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Original Research Article

Role of Open Kinetic Chain Versus Closed Kinetic Chain in Relation to Balance and Gait of an Individual with Ankle-Related Injuries

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Abstract:

Background: Ankle injuries are common and can lead to complications such as fractures, chronic ankle instability, and proprioception loss. The ankle joint plays a crucial role in balance and gait, and injuries can result in proprioception loss and balance issues.

Methods: This comparative study included 30 patients with past ankle injuries. The participants were divided equally into two groups: Group A and Group B. Group A underwent open kinetic chain (OKC) exercises, focusing on isolated joint movements without fixing the distal end of the limb. Group B performed closed kinetic chain (CKC) exercises involving multiple joints and movements. The study duration was 4 weeks, with a 30-minute session per day, 5 days per week.

Results: Both Group A and Group B showed significant improvements over time. The Visual Analog Scale (VAS) scores for pain decreased progressively, and balance scores increased significantly. Repeated Measures Analysis of Variance showed a significant reduction in pain intensity and improvement in balance for both groups.

Conclusion: The study findings support the effectiveness of both open kinetic chain and closed kinetic chain exercises in reducing pain and improving balance in individuals with ankle-related injuries. Further research with larger sample sizes and control groups is needed to validate these findings and optimize rehabilitation strategies for ankle injuries.

Keywords: Open kinetic chain, Closed kinetic chain, Ankle-related injuries, Balance and gait.

Introduction

The ankle joint is a synovial joint composed of the talus, tibia, and fibula bones. It forms the hinged variety of synovial joint, allowing for dorsiflexion and plantarflexion movements. The ankle joint is stabilized by collateral ligaments, with the lateral ligaments being more frequently injured than the medial deltoid ligament. Injuries to the ankle joint are common, with ankle sprains accounting for the majority of cases. These injuries can lead to various complications, including fractures, chronic ankle instability, and proprioception loss.[1]

The ankle joint plays a crucial role in ambulation and bears the body's weight during walking and standing. It allows for four main movements: dorsiflexion, plantarflexion, inversion, and eversion. These movements are controlled by muscles divided into three compartments: the posterior, anterior, and lateral compartments. Gastrocnemius and soleus muscles are primarily involved in ankle plantarflexion, while the tibialis anterior muscle causes dorsiflexion. The peroneus longus and peroneus brevis muscles of the lateral compartment cause eversion.[2]

Ankle injuries account for a significant percentage of healthcare consultations, with ankle sprains being the most common type of injury. They can occur in individuals of all ages and are often the result of twisting or turning the ankle during walking. Ankle injuries can be classified into three categories based on the damaged tissue: tendon injuries (tendinopathy or tendonitis), ligament injuries (sprained ankle), and bone injuries (fractures). Ankle sprains, especially lateral sprains, have a high recurrence rate and can lead to chronic ankle instability, characterized by symptoms such as giving way, pain, and diminished proprioception.[3]

Proprioception, the awareness of joint and limb positioning, plays a crucial role in ankle stability and balance control. Proprioceptive information is provided by specialized nerves called proprioceptors located in muscles, tendons, joints, and other tissues. Ankle injuries, particularly sprains, can result in proprioception loss due to damage to these receptors, leading to balance issues and disturbances in gait patterns. Balance, the ability to maintain controlled body position, is influenced by proprioception. Loss of proprioception after ankle injuries can increase the risk of falls and re-injuries.[4]

The concept of the kinetic chain describes the interconnectedness of body parts, joints, and muscles in creating movements. There are two types of kinetic chain: open kinetic chain (OKC) and closed kinetic chain (CKC). OKC exercises involve isolated movements of a single joint, while CKC exercises involve multiple joints and movements. Balance exercises using both OKC and CKC can help improve proprioception and muscle activity, leading to better functional outcomes and reduced pain.[5]

Ankle injuries can have various causes, including sports activities, falls from heights, road traffic accidents, wearing faulty footwear, and a prior history of ankle injury. Common symptoms of ankle injuries include pain, swelling, instability, skin discoloration, stiffness, and reduced range of motion. Complications of ankle injuries can include stiffness, chronic pain, swelling, instability, and early onset arthritis in the ankle joint.[6] Understanding the anatomy of the ankle joint, the importance of proprioception and balance, and the role of the kinetic chain can guide the management and rehabilitation of ankle injuries. Rehabilitation programs focusing on proprioceptive training, balance exercises, and strengthening of the ankle muscles can help restore function, prevent re-injuries, and improve overall outcomes for individuals with ankle injuries.[7]

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: Repeated Measures Analysis Of Variance for Group B and statistical significance

Repeated Measures Analysis Of Variance (n = 15)						
Variables	**Day 1**	**Day 15**	**4th Week**	**Statistical value F**	**Eta Square**	**Significant value**
	Mean ± SD	**Mean ± SD**	**Mean ± SD**			
VAS	6.2 ± 2.1	3.2 ± 2.4	1.2 ± 1.3	67.3(S)	0.82	0.000 P<0.001
Balance	15.1 ± 6.3	24.0 ± 10.4	35.4 ± 11.0	67.1(S)	0.82	0.000 P<0.001

Table 1 displays the results of the Repeated Measures Analysis of Variance for Group B, consisting of 15 participants. The analysis examined the variables VAS (Visual Analog Scale) and BALANCE at three-time points: Day 1, Day 15, and the 4th Week. Significant findings were observed for both variables. The mean scores for VAS decreased progressively from 6.2 ± 2.1 at Day 1 to 3.2 ± 2.4 on Day 15, and further to 1.2 ± 1.3 in the 4th Week ($p < 0.001$). Similarly, BALANCE showed improvement over time, with mean scores increasing from 15.1 ± 6.3 at Day 1 to 24.0 ± 10.4 at Day 15, and reaching 35.4 ± 11.0 in the 4th Week ($p < 0.001$). These results indicate a significant reduction in pain intensity and improvement in balance for participants in Group B throughout the study period. Note: S denotes significance at 5% level $p<0.05$.

Table 2: Comparison of VAS three groups, Repeated Measures Analysis of Variance

S.No.	Outcome measures	Groups	Sample Test			Statistical value F	Eta Square	Significant value
1			Day 1	Day 15	4th Week			
	VAS	Group A	6.0 ± 2.2	3.6 ± 2.5	2.4 ± 2.1	37.9(S)	0.730	0.000 P<0.001
		Group B	6.2 ± 2.1	3.2 ± 2.4	1.2 ± 1.3	67.3(S)	0.82	0.000 P<0.001
		P value	0.80	0.6	0.07			

Table 2 presents the results of the Comparison of VAS (Visual Analog Scale) across three groups using Repeated Measures Analysis of Variance. The analysis included measurements taken at three-time points: Day 1, Day 15, and the 4th Week. The outcomes for VAS were compared between Group A and Group B. Significant differences were observed between the groups at all time points. Group A displayed mean VAS scores of 6.0 ± 2.2 at Day 1, 3.6 ± 2.5 at Day 15, and 2.4 ± 2.1 at the 4th Week ($p < 0.001$). Similarly, Group B exhibited mean VAS scores of 6.2 ± 2.1, 3.2 ± 2.4, and 1.2 ± 1.3 at the respective time points ($p < 0.001$). No significant differences were found between Group A and Group B in terms of VAS scores at any time point. These findings suggest that both Group A and Group B experienced a significant reduction in pain intensity over the course of the study. NS denotes not significant at 5% level $p>0.05$

Table 3: Comparison of VAS three groups, Repeated Measures Analysis Of Variance

S.No.	Outcome measures	Groups	Sample Test			Statistical value F	Eta Square	Significant value
1			Day 1	Day 15	4th Week			
	Balance	Group A	13.9 ± 6.7	20.7 ± 9.9	31.2 ± 9.5	104.7(S)	0.88	0.000 P<0.001
		Group B	15.1 ± 6.3	24.0 ± 10.4	35.4 ± 11.0	67.1(S)	0.82	0.000 P<0.001
		P value	**0.6**	**0.3**	**0.2**			

Table 3 presents the results of the Comparison of BALANCE across three groups using Repeated Measures Analysis of Variance. The analysis included measurements taken at three time points: Day 1, Day 15, and the 4th Week. The outcomes for BALANCE were compared between Group A and Group B. Significant differences were observed between the groups at all time points. Group A displayed mean BALANCE scores of 13.9 ± 6.7 at Day 1, 20.7 ± 9.9 at Day 15, and 31.2 ± 9.5 at the 4th Week ($p < 0.001$). Similarly, Group B exhibited mean BALANCE scores of 15.1 ± 6.3, 24.0 ± 10.4, and 35.4 ± 11.0 at the respective time points ($p < 0.001$). No significant differences were found between Group A and Group B in terms of BALANCE scores at any time point. These findings suggest that both Group A and Group B experienced a significant improvement in balance over the course of the study. S denotes significance at 5% level $p<0.05$

Discussion

The results presented in Table 1 demonstrate the outcomes of the Repeated Measures Analysis of Variance for Group B, which consisted of 15 participants. The analysis focused on the variables VAS

(Visual Analog Scale) and BALANCE, measured at three time points: Day 1, Day 15, and the 4th Week. Both variables showed significant changes over time. The mean VAS scores progressively decreased from 6.2 ± 2.1 at Day 1 to 3.2 ± 2.4 on Day 15, and further dropped to 1.2 ± 1.3 in the 4th Week ($p < 0.001$). Similarly, BALANCE improved throughout the study period, with mean scores increasing from 15.1 ± 6.3 at Day 1 to 24.0 ± 10.4 at Day 15 and rising to 35.4 ± 11.0 in the 4th Week ($p < 0.001$). These findings indicate a significant reduction in pain intensity and a notable improvement in balance among the participants in Group B.[8]

Moving on to Table 2, it displays the Comparison of VAS across three groups using Repeated Measures Analysis of Variance. The analysis included measurements taken at the same three time points: Day 1, Day 15, and the 4th Week. The focus was on comparing the outcomes for VAS between Group A and Group B. Significant differences were observed between the groups at all-time points.

Both Group A and Group B experienced significant reductions in pain intensity over the course of the study, as indicated by the decreasing mean VAS scores. No significant differences were found between the two groups at any time point. These results align with the findings from Table 1, suggesting that both Group A and Group B exhibited similar improvements in pain levels throughout the study.[9]Finally, Table 3 presents the Comparison of BALANCE across the three groups using Repeated Measures Analysis of Variance. The analysis examined the measurements taken at the same three time points: Day 1, Day 15, and the 4th Week. The focus was on comparing the outcomes for BALANCE between Group A and Group B. Significant differences were observed between the groups at all-time points. Both Group A and Group B demonstrated significant improvements in balance over the study period, as indicated by the increasing mean BALANCE scores. No significant differences were found between the two groups at any time point.

These findings support the notion that both Group A and Group B experienced comparable enhancements in balance throughout the study.[10]

Comparing the results of this study with previous research, it is important to note that individual studies may differ in terms of methodology, sample size, population characteristics, and other factors. Therefore, direct comparisons should be made cautiously.

However, the significant improvements in both pain intensity (VAS) and balance observed in this study align with findings from other studies investigating similar interventions or treatments. These consistent outcomes suggest the effectiveness of the intervention in reducing pain and enhancing balance, contributing to the existing body of knowledge on this subject.[11]

Conclusion

In conclusion, the results from this study highlight the significant improvements in pain intensity and balance observed in both Group A and Group B over the study period. The findings provide support for the effectiveness of the intervention in reducing pain and enhancing balance. Future studies could benefit from larger sample sizes and a comparison with a control group to further validate these findings.

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