

Orthotic Management of Ankle Plantarflexion Contracture Using Static Progressive AFO in a Post-Stroke Patient: A Case Report

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ABSTRACT

Aims: To evaluate, the effectiveness of a developed Static Progressive Ankle Foot Orthosis in improving ankle joint Range of Motion and decrease in muscle tone in a Post Stroke Patient with Ankle Plantarflexion Contracture.

Study design: A single subject case report study design was used to

Place and Duration of Study: DSMNRU, Lucknow, Uttar Pradesh, Study time: 20 Days

Methodology: A single-case study was conducted on a post-stroke patient presenting with ankle plantarflexion contracture. Baseline evaluation included measurement of ankle range of motion (ROM) using a universal goniometer and muscle tone using the Modified Ashworth Scale (MAS) A static progressive AFO was designed using a Hirth joint mechanism with 40 interlocking teeth for precise angular adjustment. A butyl rubber washer was incorporated to improve friction, stability, and reduce mechanical wear. Ankle range of motion (ROM) was measured using a universal goniometer before and after a 3-week intervention period. The orthosis was applied with gradual adjustments to provide low-load prolonged stretch.

Results: The results indicate that the use of a static progressive AFO contributed to improvement in ankle joint range of motion, although spasticity levels remained unchanged during the study period.

Conclusion: The developed static progressive AFO is an effective intervention for managing ankle joint contractures in post-stroke individuals in improving joint mobility.

Keywords: Stroke, Ankle Contracture, Static Progressive Orthosis, Ankle-Foot Orthosis (AFO), Range of Motion, Rehabilitation

INTRODUCTION

Stroke is a medical emergency that occurs when blood flow to the brain is interrupted, either due to a blockage or bleeding. This lack of blood flow can lead to brain cell death and serious complications. Strokes can be fatal and need immediate treatment.¹

Stroke is a major cause of long-term disability and often leads to weakness and stiffness in the lower limbs. One common problem after stroke is ankle contracture, especially plantarflexion, caused by spasticity, muscle imbalance, and prolonged immobility. This affects walking, balance, and overall independence.²

After stroke, damage to upper motor neurons causes overactivity of plantarflexor muscles and weakness of dorsiflexors,

leading to abnormal ankle positioning. Continuous spasticity and reduced movement further worsen joint stiffness.

Conservative treatments include physiotherapy, stretching, casting, and orthoses. Adjustable ankle-foot orthoses (AFOs) are effective because they provide prolonged stretch and allow gradual correction of ankle position.³⁻⁵

Reduced ankle dorsiflexion is common and limits functional activities like walking. Muscles can adapt to prolonged stretch by increasing their length, which helps prevent contracture. Although many treatments exist, prolonged low-load stretch (such as with adjustable AFOs or casting) is more effective than short-duration stretching.

Night splints and positioning also help improve ankle range of motion.⁶

MATERIALS & METHODS

Patient information:

A 70-year-old male patient with a body weight of 78 kg presented with a history of right-sided hemiplegia following stroke. The patient was experiencing difficulty in walking, maintaining balance, and performing daily activities due to stiffness and reduced mobility at the ankle joint.

The patient's condition was consistent with post-stroke complications, where prolonged immobility and neuromuscular impairment often lead to muscle tightness, joint stiffness, and contracture formation. These factors contribute to abnormal gait patterns, instability, and increased risk of falls.

Parameter	Finding
Age	70 years
Gender	Male
Body Weight	78 kg
Diagnosis	Post-stroke hemiplegia
Affected Side	Right side
Condition	Ankle plantarflexion contracture
Range of Motion (ROM)	38° (restricted)
Modified Ashworth Scale	Grade 4 (severe spasticity)
Functional Status	Difficulty in walking and balance
Gait Pattern	Equines gait

Clinical finding

On clinical examination, the patient showed ankle joint contracture on the affected side. The pre-intervention evaluation showed that the range of motion (ROM) of the ankle joint was 38° Plantarflexion, indicating restricted movement. Additionally, the Modified Ashworth Scale (MAS) grade was 4, which signifies severe spasticity with rigidity in flexion or extension, making passive movement difficult.

Therapeutic Intervention:

The orthosis is designed using a Hirth joint mechanism consisting of 40 interlocking teeth, which provides precise positioning, high stiffness, and controlled angular adjustment of the ankle joint. Previous studies have shown that Hirth joints ensure

accurate alignment and efficient load distribution, making them suitable for such applications. To enhance the joint performance, a butyl rubber washer is placed between the teeth. This material is elastic, compressible, and has good damping properties, which helps in increasing friction, preventing slipping, reducing mechanical wear, and protecting the teeth from damage. It also absorbs vibration and provides cushioning, allowing smooth and gradual adjustment of ankle range of motion.

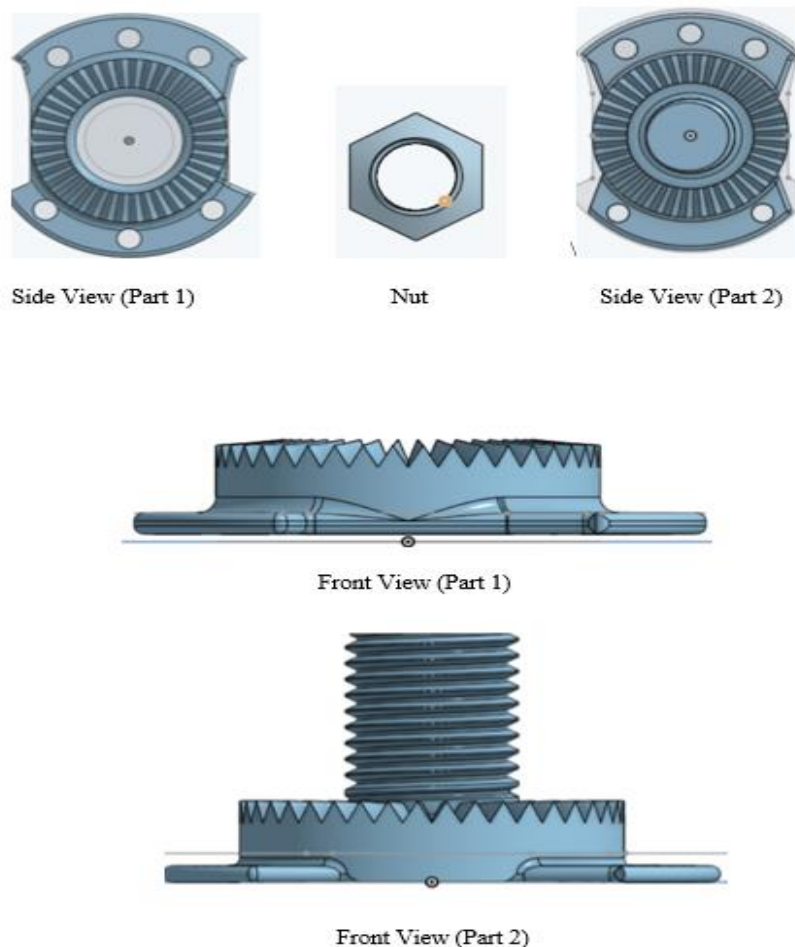
A stroke patient with plantarflexion contracture was considered for this study where demographic details such as age, gender, body weight, and clinical history were collected using a structured data collection form. The subject was informed

about the purpose, procedure, and duration of the study, and written informed consent was obtained prior to participation. Initial assessment was carried out to evaluate the ankle joint condition and functional limitations. The pre-intervention Range of Motion (ROM) of the ankle joint was measured using a Universal Goniometer without any orthotic support, and muscle tone was assessed using the Modified Ashworth Scale (MAS).

Following the baseline evaluation, a Static Progressive Ankle-Foot Orthosis (AFO) was provided as the intervention. The orthosis was applied to provide a low-load prolonged stretch to the ankle joint in a controlled and gradual manner. The subject was instructed regarding proper use of the orthosis, wearing schedule, and necessary precautions to prevent discomfort, skin irritation, or excessive pressure. The

intervention was continued for a period of three weeks, during which gradual adjustments were made to increase the stretch within the tolerance level of the subject. Regular monitoring was carried out to ensure safety and compliance.

After completion of the intervention period, post-intervention evaluation of ROM and muscle tone was measured and recorded. The ankle joint ROM was measured using the Universal Goniometer without the orthosis, and MAS grading was reassessed to determine changes in muscle tone. The pre- and post-intervention values were recorded and compared to evaluate the effectiveness of the Static Progressive Ankle-Foot Orthosis. The entire procedure was conducted as an individual case study with detailed observation and analysis of outcomes.



CAD Model of Ankle joint



Fig A



Fig B



Fig C

Initial trial of the Static Progressive AFO

RESULT

The present case study was conducted to evaluate the effectiveness of a Static Progressive Ankle-Foot Orthosis (AFO) on ankle joint plantarflexion contracture in a post-stroke individual. A 70-year-old male patient with right-sided hemiplegia was evaluated before Pre Intervention and after Post intervention.

The pre-intervention assessment showed that the ankle joint Range of Motion (ROM) was 38° , indicating restricted movement, and the Modified Ashworth Scale (MAS) score was Grade 4, suggesting severe spasticity.

After 2 weeks of intervention using the static progressive AFO, the post-intervention assessment revealed that the ROM improved to 33° , indicating a

reduction in 5 degrees of contracture and improvement in joint mobility. However, the MAS score remained Grade 4, showing no change in muscle tone or spasticity.

Overall, the results indicate that the use of a static progressive AFO contributed to improvement in ankle joint range of motion,

although spasticity levels remained unchanged during the study period. This suggests that the orthosis was effective in improving joint flexibility but had limited effect on reducing muscle tone within the given duration.

Table 2: Comparison (Pre vs Post)

Parameter	Pre Value	Post Value
ROM (Ankle Plantarflexion contracture)	38°	33°
MAS	4	4

DISCUSSION

Stroke is a major cause of long-term disability and often results in lower limb motor impairments. One common complication is ankle contracture, especially plantarflexion, caused by spasticity, muscle imbalance, and prolonged immobility.

This limits dorsiflexion and negatively affects gait, balance, and daily activities. Static progressive ankle-foot orthoses (AFOs) are effective in managing contractures by providing low-load, prolonged stretch, which promotes soft tissue elongation and improves joint range of motion. In this study, an AFO was developed using a Hirth joint mechanism with 40 teeth and a butyl rubber washer. This design allows controlled angular adjustment, improves joint stability, reduces slipping, and minimizes mechanical wear. The results showed improvement in ankle dorsiflexion range of motion, reduced stiffness, and better functional performance such as standing and walking. The orthosis was well tolerated, and its adjustable design improved patient compliance.

Overall, the developed AFO proved to be an effective and practical solution for managing ankle contractures in post-stroke individuals.

The developed static progressive ankle-foot orthosis proved to be an effective intervention in managing ankle joint contractures in post-stroke individuals. It improves ankle range of motion, reduces stiffness, and enhances functional activities such as standing and walking. The adjustable design allows gradual

progression, making it a practical and beneficial tool in rehabilitation.

CONCLUSION

The present case study demonstrated that the use of a static progressive ankle-foot orthosis (AFO) in a Post-Stroke Patient Hemiplegia With Plantarflexion Contracture resulted in a moderate improvement in ankle joint range of motion, with ROM contracture reducing from 38° pre-intervention to 33° post-intervention, indicating a reduction in plantarflexion contracture; however, the Modified Ashworth Scale (MAS) score remained unchanged at Grade 4, suggesting that while the orthosis was effective in improving joint mobility, it had no significant effect on reducing spasticity over the 2-week intervention period.

Declaration by Authors

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