

Effects of open versus closed kinetic chain exercises on pain, instability and balance in athletes with chronic ankle instability

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ABSTRACT

Background: The ankle joint is a key component of the body's balance mechanism. Estimates show that foot and ankle injuries account for 27% of all injuries sustained by collegiate elite athletes.

Objective: The objective of this study is to evaluate the impact of activities involving an open versus a closed kinetic chain on pain, instability, and balance in athletes with a history of chronic ankle instability.

Methods: The ethical approval for the study was obtained having reference number REC/RCR/&AHS/22/0446. 30 male patients between the ages of 20 and 40 who had a history of chronic ankle injuries and balance issues in athletes from Pakistan Sports Board, Lahore were divided into two groups, according to the file number, the last even and odd digits were added to the open chain kinetic and close kinetic groups, respectively. Treatment for both groups lasted 4 weeks, with 3 sessions per week.

Results: The mean age of the open and close groups is 28.58±3.9, 29.25±4.4 respectively. Between group analysis Open and close chain NPRS post data mean and SD 0.40±8.28, 1.60±0.50 with p value <0.05. Total score of FAAM Open and close chain post data with p value >0.05. Within group analysis of open chain and close chain pre and post NPRS data with p value <0.05. Pre and post total score FAAM Open chain and close chain with p value < 0.05.

Conclusion: Both treatments are equally effective there is no significant difference between the groups.

Clinical Trial Number: NCT05717426

Keywords: Ankle Injuries, Ankle Joint, Ankle Sprain, Distal Tibiofibular Joint, Talocrural Joint

DOI: <https://doi.org/10.33897/fujrs.v4i2.364>

Introduction:

The ankle joint complex, which is made up of the lower leg and foot, is a crucial component of walking. (1) The ankle's bony and ligamentous structure allows it to function with a high degree of stability despite being subject to considerable compression and shear stresses while moving. (2) Ankle joint instability is a broader category of possible dysfunctions that is associated

with both mechanical and functional instability. When we talk about mechanical instability, we're talking about objective measurements of ligament laxity. On the other hand, functional instability is a subjectively reported phenomenon that is characterized by recurrent episodes of symptomatic ankle sprains or "giving way" or instability about the ankle during daily activities and sports. (3)

Ankle joint allows dorsiflexion and plantarflexion of the foot, as well as some pronation and supination of the foot through the subtalar and midtarsal joints. As the heel strikes the ground when walking begins, the joint also acts as a shock absorber. (4) In plantar- and dorsiflexion during ankle motion, which mostly takes place in the sagittal plane, the tibiotalar joint plays a significant role. (5) According to numerous studies, the range of motion (ROM) is between 65 and 75 degrees, ranging from 10 to 20 degrees of dorsiflexion to 40 to 55 degrees of plantar flexion. (6)

Athletes who suffer from foot or ankle problems frequently lose a lot of time competing in their sport because ankle instability may also have altered

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Received: August 3rd, 2023; **Revision:** June 11th, 2024.

Acceptance: July 1st, 2024

How to Cite: Sajjad MA, Rehman RA, Azfar H, Qazi ZN, Khalid MU, Ahmad HZ. Effects of open versus closed kinetic chain exercises on pain, instability and balance in athletes with chronic ankle instability. Foundation University Journal of Rehabilitation Sciences. 2024 July;4(2):94-99.

neuromuscular control of the ankle due to damage to muscles, receptors, or nerves from the initial ankle inversion injury. These symptoms accompany increased laxity in the ankle joint. Proprioception impairment, neuromuscular and postural control impairments, and strength deficits are all linked to ankle instability.(3)

Estimates show that 27% of elite collegiate athlete's foot and ankle injuries account for 21% of all injuries, and 21% of these illnesses require missed time at work. In addition, numerous foot and ankle injuries may recur, which has a detrimental effect on overall sports performance and quality of life.(7,8)

The most common foot and ankle injuries are those to ligaments and tendons. Sport participants who engage in physically taxing activities frequently get lateral ankle sprains. After a lateral ankle sprain, 40% of the time residual symptoms result in chronic ankle instability, a persistent problem.(9,10) The larger ankle inversion angles, those with chronic ankle stability may be more vulnerable to injuries during the first half of the stance phase of gait. A useful technique to address this maladaptive gait pattern and enable attenuation of the incorrect ankle movements during the pre-swing phase, however, may be the increased ankle eversion moments and peroneus longus muscle activation during the second half of the stance phase. (11)

An open kinetic chain is "a combination of successively arranged joints in which the terminal segments can move freely," according to Steindler. As a result, the distal portion of the extremities can move freely in space. Examples of this include kicking with the foot, waving a hand, and extending the knee when seated.(12) As a result, the distal portion of the extremities can move freely in space. Examples of this include kicking with the foot, waving a hand, and extending the knee when seated. Exercise in open kinetic chain is crucial for identifying distinct muscle groups. It often generates more distraction and rotational forces and frequently employs the contraction of muscles.(13)

Compared in a randomized controlled experiment, the efficacy of closed and open kinetic workouts in the treatment of chronic ankle instability. Open chain kinetic chain exercise groups are formed at random from the 30 selected participants. The dynamic balance of the ankle was evaluated using the y-balance test. After the intervention, there were significant differences in dynamic balance and the activation of the tibialis anterior and gastrocnemius muscles between the closed and open kinetic chain training groups. Exercises involving the closed kinetic chain enhanced

young, healthy women's dynamic balance more than open kinetic chain.(14)

In a randomised controlled trial investigation, 11 male athletes without a history of medial tibial stress syndrome were included together with 22 male athletes having a history of the condition. As the findings of the post hoc analysis in relation to the intergroup difference analysis. When comparing the control group's post-intervention proprioception and inversion/eversion strength imbalance of the ankle joint to the closed kinetic chain exercises group in health, a significant change was found. Furthermore, there were no significant differences ($P \leq 0.05$) between the closed kinetic chain exercises group and the healthy group in the results.(15)

Another study was conducted on 21 adults, healthy participants from S University in Asan, South Korea, participated in the study. Each participant was included in the experiment for a total of four weeks after receiving a comprehensive description of the goals and procedures of the study, as well as a preliminary exam. experiment serves as a representation of important variables. Using the TheraBand for open chain kinematic exercise proves to be more efficacious. Based on the subject's ability to exercise, we can deduce that choosing the appropriate exercise within the appropriate framework can be tailored for therapeutic purposes. These findings will serve as a foundation for future clinical research. (16)

A study involved 30 female participants who were divided into groups at random and exercised three times per week. Both static and dynamic balance was measured before and after exercise. It was noted that exercises using open and closed chains composed of elastic bands improved balance and reduced the number of falls among the elderly.(17)

Researchers have discovered that there is insufficient data to determine which open and closed kinetic chain exercises are better for relieving pain, instability, and balance issues in those with chronic ankle instability.

Methods:

It was a randomized clinical trial with clinical trial registry no. NCT05717426 and research ethical committee reference no. REC/RCR/&AHS/22/0446. A single blinded study was conducted on January 2023 and July 2023. It included male patients between age 20 and 40, those who had a history of chronic ankle injuries in athletes, and setting was Pakistan Sports Board, Lahore. The sample size was 30(18) and non-

probabilities convenient sampling technique was used; groups were randomly divided into open and close chain groups. Participants with pain greater than 6 and no prior history of injury were recruited to the trial; those with a history of fractures or recurring dislocations and athletes that experienced Achilles tendon or calf muscle soreness were not included. Treatment protocol was of 4 weeks which included 03sessions per week. Baseline data was gathered at the beginning of the first session, and data from the fourth week was compared to this baseline.

There was an open chain group. Resistance bands and free ankle weights were used to do 10 repetitions of 3 sets of the foot exercises for dorsiflexion, plantar flexion, inversion, and eversion.

The Close Chain Group engaged in three sets of ten repetitions of a stabilisation exercise while bearing weight to develop their ankle's neurological control.

The numeric pain rating scale (NPRS) was used to assess pain. On a 10-point numeric scale, 0 represents the least amount of pain (no pain) and 10 represents the severe pain (worst pain). Foot and ankle ability measure (FAAM) is a patient-reported questionnaire. (19)

To check the normality of the data Shapiro-Wilk Test was used and its p-value was more than 0.05. So, it was assumed that the data was in a normal distribution pattern and parametric tests were used for

the analysis on SPSS 21. The independent t test was used between groups.

Results:

Total number of participants included in the study was 30 males only. The mean age of the open and close groups is 28.58+3.9, 29.25+4.4, respectively.

Between group analysis Open and close chain NPRS post data mean and SD 0.40±8.28, 1.60±0.50 with p value <0.05. Total score of FAAM Open and close chain post data with p value >0.05.

Within group analysis of open chain and close chain pre and post NPRS data with p value <0.05. Pre and post total score FAAM Open chain and close chain with p value < 0.05.

Discussion:

The purpose of the study was to compare the effects of open kinetic chain workouts versus closed kinetic chain exercises on athletes' chronic ankle instability. Since chronic ankle instability is a complex disorder, achieving the intended functional results will require a multimodal rehabilitation strategy. In our study, isometric strength and perceived ankle instability increased in both the open and closed chain groups.

According to a study, there was a significant difference (p>0.05) between the open chain kinematic and close chain kinematic groups' VAS, ROM, and ADLs. ADLs in the close chain kinematic group were,

Table 1: Descriptive Statistics of Participants

	Open Chain Group	Close Chain Group
N	15	15
Mean Age	28.58±3.9	29.25±4.4
Gender	Male	Male

Table 2: Pre and Post NPRS and FAAM Score Between the Group Analysis T-Test

Variable	Open Chain Mean±SD	Close chain Mean±SD	P value
Pre Pain	6.73±0.96	7.00±0.75	0.40
Post Pain	0.40±8.28	1.60±0.50	0.00
Pre total FAAM score	37.26±8.30	35.60±8.06	0.55
Post total FAAM score	3.13±0.35	3.20±0.41	0.63

Table 3: Pre and Post NPRS and FAAM Score Within the Group Analysis Paired T Test

Variable	Pre Treatment Mean±SD	Post Treatment Mean±SD	p-value
Pain in open chain group	6.73±0.96	0.40±8.28	0.00
Pain in close chain group	7.00±0.75	1.60±0.50	0.00
FAAM open chain group	37.26±8.30	3.13±0.35	0.00
FAAM close chain group	35.60±8.06	3.20±0.41	0.00

nevertheless, significantly different from those in the open chain kinematic group when comparing the groups ($p>0.05$). Our study's findings demonstrated that both treatments are equally successful.(20)

Improvements in dynamic postural control and subjective function were seen in both the open chain kinematic and closed chain kinematic groups in a study that employed an intervention based on kinetic chain exercises, but closed chain kinematic demonstrated higher improvements than open chain kinematic. The control group made no progress. GROC revealed a significant difference in the median score between the closed chain kinematic group and the open chain kinematic and control groups ($p=0.04$ and $p=0.03$, respectively).(21)

In contrast to the current investigation, Namjin Jung investigated the dynamic balance of the ankle joint and muscle activation in patients with chronic ankle instability during open and closed kinetic activities. The participants with chronic ankle instability displayed a difference in muscle activation and dynamic balancing skills during the closed and open kinetic chain workouts. These results imply that stretching therapy is not as effective for patients with recurrent ankle instability as closed and open kinetic chain exercises.(22)

Thirty individuals were divided into three distinct exercise groups at random using the CAIT questionnaire. The exercise groups were tested three times a week for four weeks to see how the groups affected muscle activity and dynamic balancing abilities. As such, there were notable differences in the person with chronic ankle instability's capacity to activate muscles and maintain dynamic balance between the closed and open kinetic chain activities. These findings, which supported the conclusions of our investigation, imply that both closed and open kinetic systems are effective.

(23)

In another research, the effects of static and dynamic balance activities on the ankle joints of young, healthy women with open and closed kinetic chains were studied. For four weeks, each group worked out three times each week. The findings of Romberg's Test revealed that the major influence of time (influence size: $d=0.97$) had a significant impact on the trace length with eyes closed. Both closed kinetic chain and open kinetic chain workouts helped subjects' balance. Exercises involving the closed kinetic chain improved the dynamic balance of young, healthy women more than those involving the open kinetic chain.(24)

Using individuals with chronic ankle instability, this study compared the advantages of open and closed kinetic chain workouts for managing their pain, balance, and instability. The study has limitations, including a small sample size, the need for improvement, and results on a wide population.

Conclusion:

This study found that both open chain and closed chain kinetic exercises are equally successful at treating ankle instability; in fact, both types of exercises may be beneficial to exercise when it comes to functional tasks, particularly activities of daily living (ADLs).

Disclaimer: This study was part of MSPT program.

Conflict of interest: None to declare.

Source of funding: None to declare.

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Authors Contribution:

Sajjad MA: Conception and design of study

Rehman RA: Acquisition of Data

Azfar H: Observer

Qazi ZN: Drafting

Khalid MU: Data analysis and interpretation

Ahmad HZ: Critical revision

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