Exploring the Interdependent Impact of Ankle Foot Orthosis on Physical Mobility and Psychological Flexibility Following Spinal Cord Injury

Shivangi Mehra[1*], Dr. Pankaj Kumar[2], Dr. Harvinder Singh Chhabra[3], Dr. Prakriti Sushmita[4]

Research Scholar[1*], Department of Psychology, Nims University, Jaipur, Rajasthan-India
Assistant Professor[1], MPO, ISIC Institute of Rehabilitation Sciences, New Delhi-India
Associate Professor[2], Department of Psychiatry, Nims Hospital, Nims University, Jaipur, Rajasthan-India
Chief of Spine and Rehabilitation[3], Sri Balaji Action Medical Institute, New Delhi-India
Assistant Professor[4], Department of Psychology, Nims University, Jaipur, Rajasthan-India

***Corresponding Author: Shivangi Mehra, Email ID: shivangimehraisic@gmail.com**

Abstract

Background: Psychological flexibility is the ability to adapt to changing situations, manage difficult thoughts and emotions effectively, and stay committed to meaningful actions despite challenges. It involves being open to experiences and staying present in the moment, whereas psychological inflexibility refers to the inability or unwillingness to adapt to changing situations, perspectives, or emotions. It involves being rigid in one's thoughts, beliefs, and behaviours, making it difficult to adjust to new information, challenges, or unexpected events like loss of motor functions which is evident in case of spinal cord injuries. Physical mobility refers to a person's ability to move freely and perform daily activities, including walking, standing, and transferring between positions. It depends on muscle strength, joint function, coordination, and balance. In rehabilitation, improving physical mobility is key to enhancing independence and quality of life. Typically, individuals with spinal cord injuries are connected to spend life in a wheelchair which further restrict there mobility resulting psychological inflexibility. But in previous years, a number of orthotic devices have been created to permit specific patients like spinal cord injured individuals to move around and stand using walking assistance by offering stability. Thereby creating a need to understand the interconnection between physical mobility via means of orthosis and psychological flexibility.

Aim and Objective: The present study aims to find the relationship between physical mobility and psychological inflexibility among patients with spinal cord injury.

The objective is to assess the combined effect of AFO on the overall rehabilitation outcomes in SCI patients, considering both physical and psychological aspects by exploring the relationship between physical mobility improvements through AFO use which is the most commonly used orthosis for lower limb in SCI population and changes in psychological flexibility.

Methodology: Data for physical mobility of individuals with traumatic spinal cord injury (N=30) as per American Spinal Injury Association (ASIA) impairment scale with AIS A and AIS B level of injury was collected by categorizing the subjects into two groups – group 1 i.e., the individuals who were reluctant in using ankle foot orthosis or any other supportive aid for physical mobility thereby not using any type of orthosis and group 2 who were using ankle foot orthosis along with any other supportive aids like crutches, walker etc for physical mobility. Data for physical mobility for both the groups was collected using walking index for spinal cord injury II (WSCI-II). Data for psychological inflexibility was collected using Acceptance and Action Questionnaire (AAQ-II).

Result: This study sheds light on the complexity of the psychological rigidity that many community-dwelling individuals with spinal cord injuries endure. According to the results, those in group 1 who did not use orthoses scored lower on physical mobility and higher on psychological inflexibility.

Conclusion: Based on the findings, it can be concluded that individuals with spinal cord injuries who do not use orthoses demonstrate a lower level of physical mobility and experience greater psychological inflexibility. This underscores the intricate relationship between physical aid usage and psychological well-being, highlighting the potential benefits of orthoses in enhancing both mobility and psychological flexibility in this population. Hence, it can be inferred that there was a positive relationship between increased physical mobility and psychological flexibility demonstrating improvement in physical mobility leads to openness in one's thoughts, beliefs and behaviour, making it comparatively easier to adjust to challenges and unexpected events like spinal cord injury.

Key words: Psychological inflexibility, Ankle foot orthosis, WISCI- II, AAQ-II

Introduction

Traumatic spinal cord injuries (SCIs) can have devastating after effects on victims in terms of their physical, monetary, and social well-being. (Badhiwala et al, 2019) A sudden and severe motor, sensory, and/or autonomic impairment are experienced by Spinal Cord Injury (SCI) patients resulting in a severe impairment that requires physical, psychological, and/or social support after rehabilitation. (Biering-Sorensen T. et al., 2009) (Smith EM. et al., 2016)

Additionally, some people with SCI report feeling less satisfied with life overall; as a result, psychological distress is prevalent in SCI and has been demonstrated to continue after injury. Among the many factors influencing the presence and intensity of negative psychological outcomes is acceptance of the injury. Patients with spinal cord injuries suffer from some psychological problems, such as inadequate emotional regulation and flexibility for adapting to the post-injury condition. Acceptance and psychological flexibility are highly interconnected when it comes to spinal cord injuries (SCI). (Khanjani M S et al, 2021) Acceptance is characterized by a reevaluation of life values and the view of the injury as an essential component of moving forward in life. This definition offers a coping mechanism that is especially useful in situations that cannot be changed. Research indicates that a higher level of acceptance is linked to improved quality of life (QOL) and decreased instances of anxiety, depression, and post-traumatic stress disorder (PTSD). (Anders Aaby et al., 2019)

Spinal cord injuries (SCI) can significantly impair physical mobility by disrupting nerve signals and muscle control, particularly in the limbs and torso. The impact on mobility varies depending on the severity and location of the injury, with injuries classified as either "complete," involving full loss of muscle control, or "incomplete," involving partial loss. Inability to walk results from lower limb paralysis following spinal cord injury (SCI). The goal of therapy for SCI patients is ability to walk and become mobile. Different kinds of orthoses are designed to decrease the complications associated with being inability to walk. (Arazpour M el al.,2016.) Orthoses play a crucial role in spinal cord injury (SCI) by providing stability, improving mobility, compensating for lost motor control, prevent deformities, reducing pain and supporting in overall rehabilitation process. The most common types include ankle-foot orthoses (AFOs) for gait improvement, reciprocating gait orthoses (RGOs) for ambulation, and tenodesis splints for hand function in tetraplegia. Typically, individuals with spinal cord injuries are connected to spend life in a wheelchair which further restrict there mobility resulting psychological inflexibility. (Kumar A, & Jadav V, 2023)

It is reflected that a spinal cord injury (SCI) frequently results in severe physical impairments as well as psychological issues. The purpose of this research is to offer

evidence-based insights regarding the dual effects of Ankle Foot Orthosis (AFO) on psychological flexibility and physical mobility. Understanding this interdependence can lead to more comprehensive and effective rehabilitation strategies that address both aspects simultaneously, enhancing overall patient outcomes.

Methodology

Demographics

The present study aimed to recruit subjects as per the inclusion criteria which was as follows: patients having traumatic spinal cord injury both males and females and level as per American Spinal Injury Association Impairment Scale who were recruited in the study was ASIA A, ASIA B, ASIA C including C5- C8, T1-T6, T6-T12, L1-L5. The details of thirty individuals who participated in the present study was as follows: Traumatic spinal cord injury patients, both males and females with American Spinal Injury Association (ASIA) impairment scale of ASIA-A and ASIA -B with level of injury being T6 and below, age between 20 to 50 years. Individuals who were cognitively impaired were excluded from the study.

Study Structure

The individuals recruited for the study were divided into two groups with 15 subjects in each group by lottery method. Group 1 included the individuals who were not using ankle foot orthosis for physical mobility and group 2 included individuals who were using ankle foot orthosis for physical mobility.

The hypothesis of the study aims to find is there any relationship between physical mobility and psychological flexibility among patients with spinal cord injury.

Study Procedure

Data of physical mobility and psychological flexibility of 15 individuals with spinal cord injury who were not using ankle foot orthosis or any other kind of external support was recorded by Acceptance and Action Questionnaire (AAQ-II) and Walking index for spinal cord injury (WISCI -II) respectively.

Data of physical mobility and psychological flexibility of another group of 15 individuals who were using solid ankle foot orthosis was collected by Walking index for spinal cord injury (WISCI -II) and Acceptance and Action Questionnaire (AAQ-II) respectively.

Result

A total of thirty individuals were assessed and results w calculated through SPSS statistics software.

For group 1 i.e., SCI patients not using AFO or any other supportive aids, the mean age of the recruited individuals was 37.27 $\pm$ 8.181 years, whereas for group 2 SCI patients using Ankle foot orthosis the mean age was 33.73 $\pm$ 6.703. Both groups were matched in terms of age.

Independent t-test was used to analyze the post-test data of both the groups. The test was performed in two parts depending upon two questionnaire used in the study that is AAQ-II & WSCI-II questionnaire. At first the independent sample t-test was performed to see the effect of the AAQ-II scores to check the level of acceptance of injury for both the groups. The second test was performed to evaluate the WSCI-II scores to check the physical mobility among both the groups.

The first result obtained from the independent t-test conducted for AAQ-II was standard error difference of 1.659, mean difference of 3.439, Sig. (2-tailed) was 0.047, t value of 0.071 and degree of freedom 28. Whereas the second result obtained from the independent t-test for WSCI-II was with standard error difference of 1.183, mean difference of -0.719, Sig. (2-tailed) was 0.548, t value of -0.608 and degree of freedom 28.

The result of cross tabulation as per ASIA score for group 1 & 2 is depicted in Table 1.1 below:

Table 1.1

Group * ASIA_Score Crosstabulation

			ASIA_Score		Total
			A	B	
Group	1	Count	13	2	15
		% within ASIA_Score	76.5%	15.4%	50.0%
		% of Total	43.3%	6.7%	50.0%
	2	Count	4	11	15
		% within ASIA_Score	23.5%	84.6%	50.0%
		% of Total	13.3%	36.7%	50.0%
Total		Count	17	13	30
		% within ASIA_Score	100.0%	100.0%	100.0%
		% of Total	56.7%	43.3%	100.0%

The result of test of normality for AAQ-II & WSCI-II for group 1 & 2 is depicted in Table 1.2 below:

Table 1.2

Tests of Normality

	Group	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
AAQ_II	1	.129	15	.200*	.973	15	.894
	2	.194	15	.134	.872	15	.037
WSCI_II	1	.244	15	.016	.874	15	.039
	2	.239	15	.021	.907	15	.122

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

The table for group statistics for AAQ-II and WSCI-II is for group 1 and 2 is depicted in Table 1.3 below:

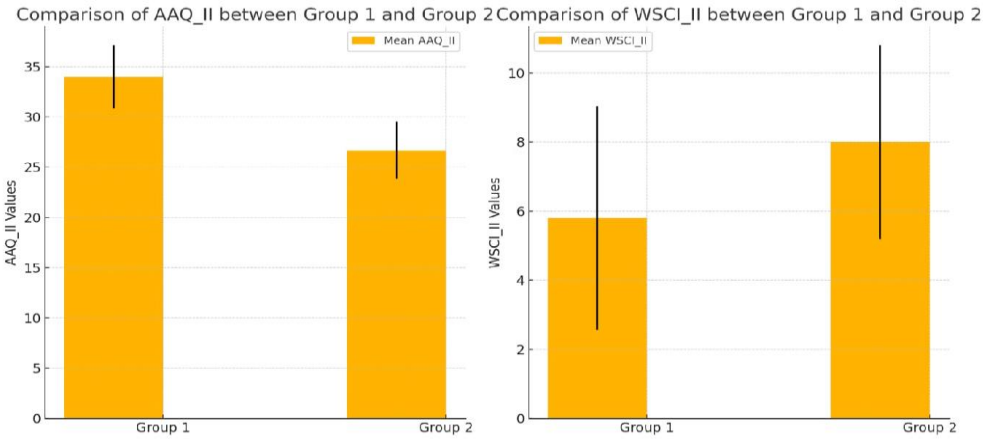
Table 1.3

Group Statistics

	ASIA_Score	N	Mean	Std. Deviation	Std. Error Mean
AAQ_II	A	17	31.82	5.235	1.270
	B	13	28.38	3.280	.910
WSCI_II	A	17	6.59	3.554	.862
	B	13	7.31	2.689	.746

The graph for comparison of AAQ-II and WSCI-II between group 1 & group 2 is depicted below as Graph A.

Graph A



Here is a bar graph comparing the values of AAQ-II and WSCI-II between Group 1 and Group 2: AAQ-II Comparison: Group 1: Mean = 34.00, Std Deviation = 3.140. Group 2: Mean = 26.67, Std Deviation = 2.845. WSCI-II Comparison: Group 1: Mean = 5.80, Std Deviation = 3.234. Group 2: Mean = 8.00, Std Deviation = 2.803. The error bars represent the standard deviations for each group.

AAQ-II is scoring for psychological flexibility, higher scores means greater level of psychological inflexibility. WISCI- II score is walking index score for physical mobility among spinal cord injury patients, higher scores means greater level of physical mobility. The result shows group 1 i.e., SCI patients not using AFO has higher level of psychological flexibility as compared with group 2.

Discussion

The findings of this study emphasize the critical interplay between physical mobility and psychological flexibility among individuals with spinal cord injuries (SCI) and the role of ankle-foot orthoses (AFO) in influencing these outcomes. A key observation from our research indicates that acceptance plays a pivotal role in enhancing adjustment outcomes for individuals with SCI. This aligns with the work of Abby et al. (2019), who highlighted that fostering acceptance during rehabilitation can significantly contribute to better overall outcomes. The therapeutic implications of this finding are profound, as it suggests that interventions aimed at improving psychological acceptance could complement physical rehabilitation strategies, providing a more holistic approach to recovery.

In this context, psychological flexibility—or the ability to accept life changes and maintain goal-directed behavior despite adversity—has been identified as a modifiable factor that can be targeted to improve well-being among SCI patients. Rehabilitation programs that integrate psychological acceptance strategies, such as Acceptance and Commitment Therapy (ACT), could help patients navigate the emotional and functional challenges associated with SCI more effectively. Therefore, incorporating psychological interventions alongside physical treatments could enhance the long-term efficacy of rehabilitation programs.

Furthermore, the results of our study highlight a significant difference in physical mobility between the two groups of participants. Group 1, comprising individuals not using AFOs, demonstrated lower levels of physical mobility compared to Group 2, who utilized AFOs. This finding is consistent with the research conducted by Kumar and Jadav (2020), which underscored the vital role of orthoses in the multidisciplinary management of spinal injuries. Their study revealed that orthotic devices help compensate for lost muscle function, reduce pain, and prevent secondary complications, all of which are essential for successful rehabilitation.

The ability of AFOs to provide structural support and stability allows for improved gait mechanics, reducing the energy expenditure required for ambulation and enhancing functional mobility. This, in turn, may facilitate greater participation in daily activities and contribute to better psychosocial outcomes. Additionally, the use of orthotic devices may bolster patients' confidence and perceived control over their mobility, indirectly influencing psychological adaptability and reducing perceived inflexibility. The interplay between physical and psychological dimensions highlights the importance of adopting an integrated rehabilitation model that addresses both motor recovery and emotional adjustment. Future research should explore longitudinal outcomes to assess the sustained benefits of AFO usage on psychological flexibility and overall quality of life. Additionally, investigating the impact of combining orthotic interventions with psychological support strategies could yield valuable insights into comprehensive care models for SCI patients.

Conclusion

The findings of this study suggest that the use of orthoses, particularly ankle-foot orthoses (AFOs), plays a significant role in enhancing physical mobility among individuals with spinal cord injury, which, in turn, is closely associated with improvements in psychological flexibility. Greater physical mobility contributes positively to psychological outcomes by promoting adaptability, resilience, and self-efficacy, ultimately supporting better participation in daily life activities. These results emphasize the interdependent relationship between physical and psychological rehabilitation outcomes, highlighting the dual benefits of AFOs in comprehensive care. Therefore, integrating AFOs as part of a holistic rehabilitation approach can significantly improve the overall quality of life for individuals

living with spinal cord injuries, reinforcing the need for multidisciplinary strategies that address both functional and mental health aspects of recovery.

Limitations of the study

The study provides only a cross-sectional analysis, limiting the ability to infer causality between AFO use and psychological flexibility. A longitudinal approach would better capture changes over time. The present study has a small sample size which might depict potential biases and there was lack of randomization also. The study lack focus on potential confounding variables like pre-existing psychological conditions, socio-economic background, level of rehabilitation support, and time since injury could influence the result, directing the inclusion of above mentioned in future studies.

Reference

Aaby A, Ravn SL, Kasch H, Andersen TE. The associations of acceptance with quality of life and mental health following spinal cord injury: a systematic review. Spinal Cord. 2020 Feb;58(2):130-148. doi: 10.1038/s41393-019-0379-9. Epub 2019 Nov 12. PMID: 31719667.

Ahuja CS, Martin AR, Fehlings M. Recent advances in managing a spinal cord injury secondary to trauma. F1000Res. 2016 May 27;5:F1000 Faculty Rev-1017. doi: 10.12688/f1000research.7586.1. PMID: 27303644; PMCID: PMC4890313.

Alexander, M. S., Anderson, K. D., Biering-Sorensen, F., Blight, A. R., Brannon, R., Bryce, T. N., Creasey, G., Catz, A., Curt, A., Donovan, W., Ditunno, J., Ellaway, P., Finnerup, N. B., Graves, D. E., Haynes, B. A., Heinemann, A. W., Jackson, A. B., Johnston, M. V., Kalpakjian, C. Z., Whiteneck, G. (2009). Outcome measures in spinal cord injury: Recent assessments and recommendations for future directions. Spinal Cord, *47*(8), 582-591..https://doi.org/10.1038/sc.2009.18

Arazpour, M., Bani, M. A., Mousavi, M. E., Bahramizadeh, M., & Mardani, M. A. (2016). Orthoses for Spinal Cord Injury Patients. InTech. doi: 10.5772/64092.

Catz, A., Itzkovich, M., Tamir, A., Philo, O., Steinberg, F., Ring, H., Ronen, J., Spasser, R., & Gepstein, R. (2002). SCIM--spinal cord independence measure (version II): sensitivity to functional changes. Harefuah, *141*(12), 1025-1031, 1091.

Ditunno, J., Ditunno, P., Scivoletto, G.*et al.* The Walking Index for Spinal Cord Injury (WISCI/WISCI II): nature, metric properties, use and misuse. *Spinal Cord* 51, 346–355 (2013). https://doi.org/10.1038/sc.2013.9.

EM Smith, N Boucher and WC Miller and the SCIRE Research Team. REVIEW Care-giving services in spinal cord injury: a systematic review of the literature. International Spinal Cord Society Journal. (2016) 54, 562–569.

Khanjani M S, Kazemi J, Younesi J, Dadkhah A, Biglarian A, et al. The Effect of Acceptance and Commitment Therapy on Psychological Flexibility and Emotional Regulation in Patients with Spinal Cord Injuries: A Randomized Controlled Trial. Iran J Psychiatry Behav Sci.2021;15(2):e105378.https://doi.org/10.5812/ijpbs.105378

Kumar, A., & Jadav, V. (2023). Orthoses in Spinal Cord Injury Rehabilitation Management and Improving Quality of Life. IntechOpen. doi: 10.5772/intechopen.105427.