

Comparative Study: Effects of Open Kinetic Chain Versus Closed Kinetic Chain Exercises on Balance and Gait in Individuals with Ankle Related Injuries

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Abstract:

Background: Ankle injuries, such as sprains, often lead to pain, swelling, and impaired proprioception, affecting balance and gait. Open kinetic chain (OKC) and closed kinetic chain (CKC) exercises are commonly used in ankle injury rehabilitation, but their differential effects on balance and gait remain unclear. Understanding the comparative outcomes of these exercise approaches is crucial for optimizing rehabilitation protocols.

Methods: This comparative study included 30 participants with past ankle injuries divided equally into two groups. Group A underwent OKC exercises, including non-weight bearing exercises with a resistance band, targeting ankle joint movements. Group B performed CKC exercises, involving weight-bearing exercises through the affected joint. Pain levels were assessed using the Visual Analogue Scale (VAS), and balance was evaluated using the Single Leg Stance Test (SLS). The study lasted for four weeks, with 30 minutes of exercise per day, five days a week.

Results: Both groups showed progressive reductions in pain levels throughout the intervention period. Group B demonstrated slightly greater improvements in pain reduction compared to Group A. Similarly, both groups exhibited enhanced balance over time, with Group B showing greater gains compared to Group A. Statistical analyses confirmed the significant effects of time on pain reduction and balance improvement in Group A, with a high proportion of variance attributed to the intervention.

Conclusion: The exercise program effectively reduced pain and improved balance in individuals with ankle injuries. Both OKC and CKC exercises yielded benefits, but CKC exercises appeared particularly effective in promoting balance improvement. These findings have important implications for tailoring rehabilitation programs and optimizing pain management and functional recovery in individuals with ankle injuries.

Keywords: Closed kinetic chain exercises, Balance, Gait, and Rehabilitation.

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Introduction

Ankle injuries, particularly ankle sprains, commonly can lead to pain, swelling, and impaired proprioception. These factors significantly impact an individual's ability to maintain balance and exhibit normal gait patterns. With the ankle joint being crucial for ambulation and weight-bearing, exploring effective rehabilitation strategies to restore balance and optimize gait in individuals with ankle injuries is imperative.[1]

The rehabilitation process for ankle injuries often involves various exercise protocols aimed at improving strength, stability, and proprioception. Two commonly employed exercise approaches are open kinetic chain (OKC) exercises and closed kinetic chain (CKC) exercises. OKC exercises involve movement at the distal segment of the limb, such as ankle joint exercises without weight-bearing, while CKC exercises involve exercises with weight-bearing through the affected joint, such as squatting or lunging exercises.[2]

The choice between OKC and CKC exercises has been a topic of debate in the field of rehabilitation, particularly regarding their effects on balance and gait in individuals with ankle injuries. While both exercise approaches have their merits, their differential impact on balance and gait outcomes remains a subject of interest and investigation.[3]

Understanding the comparative effects of OKC and CKC exercises on balance and gait is crucial for optimizing rehabilitation protocols and improving patient outcomes. Therefore, this study aimed to compare the effects of OKC versus CKC exercises on balance and gait in individuals with ankle injuries. By evaluating the effectiveness of these exercise approaches, we can provide valuable insights into the most appropriate exercise strategies for individuals with ankle injuries.[4] The primary objective of this comparative study was to determine

whether CKC exercises yield superior outcomes in terms of balance and gait compared to OKC exercises. By assessing pain levels and balance using the Visual Analogue Scale (VAS) and the Single Leg Stance Test (SLS), respectively, we aimed to identify the exercise approach that leads to greater improvements in these crucial aspects of ankle injury rehabilitation.[5]

The findings of this study have the potential to inform clinical practice and guide rehabilitation programs for individuals with ankle injuries. By elucidating the effects of OKC and CKC exercises on balance and gait, healthcare professionals can tailor treatment plans to optimize patient outcomes, reduce pain, and improve functional mobility.[6]

Material and Methodology

Sample Size: The sample participants size is 30 patients, divided equally into two groups.

Study Design: A comparative study

Population: Patients with past ankle injuries.

Sampling Method: Random sampling method.

Source of Data: PMCH, Udaipur.

Study Sitting: 30 minutes per day.

Duration of study: 5 days per week, a total of 4 weeks.

Inclusion Criteria

1. History of ankle related injury (past injuries).
2. Age – participants must be between 15-60 years.
3. Gender- both males and females
4. Balance and gait issues during walking due to injury.
5. Difficulty in performing normal ADL'S easily.
6. Persistent pain in or around ankle joint
7. Ankle stiffness and decreased range of motion of ankle joint.

Exclusion Criteria

1. Age more than 80 years.
2. Recent surgeries.
3. Infection or open wounds.
4. Joint deformity.
5. Psychological issues.
6. High risk health status.
7. Osteoporotic bone.

Procedure:

The study involves participants who meet the inclusion criteria and are randomly divided into two groups: Group A and Group B. Both groups will sign a consent

form. Group A will undergo open kinetic chain exercises, which involve isolated joint movements without fixing the distal end of the limb.

The exercises for Group A include non-weight bearing exercises with a resistance band, focusing on ankle dorsiflexion, ankle plantarflexion, inversion, and eversion. These exercises will be performed in a supine lying position under the guidance of the resistance band.

Results

Table 1: Comparison of Vas in Group-A And Group-B

V A S	Group- A	Group- B
	Mean \pm SD	Mean \pm SD
Day 1	6.0 \pm 2.2	6.2 \pm 2.1
Day 15	3.6 \pm 2.5	3.2 \pm 2.4
4th Week	2.4 \pm 2.1	1.2 \pm 1.3

The results of the study demonstrated a progressive reduction in pain levels, as measured by the Visual Analogue Scale (VAS), in both Group A and Group B throughout the intervention period. On day 1, the mean VAS scores were 6.0 \pm 2.2 in Group A and 6.2 \pm 2.1 in Group B, indicating similar baseline pain levels. By day 15, both groups experienced a notable decrease in pain, with Group A showing a mean VAS score of 3.6 \pm 2.5 and Group B

demonstrating a slightly greater improvement with a mean VAS score of 3.2 \pm 2.4.

At the end of the fourth week, Group A exhibited further reduction in pain with a mean VAS score of 2.4 \pm 2.1, while Group B showed the most substantial improvement, with a mean VAS score of 1.2 \pm 1.3, indicating a significant decrease in pain levels in both groups over the course of the intervention.

Table 2: Comparison of Balance in Group - A and Group - B

Balance	Group - A	Group - B
	Mean \pm SD	Mean \pm SD
Day 1	13.9 \pm 6.7	15.1 \pm 6.3
Day 15	20.7 \pm 9.9	24.0 \pm 10.4
4th Week	31.2 \pm 9.5	35.4 \pm 11.0

The results from Table 2 indicate improvements in balance among participants in both Group A and Group B throughout the intervention period. On day 1, Group A had a mean balance score of 13.9 \pm 6.7, while Group B had a slightly higher mean balance score of 15.1 \pm 6.3, suggesting comparable baseline balance levels. By day 15, both groups showed

increased balance, with Group A reaching a mean score of 20.7 \pm 9.9 and Group B exhibiting a more substantial improvement with a mean score of 24.0 \pm 10.4. At the end of the fourth week, Group A demonstrated further enhancement in balance with a mean score of 31.2 \pm 9.5, while Group B displayed the highest improvement, reaching a mean score of

35.4 \pm 11.0. These findings suggest that both open kinetic chain exercises (Group A) and closed kinetic chain exercises

(Group B) contribute to improved balance over time, with Group B showing greater gains in balance compared to Group A.

Table 3: Repeated Measures Analysis Of Variance for Group A and Statistical Significance

Repeated Measures Analysis Of Variance (n = 15)						
Variables	Day 1	Day 15	4 th Week	Statistical value F	Eta Square	Significant value
	Mean \pm SD	Mean \pm SD	Mean \pm SD			
VAS	6.0 \pm 2.2	3.6 \pm 2.5	2.4 \pm 2.1	37.9(S)	0.730	0.000 P<0.001
Balance	13.9 \pm 6.7	20.7 \pm 9.9	31.2 \pm 9.5	104.7(S)	0.88	0.000 P<0.001

Table 3 presents the results of the repeated measures analysis of variance (ANOVA) conducted for Group A. The analysis included the variables VAS (Visual Analogue Scale) and BALANCE measured on Day 1, Day 15, and the 4th week. For the VAS variable, there was a statistically significant effect of time ($F = 37.9$, $p < 0.001$), indicating a significant reduction in pain levels over the course of the intervention. The Eta Square value was 0.730, suggesting that 73% of the variance in pain reduction could be attributed to the intervention. Similarly, for the BALANCE variable, there was a significant effect of time ($F = 104.7$, $p < 0.001$), indicating a significant improvement in balance throughout the intervention. The Eta Square value was 0.88, suggesting that 88% of the variance in balance improvement could be attributed to the intervention. These findings demonstrate the effectiveness of the exercise program in reducing pain and improving balance in Group A participants.

Discussion

The results of the study revealed positive outcomes in terms of pain reduction and improved balance in individuals with ankle injuries participating in the exercise intervention. Both Group A and Group B experienced a progressive decrease in pain levels, as indicated by the Visual Analogue Scale (VAS), throughout the intervention

period. Significant reductions in pain were observed in both groups, with Group B showing slightly greater improvements compared to Group A. These findings indicate that both open kinetic chain (Group A) and closed kinetic chain (Group B) exercises are effective in reducing pain in individuals with ankle injuries.[7] Furthermore, improvements in balance were observed in both Group A and Group B over the course of the intervention. Participants in both groups demonstrated enhanced balance at each time point, with Group B exhibiting greater improvements compared to Group A.[8] These results suggest that both open and closed kinetic chain exercises contribute to improved balance in individuals with ankle injuries, with closed kinetic chain exercises yield greater gains.[9] The repeated measures analysis of variance (ANOVA) conducted for Group A confirmed the significant effects of time on both pain reduction and balance improvement. The statistical values (F) indicated significant differences over time, with substantial reductions in pain and significant enhancements in balance. The high Eta Square values indicate that a significant proportion of the variance in pain reduction (73%) and balance improvement (88%) can be attributed to the intervention.[10]

Conclusion

In conclusion, the findings demonstrate the effectiveness of the exercise program in reducing pain and improving balance in individuals with ankle injuries. Both open and closed kinetic chain exercises offer benefits, but closed kinetic chain exercises appear to be particularly effective in promoting balance improvement. These results have important implications for the development of rehabilitation programs tailored to individuals with ankle injuries, aiding in their pain management and functional recovery.

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