THE EFFECT OF OPEN KINEMATIC CHAIN EXERCISES AND CLOSED KINEMATIC CHAIN EXERCISES WITH PATELLAR TAPING ON STATIC AND DYNAMIC Q ANGLE ON FEMALE RECREATIONAL RUNNERS-A RANDOMIZED CONTROLLED TRIAL

By

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In partial fulfillment of the

requirements for the degree of

MASTER OF PHYSIOTHERAPY (MPT)

In

SPORTS

Under the guidance of

Prof. Joseph Oliver Raj

Dean

Abhinav Bindra Sports Medicine & Research Institute, Bhubaneswar, Odisha

2024

DECLARATION BY THE CANDIDATE

I hereby declare that this dissertation/thesis entitled **“The effect of open kinematic chain exercises and close kinematic chain exercises with patellar taping on static and dynamic Q angle on female recreational runners – randomized controlled trial**” is a bonafide and genuine research work carried out by me under the guidance **of Prof. Joseph Oliver Raj, Dean - ABSMARI.**

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CERTIFICATE BY THE GUIDE

This is to certify that the dissertation entitled **THE EFFECT OF OPEN KINEMATIC CHAIN EXERCISES AND CLOSED KINEMATIC CHAIN EXERCISES WITH PATELLAR TAPING ON STATIC AND DYNAMIC Q ANGLE ON FEMALE RECREATIONAL RUNNERS-A RANDOMIZED**

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ENDORSEMENT BY THE DEAN

This is to certify that the dissertation entitled “ **The effect of open kinematic chain exercises and close kinematic chain exercises with patellar taping on static and dynamic Q angle on female recreational runners – randomized controlled trial.**” is a bonafide research work done by **Nikita Vikram Singh Ranawat** under the guidance of **Prof. Joseph Oliver Raj , DEAN, ABSMARI**.

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Place: **Prof . Joseph Oliver Raj**

Dean , ABSMARI

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Date: Signature of candidate

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LIST OF ABBREVIATIONS

1. ABSMARI – Abinav Bindra Sports Medicine and Research Institute
2. ACSM – American College of Sports Medicine
3. OKC - Open kinematic chain exercises
4. CKC – Closed kinematic chain exercises
5. FNA – Femoral neck anteversion
6. ANOVA- analysis of variance
7. SQA- Simplified Q angle
8. QT- Quadricep tendon
9. TT- Tibial tuberosity
10. ASIS – Anterior superior iliac spine
11. FPPA- Frontal plane projection angle
12. DKV- Dynamic Knee Valgus
13. TPAT – Trochanteric prominence angle test
14. TFA- Thigh foot angle
15. TMA – Trans malleolar axis
16. PFPS- Patellofemoral pain syndrome
17. ACL- Anterior cruciate ligament

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ABSTRACT

THE EFFECT OF OPEN KINEMATIC CHAIN EXERCISES AND CLOSED KINEMATIC CHAIN EXERCISES WITH PATELLAR TAPING ON STATIC AND DYNAMIC Q ANGLE ON FEMALE RECREATIONAL RUNNERS- A RANDOMIZED CONTROLLED TRIAL

BACKGROUND: Female Runners are the most common athletes of facing knee injuries than males. There are various factors leading to knee injuries such as anatomical, physiological, neuromuscular and hormonal. One of the most important biomechanical parameters is the Q angle which is the intersection of the line from the anterior superior iliac spine to the center of the patella and a line connecting the center of the patella to the tibial tuberosity. it's contributing factors such as femoral anteversion, and external tibial rotation. Excessive Q angle leads to uneven distribution of the pressure. as there is a dearth of studies for correction of excessive Q angle. Also, there is no clarity on choosing exercises for the correction of Q angle. Both open kinematic chain exercises, and close kinematic exercises with patellar taping coupled together are used as an intervention in this study. This study aims to evaluate the effect of open kinematic chain exercises vs close kinematic chain exercises with patellar taping on static and dynamic Q angles on female recreational runners.

METHODS: Forty five female recreational runners aged between 18 to 25 were randomly assigned to a group open kinematic chain exercise with patellar taping (n = 15), close kinematic chain exercises with patellar taping (n=15) and control group (n=15) . Each exercise intervention consisted of 45 minutes of exercise including warm up of 10 minutes and cool down of 5 minutes. Static Q angle was, dynamic Q angle, femoral anteversion and external tibial rotation were asses before and after the 4 weeks of intervention using simplified q angle technique. dynamic knee valgus test, Criag test and tibiofemoral angle measurement.

RESULTS: The findings of this study suggested that femoral anteversion showed p 0.05 external rotation showed improvement in static Q angle and dynamic Q angle.

KEYWORDS: female recreational runners, Excessive Q angle, open chain kinematic excercises, close kinematic chain exercises, patellar taping,

Introduction

Running, whether for recreation, fitness or professionally, has gained popularity all over the world. Associated with this relatively inexpensive and popular code of sport, is the risk of injury. (1) An estimated total number of global runners is *621.16 million people (2)* Clinical studies reported that the most prevalent site of running injury was the knee. Knee injuries has been reported about 25% of all running injury. Runners with a Q-angle of more than 20° were at 1.7 times greater risk of injury (3)

Running gait can be divided into two phases regarding the lower extremity - stance and swing. These can be further divided into five phases. 1. Stance phase absorption. 2. Stance phase generation. 3. Swing phase generation. 4. Swing phase reversal. 5. Swing phase absorption. (4)

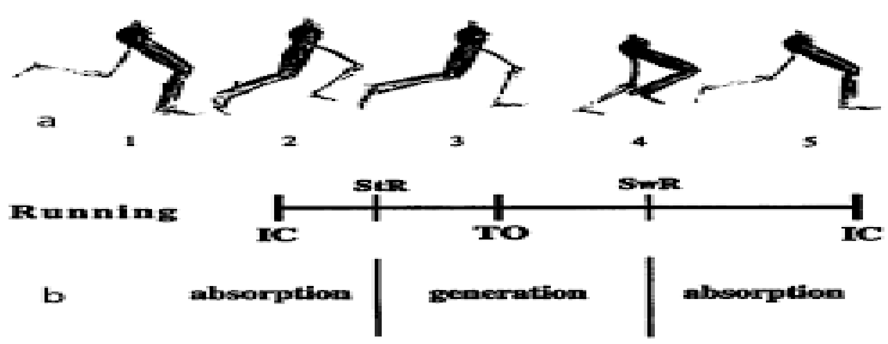

Fig 1.1 Phases of running

Q angle is an biomechanical parameter. It represents the direction of the quadricep muscle force vector in the frontal plane . Also the contributing factors such as femoral anteversion , External tibial torsion angle which increases the Q angle . (5)

Q ANGLE

The Q-angle is defined as the angle between the quadriceps muscle (primarily the rectus femoris) and the patellar tendon and represents the angle of quadriceps muscle force. There are two types of Q angle observed which are static and dynamic Q angle. Static Q angle is defined as the frontal plane resultant force vector of the quadriceps musculature and patellar tendons acting, respectively, on the patella. . Dynamic Q-angle is defined as the Q-angle through the knee joint's flexion, with or without a dynamic activity. Its measurement requires either the same bony points as on static Q-angle or using dynamic knee valgus (DKV) through the measurement of frontal plane projection.[6]

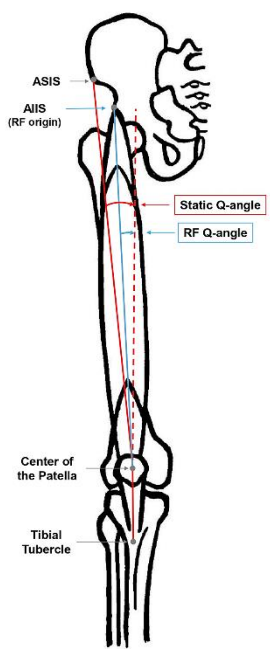

Fig . 1.2 Static Q angle

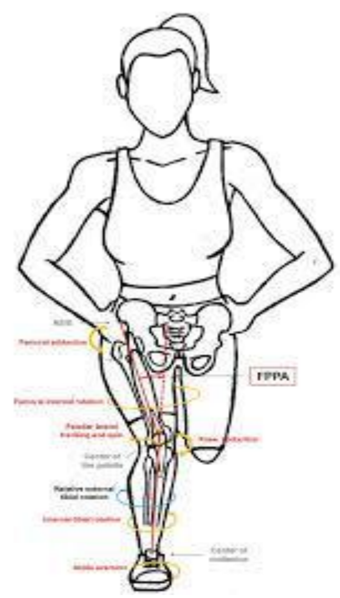

fig 1.3 dynamic Q angle

FEMORAL ANTEVERSION AND EXTERNAL TIBIAL ROTATION

Femoral neck anteversion (FNA) is the angle between the femoral neck and femoral shaft, indicating the degree of torsion of the femur. It also called femoral torsion or femoral version, is the angle between the projection of two lines in the axial plane perpendicular to the femoral shaft; one line going through the proximal femoral neck region and the second one through the distal condylar region (Figure 1.4), indicating the degree of 'twist' of the femur. Normal value of femoral anteversion is 15 degrees in females. Greater than this is considered as abnormal FNA Abnormal femoral anteversion affects the line of muscle action and biomechanics of hip is also altered. (7)

Specifically femoral anteversion had the strongest association with greater Q angle. Excessive femoral anteversion would essentially place the femur into a more medially rotated position, potentially resulting in increased Q angle. (8)

- The normal range of tibial torsion is reported to be about 13-18 degrees. More than 18 degrees is defined as the external tibial torsion. **Increased external tibial torsion**, which further leads to lateral stretch from the rectus femoris muscle to the patella increases Q angle. (9)

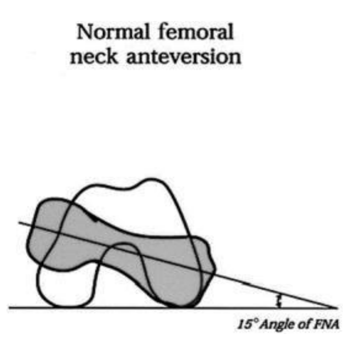

FIG 1.4 femoral neck anteversion

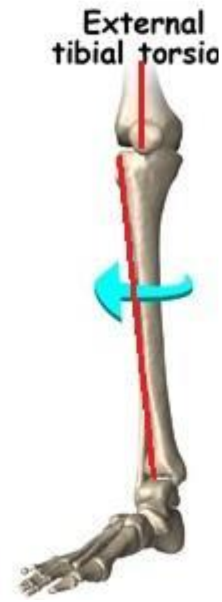

Fig1.5 External tibial rotation

OPEN KINEMATIC CHAIN EXERCISE

Open kinetic chain exercises are the exercises which occurs when the movement allows the distal part of the limb to move freely while the proximal part is fixed. OKC exercise plays an important role in isolating individual muscle groups. It tends to generate more distraction and rotational forces and is often used with concentric muscle contraction. (10)

Fig 1.6 OPEN KINEMATIC EXERCISE

CLOSE KINEMATIC CHAIN EXERCISE.

Closed kinetic chain 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. Thus, both proximal and distal parts receive resistance training at the same time. In the case of the lower limb, CKC exercises are more functional, as weight bearing is, by definition, a closed kinetic chain activity of the lower limb. CKC exercise has been cited as producing superior eccentric contraction and co-contraction of muscles, as well as reducing shear forces while adding compressive forces to the joints, thereby enhancing joint stability. (11)

Fig 1.7 CLOSE KINEMATIC CHAIN EXCERCISE

PATELLAR TAPING

MC Connell tailored Patellar taping is the most common technique used generally to correct the patellar tilt shift and the functional position. Rigid taping is used to the correct the anatomical alignment of the particular structure. Ideal Q angle is increased due to lateral patellar tilt and rotation.

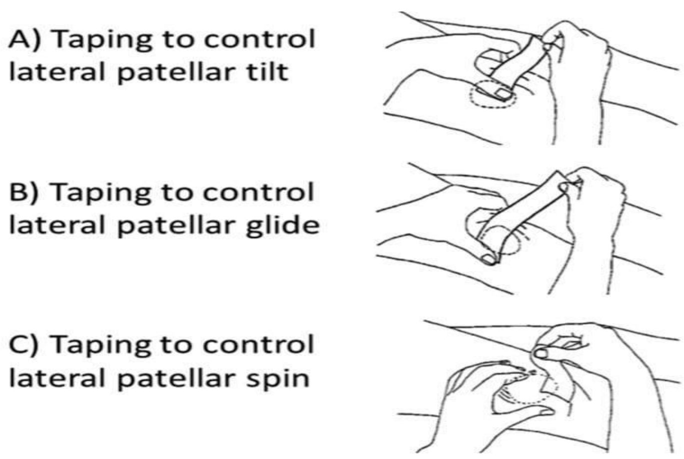

Fig 1.8 components of Mc Connell's tailored patellar taping

Need of the study

1. To find an effective prevention strategy for female runners to be added in the training regime to prevent the increment of Q angle.
2. As there is dreath of study on effective treatment on reducing the static and dynamic Q angle with dependent variable as it is the most common cause of knee injuries.
3. To find out the changes in Q angle during movement and other ways to alter the changes with effective treatment.

Aim of the study

To evaluate the effect of open kinematic chain exercises and close kinematic chain exercises with patellar taping on static and dynamic Q angle in female recreational runners

Objective of the study

1. To see the effect of close kinematic chain with patellar taping on static and dynamic Q angle, femoral anteversion and tibial torsion .

2. To see the effect of open kinematic chain exercise with patellar taping on static and dynamic Q angle, femoral anteversion and tibial torsion .

3. To see the effect of patellar taping on static and dynamic Q angle.

Hypotheses

Null hypotheses

1: There will be no significant effect of open kinematic chain exercise with patellar taping on static and dynamic Q angle, femoral anteversion and tibial torsion.

2 : There will be no significant effect of close kinematic chain exercise with patellar taping on static and dynamic Q angle, femoral anteversion, and tibial torsion.

3: There will be no significant difference between open kinematic exercises and close kinematic exercises with patellar taping on static and dynamic Q angle, femoral anteversion, and tibial torsion

Alternative hypotheses

1 :. There will be significant effect of close kinematic chain exercise with patellar taping on static and dynamic Q angle, femoral anteversion, and tibial torsion.

2 : There will be significant effect of open kinematic chain exercise with patellar taping on static and dynamic Q angle, femoral anteversion and tibial torsion

3: There will be significant difference between open kinematic exercises and close kinematic exercises with patellar taping on static and dynamic Q angle, femoral anteversion, and tibial torsion

Review of literature

1. **Nihar Ranjan Mohanty, Shyamal Koley (et al 2018)** cconducted a study on ‘ lower extremity malaingment and its correlation to Q angle in state level athletes of odhisa .’ a significant positive correlation (p<0.001) of right Q angle was noted with right femoral anteversion right tibial torsion and right navicular drop.
2. **Prabhjot Kaur Chhabra , Mayura Setiya1 , Rajan Godwin2 (2016)** conducted a study on “Quadriceps angle: An Important Indicator of Biomechanical Function of Lower Extremity and Its Relation with Anterior Knee Pain “ • Q-angle is significantly associated with anterior knee pain in both males and females with females having greater Q-angle, being more prone to anterior knee pain .
3. **Dennis Y. Wen (2007)** conducted a study on Risk factor for overuse injuries in runners • Most likely, the risk factors for running injuries are multifactorial, with some underlying risk associated with various anatomic factors, but with the need for certain training factors, to manifest that underlying risk.
4. **Hassan daneshmandi Farzaneh saki sareh shaheidari abolfazl khoori (2011)** conducted a study on Lower extremity Malaligment and its linear relation with Q angle in female athletes”. this study was that alignment of lower extremity is associated with the magnitude of the Q angle. Specifically, tibiofemoral angle, femoral anteversion and hip internal rotation had the strongest association with greater Q angle Excessive Q angle has been identifying as a risk factor for knee injuries.
5. **Tsung-Yu Lan, Wei-Peng Lin, Ching-Chuan Jiang and Hongsen Chiang (2010)** conducted a study on “Immediate Effect and Predictors of Effectiveness of Taping for Patellofemoral Pain Syndrome” it was concluded. that Taping is an effective treatment for patellofemoral pain syndrome, but was less effective in patients with higher body mass index, larger lateral patellofemoral angle, and smaller Q angle .
6. **Christian Barton ,Vivek Balachandar, Simon Lack, Dylan Morrissey (2014)** conducted a study on Patellar taping for patellofemoral pain: a systematic review and meta-analysis to evaluate clinical outcomes and biomechanical mechanisms Tailoring patellar taping application (ie, to control lateral tilt, glide and spin) to optimise pain reduction is important for efficacy
7. **H Bakhtiary, E Fatemi (et al 2014)** conducted a study on Open versus closed kinetic chain exercises for : patellar chondromalacia” it concluded indicate that semi-squat exercises (closed kinetic chain) are more effective than SLR exercise (open kinetic chain) in the treatment of patellar chondromalacia . the Q angle was reduced in both groups.
8. **Ms. AYSLAN JORGE SANTOS DE ARAUJO Dr. WALDERI MONTEIRO DA SILVA JUNIOR (2014)** conducted a study on “THE Q ANGLE ANALYSIS, DURING RESISTANCE TRAINING, ON OPEN KINEMATICS CHAIN AND INTERMIDIATE CLOSED KINEMATICS CHAIN, THROUGH PHOTOGRAMETRY” – a clinical trail a clinical trial concluded that he study showed that the Q angle, when compared to exercises of

open and intermediate closed kinematic chain, has changed as the movement of knee flexion was realized for both knees, normal and valgus. Thus, it applies a combination of exercises in the OKC and ICKC during muscle strengthening.

9. **Skouras AZ, et al (2022).** conducted a study on Clinical Significance of the Static and Dynamic Q-angle Dynamic Q-angle (frontal and transverse plane) seems to be a promising biomechanical parameter but should be investigated more extensively for weighting assessment methods and its clinical value in predicting, preventing, and rehabilitating various painful syndromes and injuries.

METHODOLOGY

- **Study design:** Randomized Controlled trial
- **Study population:** Recreational Female runners
- **Sample size :**45 (15/group)
- **Sampling technique:** Purposive sampling
- **Study setting:** Abhinav Bindra sports medicine and research institute
- **Study duration** : 1 year

INCLUSION CRITERIA

1. Q angle more than 18 degrees in female .
2. Age :18 to 25 (16)
3. Recreational runners

EXCLUSION CRITERIA

1. Subjects with fracture, sprain or any soft tissue injury within the past 6 months.
2. Subjects suffering from any cardio vascular dysfunction.
3. Subject involved in treatment including massage or any strengthening exercise regime
4. Known pregnancy
5. Neurological involvement that would influence balance and coordination during kinematic testing.

MATERIALS USED

1. Goniometer
2. Camera
3. Rigid tape
4. Tukfut scissor
5. Underwrap
6. Kinovea software
7. Reflective Marker
8. Resistance Bands
9. Weight sand Bag

OUTCOME MEASURES

1. Simplified Q angle measurement
2. Dynamic knee valgus
3. Craig test
4. Thigh foot Illustration of tibial torsion using angle.

PROCEDURE

This present study was reviewed and approved by the institutional ethical committee. A total of 45 samples were selected by purposive sampling. The subjects were selected based on inclusion and exclusion criteria . They were included in this study with some criteria like the female recreational athletes who were practicing running three to five times per week at the time of investigation and according to ACSM pre-participation evaluation who can perform moderate intensity exercise without any complications. The study Protocol was explained to all participants and their informed consent was obtained. Group allocation was done by using Block Randomization (3 boxes for open kinematic chain exercises, close kinematic chain exercises, and patellar taping each box contain 15 pieces of paper (5 -A, 5-B, 5-C) 15 subjects were placed in Group A (open kinematic chain exercises) 15 subjects were placed in Group B (close kinematic chain exercises) 15 subjects were placed in group C (Control group) Baseline assessments were taken which include Static Q angle , Dynamic Q angle , Femoral anteversion and external tibial torsion . The assessment for Static Q angle was taken using simplified q angle technique , dynamic Q angle was taken using a dynamic knee valgus test femoral anteversion using the Criag test and external tibial rotation was taken using tibiofemoral angle TFA angle .

SIMPLIFIED Q ANGLE.

It is used to measure the static Q angle of participants. Participants were asked to lie in a supine position with the quadriceps fully relaxed. Landmarks such as anterior superior iliac spine (ASIS) were marked bilaterally using adhesive markers. Superomedial and Superolateral borders of the patella were marked using water-soluble markers. A flexible measuring tape was used to measure the distance between the two points and another mark was marked just superior to this point QT at its insertion to the base of the patella. The knee was flexed to 45 degree length, TT was palpated and marked with the pen. Bi acromial distance was measured from lateral to lateral malleolus. The axis of the goniometer was placed at QT tendon. The stationary arm was aligned with the ASIS. And the movable arm was aligned with the line connecting TT mark with the QT.

Examiners measured the SQA of each participant to the approximate degree. SQA scores were recorded by each examiner on standardized data collection sheets for each test session. Examiners were blinded as to their own scoring from previous testing sessions and to the scoring of other examiners during the same testing session. The intra-rater values (ICC: 0.69, 95%CI: 0.58-0.78) and inter-rater values (ICC: 0.77, 95%CI: 0.71-0.82). [12]

Fig 1.9 Simplified Q angle

Dynamic knee valgus

It is used to measure the dynamic Q angle. The participants were asked to stand in an upright posture. The angle was recorded along the entire motion trajectory in closed kinetic chain (CKC) activities. The two-dimensional (2D) systems, the DKV was recorded at the frontal plane. FPPA was calculated via the intersection of a line connecting the ASIS and the center of the patella and a line connecting the center of the patella and the middle of the ankle joint. The participants were asked to perform a single leg squat at a degree of 60 degrees. The angle in the knee was measured, the alignment was considered neutral at 180°; an FPPA less than 180° indicated knee valgus alignment and greater than 180° indicated knee varus alignment. [13]

Trochanteric Prominence Angle Test (TPAT)

It is used to measure femoral anteversion. The participants were asked to lie down in prone position with the knees flexed at 90 degree. The gluteal tuberosity was palpated while passively internally rotating the femur. Unless the greater trochanter was at most prominent position to its most lateral position. Another examiner measured the angle formed between the shaft of tibia and a line perpendicular to the table using a goniometer. Angle more than 15 degree is considered to be increased anteversion. [] intrarater reliability is 0.89 [14]

Fig 1.10 TPAT Criag test

Thigh foot Illustration of Tibial torsion using angle.

For the prone goniometric method, the patient was positioned prone, the knee on the side to be measured flexed 90, and the ankle positioned in neutral dorsiflexion/plantar flexion. The TFA is the angular difference between the axis of the foot and the axis of the thigh. To measure TMA, we first marked the center point of each malleolus with a marking pen and these points were joined by a line across the plantar aspect of the heel, which approximated the transmalleolar axis .The TMA is defined as the angular difference between the lines projected toward the heel at right angles to the transmalleolar axis and the axis of the thigh.[15]

Clearance was taken from the ethical committee.

60 samples were screened, 45 were selected based on the selection criteria.

Randomly assigned using block randomization where

Group (n=15) Group B (n=15) Group C (n=15)

Consent form were obtained from all the subjects . pre assessment score were taken (Static Q Angle – Simplified Q angle technique , Dynamic Q angle – Dynamic knee valgus test, Femoral anteversion – criag test and External tibial torsion – TFA angle

Group A
Warm up for 10 mins
Open kinematic chain exercise with patellar taping for 25 mins
Cool down fornn5 mins

Group B

Warm up for 10 mins close kinematic chain exercise with patellar taping cool down for 5 mins

Group C

Patellar taping

Each group performed 45 minutes session for 3 days per week for 4 week.

End of the 4th week data were collected

Analysis and interpretation of data was done

Conclusion

Fig 1.11Flow chart of the procedure

WARM UP EXCERCISES

Exercises	**REPETITION/SET**
Lunges with unilateral trunk rotation	5 repetition / 1 set
Static crunches with hip abduction	5 repetition / 1 set
Static crunches with the hip flexed and trunk rotation	5 repetition / 1 set
Static crunches with trunk rotation lying down	5 repetition / 1 set
Static elbow extension with unilateral knee	5 repetition / 1 set

Fig 1.2 Lunges with unilateral trunk Rotation Fig1.13Staticcruncheswithhipabduction

Fig 1.14Static crunches with the hip flexed and trunk rotation

Fig 1.15 Static crunches with the hip

Fig 1.16Static elbow extension with unilateral knee.

OPEN KINEMATIC CHAIN EXCERCISES

EXCERCISES	PROGRESSION	REPETITION/SET
Hip extension exercises Gluteus maximus	1st week : face down leg lift 2nd week :4 point kneel leg lift 3rd week : face d own leg lift with thera loop 4th week : 4 point kneel leg lift with thera loop (11	10 /1 10/1 10/1 10/1
Calmshells with resistance Gluteus medius	1st week: Start position is sidelying with hips flexed to approximately 45 degrees, knees flexed, and feet together. 2nd week :*subject keeps the knees together while internally rotating the top hip to lift the top foot away from the bottom foot* 3rd week: identical to 1 and 2, but with the top leg raised parallel to the ground. maintains height of knee while internally rotating at the hip. 4th week : hip fully extended. , the subject maintains the height of the knee and internally rotates at the hip by bringing the foot toward the ceiling.	10 /1 10/1 10/1 10/1
Quadricep strengthening Vastus intermedius vastus medialis classical isometric quadriceps-strengthening	1ST- pull the patella superiorly for 10 secs 2ND –pull the patella superiorly for 20 secs 3RD -pull the patella superiorly for 30 secs	10 /1 10/1 10/1 10/1

exercise: " and pull the patella superiorly tightly and hold the leg in the same position for 10 seconds"	4TH – pull the patella superiorly for 40 secs	
Short-arc exercise . Although the participant was positioned in the same way as that of the leg extension exercise, the starting position of the knee was at a flexion of 60 Participants performed knee extensions and a hold of 2–3 s in the fully extended position	According to 1 RM weight will be added 1st week : the starting position of knee was at flexion of 60 2nd week : knee at flexion at 60 3rd week : knee at flexion at 60 4th week : knee flexion at 60	10 /1 10/1 10/1 10/1
Exercise Sandbags with a predetermined weight of 10 RM were attached to ankle. They initiated a straight leg raise while lying and one leg extended. The other leg was stabilized at the knee flexed with 90	According to 1 RM weight will be added 1st week : straight leg raise with weight attached 2nd week : straight leg rise with weight attached 3rd week : straight leg rise 4th week : straight leg rise	10 /1 10/1 10/1 10/1
Ankle dorsiflexion With theraband	1st week : dorsiflexion 2nd week : dorsiflexion 3rd week : dorsiflexion with inversion 4th week : dorsiflexion with eversion	10 /1 10/1 10/1 10/1

1st week: face down leg lift

2nd week :4 point kneel leg lift

3rd week: face down leg lift with thera loop

4 point kneel leg lift with thera loop

Fig 1.17.Hip extension exercise

Fig 1.18 Calmshells with resistance

Gluteus medius

Fig 1.19 Classical isometric quadricep

strengthening exercise

Fig 1.20 Short-arc exercise

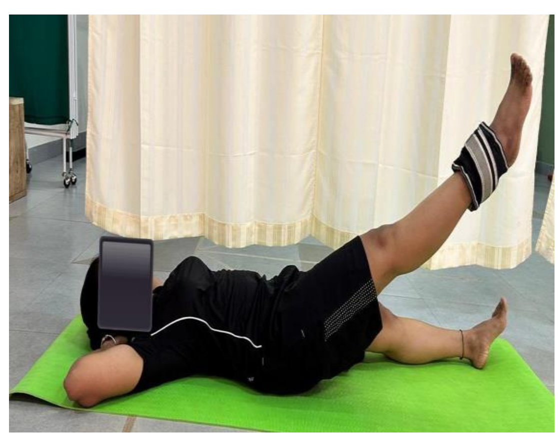

Fig 1.21 Straight leg raise

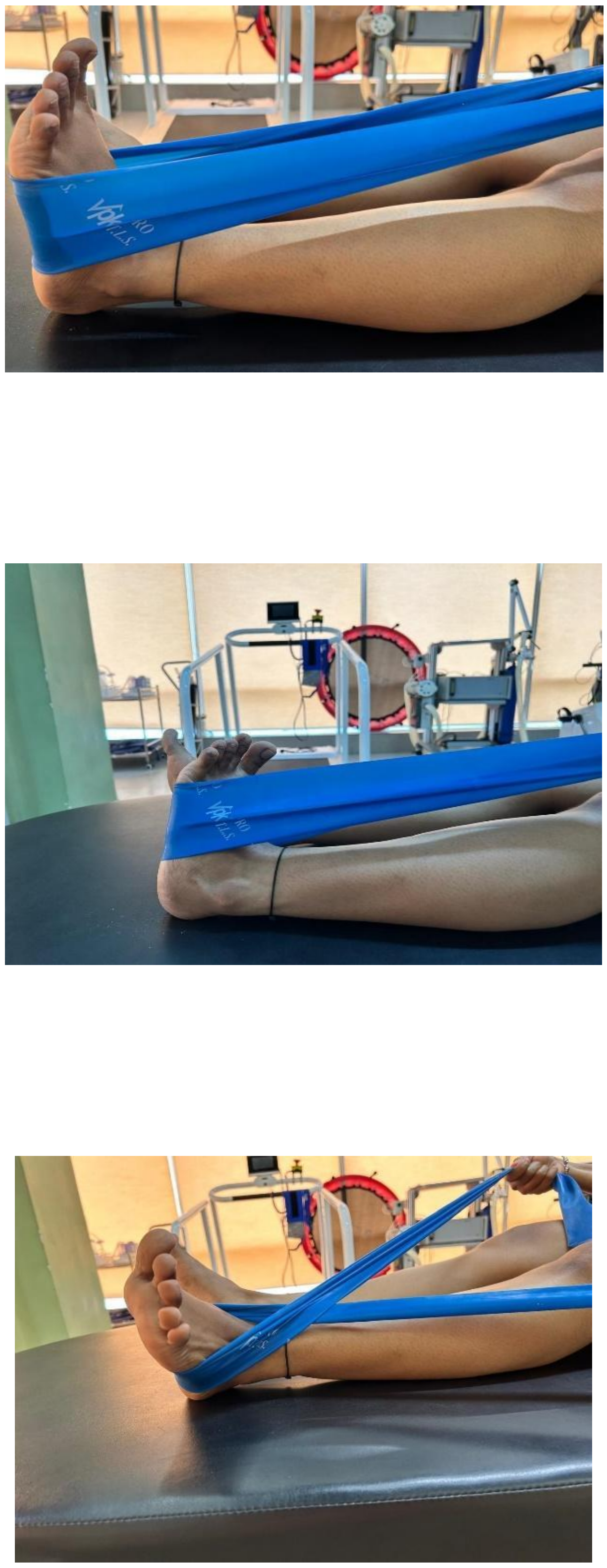

Fig 1.22. Ankle dorsiflexion with thera-band

CLOSE KINEMATIC CHAIN EXCERCISES

EXCERCISES	PROGRESSION	REPETITION / SETS
Squats	1st week : Squats 2 nd week: Single leg mini squat 3rd week :Jump to squat box 4th week : Rear foot elevated split squat	10 /1 10/1 10/1 10/1
Lunges	1st week : lunges 2nd week : assisted reverse lunges 3rd week :front foot elevated reverse lunge 4th week: forward lunges	10 /1 10/1 10/1 10/1
Step up lateral While standing next to a box or raised surface, step up and to the side on to the surface. Both feet should touch the raised surface. Then step down and onto the floor towards the same side that you started from.	1st 2nd 3rd 4th- week progression will be given with resistance band will be chosen on person strength	10 /1 10/1 10/1 10/1
Standing heel raises While standing on one leg, raise up on your toes as you lift your heel off the ground	1st – Double Heel Raise with Weights 2nd - Two Up, One Down Heel Raise Exercise with 60% to 90% Weight Transfer 3rd - Two Up, One Down Heel Raise Exercise with 100% Weight Transfer 4th -Single Leg Heel Raise Exercise with weight	10 /1 10/1 10/1 10/1
Side shuffles	1st – side shuffles 2nd - Side Shuffle With Ground Touches	10 /1 10/1 10/1

	3^{rd} – banded Side Shuffle 4^{th} - increased resistance banded side shuffle	10/1
Single leg stance Standing on one leg rotate to the outside in a slow controlled manner. Then rotate to the inside bringing your non-weight bearing leg in front of you. Only rotate as far as you feel comfortable and in control	1^{st-} - **INCREMNENT** OF WEIGHT BY 2 KG 2^{nd-} 3^{rd} - 4^{th}	10 /1 10/1 10/1 10/1

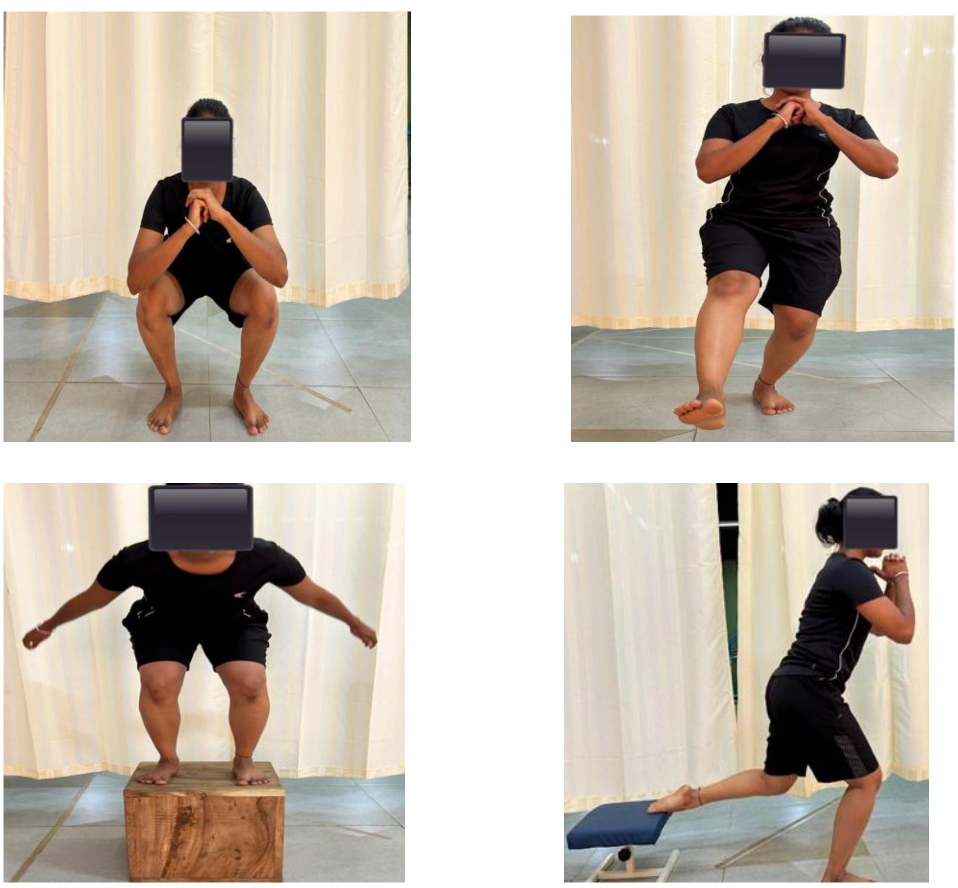

Fig 1.23. Squats with 4 week progression

Fig 1.24Lunges with four week progression

Fig 1.25 Side shuffles

Fig 1.26 Single leg stance

PATELLAR TAPING

Rigid patellar taping it corrects the tilit . rigid tape is applied to correct the lateral tilt . the tape is applied from lateral to medial taping . McConnell's tailored patellar taping. Taping does improve larger Q angle as Q angle independently correlated with the effectiveness of taping. [16] Rigid taping that is preferred for lateral maltracking of patella is tailoring patella it controls lateral tilt, glide and spin of the patella [17]

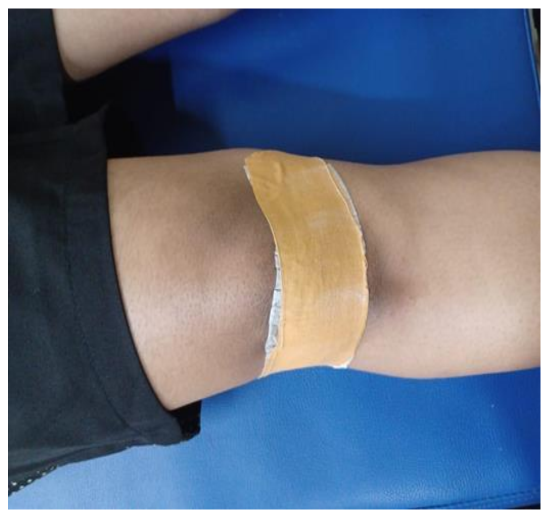

Fig 1.27. Mc Connell Patellar tailored taping .

SAMPLE SIZE CALCULATION

The sample size was calculated using the formula for experimental studies (outcome-balance)

$n=2k\ SD^2 / d^2$

Where, n: Number of samples k: Power SD—Standard Deviation d = MCID Value

k= 10.5

SD = 5.14

d = (MCID value) = 5.5

$n = 2k * SD^2/d^2$

= 21*0.87=18.27 added 2 dropouts

=15 per group (3 groups are there so a total of 45 subjects)

RESULT

Statistical analysis

Data was analyses using statistical package SPSS 29.0 (SPSS Inc., Chicago, IL) and level of significance was set at $p<0.05$ Descriptive statistics was performed to assess the mean and standard deviation of specific groups . Normality of the data was assessed using Kolmogorov Smirnov test. Interferential statistics to find out the difference between groups was done using paired t test and analysis between three groups was done using ONE WAY ANOVA to find out difference between any two groups.

Table No 1. Mean age analysis

	Mean	SD
Open kinematic	21.60	2.384
Close kinematic	22.13	2.167
Control	21.20	2.042

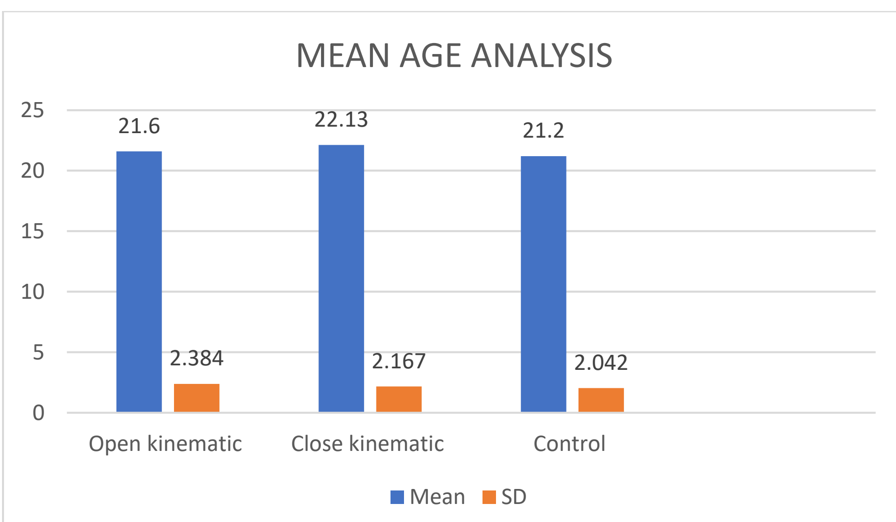

Fig 1.28. Mean age analysis

Table No . 2 Femoral Anteversion

Outcome	Pre intervention	Post intervention	Within P value	F value	Between P Value	Mean difference
Femoral anteversion open	18.60	18.40	.082	21.71	.000	0.2
Femoral anteversion close	19.27	19.27	No difference		.000	0
Femoral anteversion control	18.60	18.60	No difference		.000	0

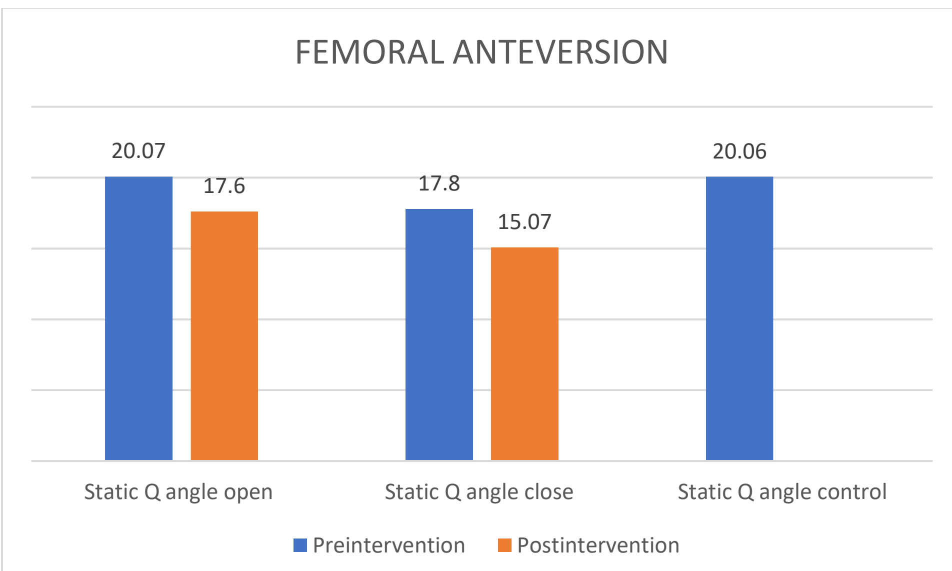

Fig no 1.29 A graphical presentation of within group analysis of femoral anteversion

Femoral anteversion with paired t test indicates statistically no significant difference within the group in open kinematic group ($p > 0.05$), close kinematic group and control group there is no difference noted . the difference in mean value was reported as follow FA OPEN group > FA CLOSE group =FA CONTROL . The between group analysis by one way anova showed no difference between the groups showed FA Group open vs closed showed ($p < 0.05$) which indicates significant difference between groups .

Table no .3 STATIC Q ANGLE

Outcome	Preintervention	Postintervention	Within P value	F value	Between P Value	Mean difference
Static Q angle open	20.07	17.60	.000	25.020	.000	0.2
Static Q angle close	17.80	15.07	.011	24.035	.000	2.47
Static Q angle control	20.06	19.20	.001	4.978	.018	0.86

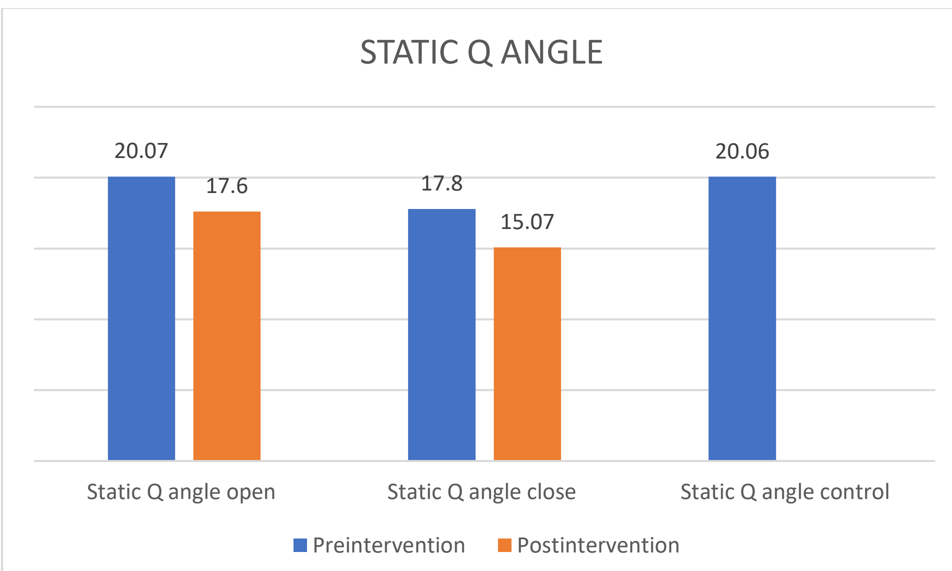

Fig 1.30. A graphical presentation of within group analysis of static Q angle

Static Q angle with paired t test indicates statistically significant difference within the group in open kinematic group (p < 0.05) , close kinematic group 0.012 states statiscally difference (p < 0.05) . in the control group (p <0.05). This indicates a statistically significant difference within the static Q angle control group before and after the intervention. The difference in mean value was reported as follow SQ control > SQclose > SQ open . The between group analysis by one way anova showed difference between the groups showed Group open vs closed showed (p > 0.05)

Table no 4. Dynamic Q Angle

Outcome	Pre intervention	Post intervention	Within P value	F value	Between P Value	Mean difference
Dynamic q angle open	15.47	13.33	.000	13.23	.001	2.14
Dynamic Q angle close	13.13	11.13	.000	22.32	.000	2
Dynamic q angle taping	15.46	14.40	.000	23.07	.000	1.06

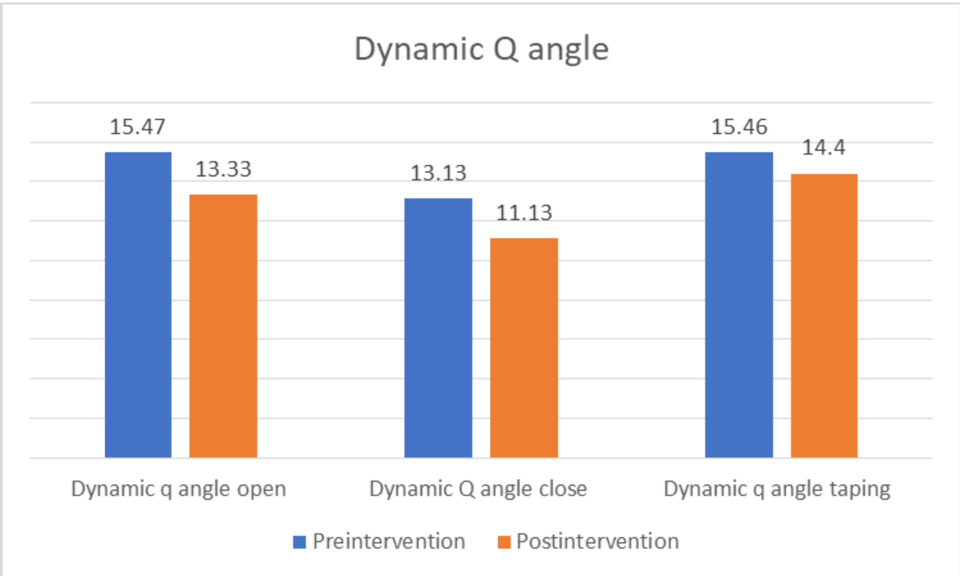

Fig 1.31 A graphical presentation of within group analysis of Dynamic Q angle

Dynamic Q angle with paired t-test indicates statistically significant difference within the group in open kinematic group (p 0.05), close kinematic group (p 0.05) . The difference in mean value was reported as follow. DQ open > DQ close> DQ taping. The between group analysis by one way anova showed difference between the groups showed Group open vs closed showed (p > 0.05)

Table no 5. External rotation

Outcome	Preintervention	Postintervention	Within P value	F value	Between P Value	Mean difference
External rotation open	20.40	18.87	.000	9.262	.002	1.53
External rotation close	31.67	29.07	.000	4.017	.054	2.6
External taping	19.40	19.33	.334			0.1

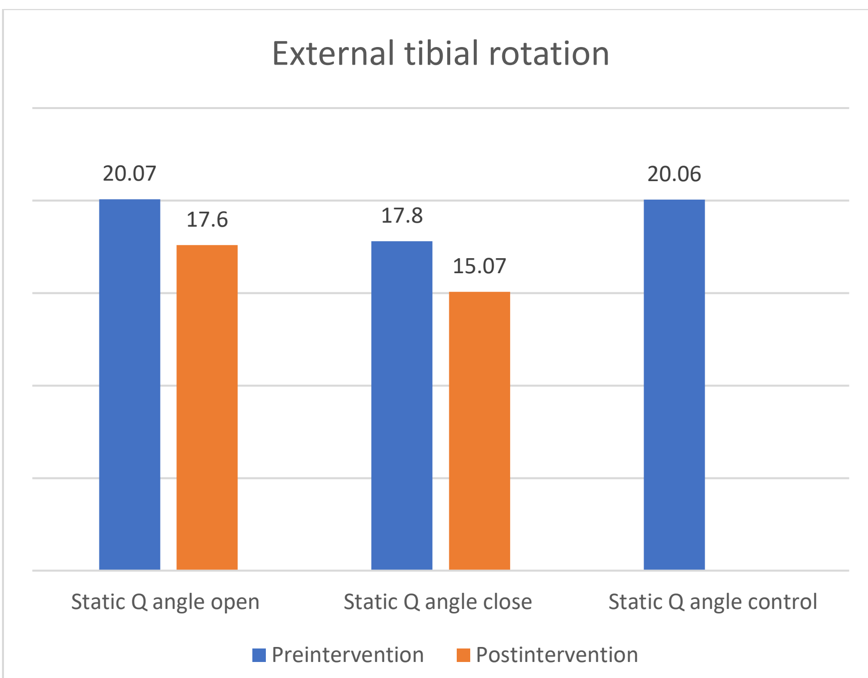

Fig 1.32 A graphical presentation of within group analysis of external tibial rotation.

External rotation with paired t test indicates statistically significant difference within the group in open kinematic group (p 0.05), close kinematic group (p 0.05) . The difference in mean value was reported as follow. EXR Close > EXR open > EXR taping. The between group analysis by one way anova showed difference between the groups showed Group open vs closed showed (p > 0.05).

Table no 6. Between group analysis summary

OUTCOME	GROUPS	MEAN	MEAN DIFFRENCE	P VALUE
FEMORAL ANTEVERSION	**CKC VS OKC**	19.27 vs18.40	0.87	.104
	CKC VS CONTROL	19.27 vs18.60	.0.67	.253
	CONTROL VS OKC	18.60 vs18.40	0.2	.880
STATIC Q ANGLE	**OKCVS CKC**	17.60 vs 15.07	2.53	0.36
	CONTROL CKC VS	15.07 vs19.20	4.13	.000
	CONTROL VS OKC	19.20 vs 17.60	1.60	.246
DYNAMIC Q ANGLE	**OKC VS CKC**	13.33vs11.13	2.20	.000
	CONTROL vs CKC	11.13vs14.40	3.27	.000
	CONTROL VS OKC	14.40 vs13.33	1.06	.022
EXTERNAL TIBIAL RO TATION	**OKC VS CKC**	18.86 vs 29.06	10.2	.000
	CKC VS CONTROL	29.06vs20.40	8.66	.000
	CONTROL VS OKC	20.40 vs18.86	1.53	0.87

Between group analysis by One way anova followed by tuckey post hoc test . For femoral anteversion . All p-values are greater than 0.05, indicating no statistically significant differences between any groups for femoral anteversion. For static Q angle there is Significant Difference in group between Control and . CKC ($p = 0.000$) group . The CKC group has a significantly lower Static Q Angle than the Control group. For Dynamic Q angle CKC (11.13) < OKC (13.33) < Control (14.40) . The CKC group performs best, followed by the OKC group, with the Control group performing the least . External tibial rotation group OKC(18.86) ≈ Control (20.40) < CKC(29.06). the OKCand Control groups perform better than the CKC group regarding External Tibial Rotation, with no significant difference between the OKC and CKC groups.

DISCUSSION

The present study investigated the effect of the open kinematic chain exercise with patellar taping versus close kinematic exercise with patellar taping vs patellar taping on static Q angle ,Dynamic Q angle , Femoral anteversion and external tibial rotation in recreational female runners . The results of the study reveal an important component in the complementation of open kinematic chain exercise compared to close kinematic exercise with patellar taping on static Q angle dynamic Q angle , femoral anteversion external tibial roation in recreational female runners . The findings presented in this study fill a gap regarding which intervention it works better on improving static and dynamic Q angle.

FEMORAL ANTEVERISON .

The four week intervention of okc exercise with patellar taping , ckc with patellar taping and patellar taping pro d uced no significant changes in pre n post of femoral anteversion in recreational female runners . Femoral anteversion (FNA) is a crucial anatomical parameter that influences the alignment of the lower extremity as it has the strongest association with excessive Q angle cessive which has been identified as a potential risk factor for knee injuries [18]

The present study found no statistically significant differences in FA within any of the groups (open, closed, and control) when assessed using paired t-tests ($p > 0.05$). This lack of significant change suggests that the interventions applied in this study whether open or closed kinematic exercises did not have a substantial effect on femoral anteversion.

The differences in mean values showed that FA was greater in the Open group compared to both the Closed and Control groups. However, the Closed and Control groups exhibited similar mean FA values. Despite these observed differences in means, the one-way ANOVA between-group analysis confirmed that these differences were not statistically significant ($p > 0.05$). Furthermore, the Tukey post-hoc test, indicated that all p-values were greater than 0.05, reinforcing the conclusion that no significant differences existed between any of the groups.

These findings align with existing literature that suggests femoral anteversion is a structural characteristic determined primarily by genetics and early childhood development, making it less susceptible to change through short-term interventions or exercise programs The static nature of femoral anteversion in response to physical interventions highlights the need for long-term strategies, such as orthotic management or surgical intervention . Current evidence supports that **FAI surgical intervention is superior to conservative management** [19], for individuals with significant anteversion that contributes to functional impairments or increased injury risk

Static Q Angle

The Q angle is a key biomechanical marker associated with knee alignment and is often used as a predictor for conditions such as patellofemoral pain syndrome (PFPS) and other knee-related pathologies. In this study, the static Q angle (SQ) was significantly affected by the interventions, as evidenced by the paired t-test results, which showed statistically significant differences within all groups—open kinematic ($p < 0.05$), closed kinematic ($p = 0.012$), and control ($p < 0.05$). These findings suggest that both open and closed kinematic exercises, as well as the control condition, led to measurable changes in the static Q angle.

The mean values for the SQ angle were ordered as follows: SQ Control > SQ Closed > SQ Open. This indicates that the Control group exhibited the highest static Q angle, while the Open group had the lowest. The reduction in the static Q angle observed in the CKC group is particularly noteworthy. The between-group analysis using one-way ANOVA showed no significant difference between the Open and Closed groups ($p > 0.05$). However, the Tukey post-hoc test revealed a significant difference between the Control and Closed groups ($p = 0.000$), with the Closed group having a significantly lower static Q angle than the Control group.

According to previous literature both OKC and CKC had equivalent effect on Q angle [20] according to pervious studies it suggested that the closed chain exercise showed statistical improvement in Q angle, quadriceps muscular strength, and leg limb girth .[21] The reduction in the static Q angle observed in the Closed group may indicate improved patellar tracking and alignment, contributing to decreased stress on the patellofemoral joint. This finding supports the use of closed kinematic exercises in rehabilitation protocols aimed at individuals with an elevated Q angle, which could help mitigate knee pain and improve function

Dynamic Q Angle

The dynamic Q angle (DQ) represents the alignment of the knee during movement, providing insight into the biomechanical stresses experienced by the knee joint during dynamic activities. In the present study, the DQ angle showed statistically significant differences within both the open kinematic ($p < 0.05$) and closed kinematic groups ($p < 0.05$) according to paired t-tests, indicating that these interventions effectively altered the dynamic alignment of the knee.

The ranking of mean DQ values—DQ Open > DQ Closed > DQ Taping—suggests that dynamic Q angles were highest in the Open group and lowest in the Taping group. The fact that the Taping group exhibited the lowest DQ angle may reflect the stabilizing effect of taping on knee alignment during movement, a finding consistent with previous studies that have highlighted that Mulligan taping and flossing bands to patients with chronic ankle instability decreased the Q-angle and lower limb muscle activity when going down the stairs. [22]

The between-group analysis by one-way ANOVA indicated no significant difference between the Open and Closed groups ($p > 0.05$). This suggests that both open and closed kinematic exercises are similarly effective in modifying the dynamic Q angle [23]. However, the trend observed in the ranking of the groups suggests that closed kinematic exercises may offer a slight advantage in optimizing knee alignment during dynamic activities, which could be critical for athletes and individuals with knee instability. The reduced dynamic Q angle in the Closed group aligns with the concept that closed kinetic chain exercises promote co-contraction of the quadriceps and hamstrings, enhancing joint stability and reducing aberrant knee movements

External Tibial Rotation

External tibial rotation is a critical component of lower limb biomechanics, influencing the rotational alignment of the knee and foot during gait and athletic activities. The results of this study revealed that the Open (18.86) and Control (20.40) groups performed better than the Closed group (29.06) in terms of external tibial rotation, with no significant difference between the Open and Control groups. This suggests that open kinematic exercises may be more beneficial for improving or maintaining external tibial rotation compared to closed kinematic exercises.

The lack of significant differences between the okc and Control groups indicates that both conditions are effective in maintaining external tibial rotation within a functional range . The poorer performance of the Closed group in this parameter may be attributed to the nature of closed kinematic exercises, which often emphasize linear movement patterns and may not adequately challenge or enhance rotational capabilities. [24]

These findings have important implications for the design of training and rehabilitation programs. For athletes who engage in sports requiring dynamic rotational movements, incorporating open kinematic exercises could be crucial for optimizing external tibial rotation and preventing rotational injuries, such as ACL tears [25] On the other hand, for individuals focusing on joint stability and alignment, closed kinematic exercises may offer other benefits that outweigh the need for enhanced rotational performance. The primary limitation of this study was the short duration of the intervention, which only lasted for four weeks. Additionally, no follow-up was conducted after the post-intervention assessment. For future research, it is recommended to include a male population to evaluate whether similar corrections in the Q angle can be observed in male runners. Furthermore, future studies should investigate changes in the Q angle resulting solely from open kinetic chain (OKC) and closed kinetic chain (CKC) exercises without the use of patellar taping .

Conclusion

The findings of this study suggest that different kinematic conditions exert varying effects on lower limb biomechanics, particularly in terms of femoral anteversion static and dynamic Q angles and external tibial rotation. The Closed kinematic group showed significant improvements in the static Q angle compared to the Control group, highlighting the potential benefits of closed kinematic exercises in reducing knee injury risk. However, for femoral anteversion and external tibial rotation, no significant differences were found between the groups, indicating that these variables may be less responsive to short-term interventions. These results underscore the importance of tailoring rehabilitation and training programs based on specific biomechanical outcomes to optimize performance and reduce injury risk in athlete

REFERENCE

1. Puckree T, Govender A, Govender K, Naidoo P. The quadriceps angle and the incidence of knee injury in Indian long-distance runners. South African Journal of Sports Medicine. 2007;19(1):9-11.
2. Novacheck, TF. "The biomechanics of running." *Gait & posture* vol. 7,1 (1998): 77-95. doi:10.1016/s0966-6362(97)00038-6.
3. *2022 Global Runner Survey*. (2022). Running USA. https://www.runningusa.org/wp-content/uploads/2022/07/2022-Global-Runner-Survey-final.pdf
4. Rauh MJ, Koepsell TD, Rivara FP, Rice SG, Margherita AJ. Quadriceps angle and risk of injury among high school cross-country runners. J Orthop Sports Phys Ther. 2007 Dec;37(12):725-33. doi: 10.2519/jospt.2007.2453. Epub 2007 Aug 29. PMID: 18560184.
5. Nguyen AD, Boling MC, Levine B, Shultz SJ. Relationships between lower extremity alignment and the quadriceps angle. Clin J Sport Med. 2009 May;19(3):201-6. doi: 10.1097/JSM.0b013e3181a38fb1. PMID: 19423972; PMCID: PMC2881465.
6. Skouras AZ, Kanellopoulos AK, Stasi S, Triantafyllou A, Koulouvaris P, Papagiannis G, Papathanasiou G. Clinical Significance of the Static and Dynamic Q-angle. Cureus. 2022 May 11;14(5):e24911. doi: 10.7759/cureus.24911. PMID: 35698708; PMCID: PMC9186474.
7. Sorcelletti M, Reeves ND, Rittweger J, Ireland A. Femoral anteversion: significance and measurement. J Anat. 2020 Nov;237(5):811-826. doi: 10.1111/joa.13249. Epub 2020 Jun 24. PMID: 32579722; PMCID: PMC7542196.
8. Daneshmandi, Hassan & Saki, Farzane & Shahheidari, Sareh. (2011). Lower extremity Malalignment and its linear relation with Q angle in female athletes. Brazilian Journal of Biomotricity 5.10.1016/j.sbspro.2011.04.298 .
9. Herrington, Lee, and Chris Nester. "Q-angle undervalued? The relationship between Q-angle and medio-lateral position of the patella." *Clinical biomechanics (Bristol, Avon)* vol. 19,10 (2004): 1070-3. doi:10.1016/j.clinbiomech.2004.07.01 .
10. Elif Turgut, Gul Baltaci Biomechanical principles of the exercise design in Comparative Kinesiology of the Human Body, 2021 DOI https://doi.org/10.1016/C2016-0-02556-1
11. Jennifer Reed MD, FAAPMR, Jimmy D Bowen MD, FAAPMR, CSCS, Principles of Sports Rehabilitation The Sports Medicine Resource Manual, 2008 https://doi.org/10.1016/B978-1-4160-3197-0.X1000-2
12. Peeler, Jason & Leiter, Jeff & Anderson, Judy. (2010). Reproducibility of a simplified Q-angle measurement technique. Current Orthopaedic Practice. 21. 158-164. 10.1097/BCO.0b013e3181b9cf76
13. Willson, J. D., & Davis, I. S. (2008). *Utility of the Frontal Plane Projection Angle in Females With Patellofemoral Pain. Journal of Orthopaedic & Sports Physical Therapy, 38(10), 606–615.* doi:10.2519/jospt.2008.2706

14. Souza RB, Powers CM. Concurrent criterion-related validity and reliability of a clinical test to measure femoral anteversion. Journal of orthopaedic & sports physical therapy. 2009 Aug;39(8):586-92.

15. Stuberg W, Temme J, Kaplan P, Clarke A, Fuchs R. Measurement of tibial torsion and thigh-foot angle using goniometry and computed tomography. Clinical orthopaedics and related research. 1991 Nov 1;272:208-12.

16. Derasari, Aditya et al. "McConnell taping shifts the patella inferiorly in patients with patellofemoral pain: a dynamic magnetic resonance imaging study." *Physical therapy* vol. 90,3 (2010): 411-9. doi:10.2522/ptj.20080365

17. Barton C, Balachandar V, Lack S, Morrissey D. Patellar taping for patellofemoral pain: a systematic review and meta-analysis to evaluate clinical outcomes and biomechanical mechanisms. Br J Sports Med. 2014 Mar;48(6):417-24. doi: 10.1136/bjsports-2013-092437. Epub 2013 Dec 5. PMID: 24311602.

18. Nguyen AD, Boling MC, Levine B, Shultz SJ. Relationships between lower extremity alignment and the quadriceps angle. Clin J Sport Med. 2009 May;19(3):201-6. doi: 10.1097/JSM.0b013e3181a38fb1. PMID: 19423972; PMCID: PMC2881465.

19. VivianeBortoluzzi Frasson [a b c], Walter Herzog [a d g], Kelly Johnston [d e], Yves Pauchard [d], Marco Aurélio Vaz Do femoral version abnormalities play a role in hip function of patients with hip pain https://doi.org/10.1016/j.clinbiomech.2022.105708

20. Das S, Kumar N, Pandey E. Effect of close kinematic chain exercise and open kinematic chain exercise on q-angle and navicular drop. Physiotherapy and Occupational Therapy Journal. 2018 Apr;11(2):37-46.

21. Matheson, G. O. (2009). *Open versus Closed Kinetic Chain Exercises for Patellar Chondromalacia in Young Women. Clinical Journal of Sport Medicine, 19(1), 76–77.* doi:10.1097/01.jsm.0000344351.03223.81

22. Jeong HC, Park SJ, Yu SH. Effect of Mulligan taping and flossing bands on Q-angle and lower limb muscular activity in men with chronic ankle instability. The Journal of Korean Academy of Orthopedic Manual Physical Therapy. 2021;27(3):17-24.

23. Lee J, Lee H, Lee W. Effect of weight-bearing therapeutic exercise on the q-angle and muscle activity onset times of elite athletes with patellofemoral pain syndrome: a randomized controlled trial. Journal of Physical Therapy Science. 2014;26(7):989-92.

24. Ellenbecker TS, Davies GJ. Closed kinetic chain exercise: a comprehensive guide to multiple joint exercise. Human Kinetics; 2001

25. Hewett TE, Myer GD, Ford KR, Paterno MV, Quatman CE. Mechanisms, prediction, and prevention of ACL injuries: Cut risk with three sharpened and validated tools. J Orthop Res. 2016 Nov;34(11):1843-1855. doi: 10.1002/jor.23414. Epub 2016 Sep 19. PMID: 27612195; PMCID:

ANNEXURES .1

CONSENT FORM

TITLE OF THE STUDY

EFFECT OF OPEN KINEMATIC CHAIN EXERCISES AND CLOSED KINEMATIC CHAIN EXERCISES WITH PATELLAR TAPING ON STATIC AND DYNAMIC Q ANGLE ON FEMALE RECREATIONAL RUNNERS-A RANDOMIZED CONTROLLED TRIAL .

I have been informed by the miss Nikita Vikram Singh Ranawat , pursuing MPT (sports) conducting the above mentioned study under the guidance of Prof . Joseph Oliver Raj , Dean ,department of physiotherapy , ABHINAV BINDRA SPORTS MEDICINE AND RESEARCH INSTITUTE (ABSMARI) ,BHUBANESWAR .

I have no objection and will be a part of that group. I also understand that the study does not have any negative implication on my health. I understand that the information produced by the study will become part of the institute record and will be utilized, as per confidentiality regulations of the institute. I am also aware that the data might be used for medical literature and teaching purposes, but all my personal details will be kept confidential.

I am well informed to ask many questions as I can to Miss Nikita Vikram Singh Ranawat either during the study or later. I wish to discuss my participation and concerns regarding these study with a person not directly involved.

I understand that my assent is voluntary and I reserve the right to withdraw or discontinue the participation from the study at any point of time during the study.

I have explained to MR/MISS/MRS the purpose of the research , the procedure required in the language he/she could understand to the best of my ability .

(Investigator) (Date)

I confirm that Miss Nikita Vikram Singh Ranawat (investigator) has explained to me in the language I can understand , the purpose of the study and the procedure . therefore, I agree to give my assent for the participation as a subject in this study and I will be accountable for the decisions.

Signature

Date

ANNEXURES. 2

ETHICAL COMMITTEE CLEARANCE CERTIFICATE

ABSMARI ETHICS COMMITTEE

ABHINAV BINDRA SPORTS MEDICINE AND RESEARCH INSTITUTE, BHUBANESWAR, ODISHA

ABSMARI

Member Secretary

MEMBERS

Member Secretary

ABSMARI ETHICS COMMITTEE

ANNEXURES. 3

ASSESSMENT FORM

DEMOGRAPHIC DATA:

Name –

Age –

Gender-

Address-

Phone Number-

Height –

Weight –

Date of Examination –

Pretest –

Posttest –

GROUP-

COMPONENT	PRE INTERVENTION SCORE	POST INTERVENTION SCORE
STATIC Q ANGLE		
DYNAMIC Q ANGLE		
FEMORAL ANTEVERSION		
EXTERNAL TIBIAL TORSION		