.E. Sports Injuries: Prevention, Diagnosis, Treatment and Rehabilitation. 2000.