

Inconspicuous Ankle Foot Orthosis (AFO) for Teen

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Facioscapulohumeral Dystrophy (FSHD) is one of the most common forms of muscular dystrophy, leading to progressive muscle weakness. Although there is no cure, symptom management options such as physical therapy, orthotics, and surgery are available. However, there is limited clinical research on FSHD in children, creating gaps in addressing their needs.

This project aims to raise awareness of FSHD and explore the benefits of discrete Ankle-Foot Orthoses (AFOs) for individuals with progressive muscle weakness. The goal is to design an AFO that supports dorsiflexion and prevents ankle inversion for a teenage client seeking an inconspicuous alternative to existing designs, improving mobility and quality of life.

Currently, there is no inconspicuous, patient-specific pediatric AFO that supports both dorsiflexion and inversion to promote a normal gait cycle. Existing device options include dynamic or jointed AFOs and supramalleolar orthoses (SMOs). These devices fail to meet the specific needs of pediatric patients and tend to be bulky, rigid, and draw attention, which can lead to bullying for the users wearing them.

To achieve a custom-fit brace, a 3D scanning method was used to fabricate rigid supports along the medial and lateral sides of the ankle. A cast mold of the patient's foot was used to generate a 3D mesh, which was scanned using the Creality RaptorX 3D scanner. The mesh file was then imported into OnShape and Solidworks to design the rigid supports. This process was replicated for both sides of the foot to produce models of the inner and outer supports. Both pieces were 3D printed using carbon fiber-reinforced PLA. Adjustable straps were sewn to velcro patches, and a bungee system was integrated using a lock lace mechanism. The bungee, sewn into the toe of the compression sleeve, provides additional dorsiflexion support when tightened. To assemble the brace, the rigid supports are placed on the medial and lateral sides of the ankle, and the velcro strap is fastened around the calf. The compression sleeve slides over the rigid supports, providing additional stability and enhancing the brace's functionality.

To evaluate the effectiveness of the designed AFO, the team used OpenCap and force plates. OpenCap's markerless motion capture system analyzed the patient's gait while wearing the brace, providing ankle angles and changes in knee and hip mechanics. A reduced range of plantarflexion and decreased subtalar inversion angle would indicate the brace successfully limits unwanted ankle motion. Minimal changes in knee and hip angles will confirm a positive impact on gait patterns with minimal muscle compensation. Additionally, ground reaction forces recorded by the force plates track the center of pressure over time, generating a stabilogram to assess balance during induced ankle inversion of 17°. Inversion support effectiveness will be evaluated by measuring a reduction in mediolateral displacement of the center of pressure.

The designed AFO supports dorsiflexion and prevents ankle inversion, offering a low-profile design that enhances wearability for a teenage client. The use of lightweight yet durable materials ensures comfort, long-term usability, and structural support. This design overcomes the limitations of current AFOs, offering a viable solution for individuals with FSHD that balances both functionality and discretion.

This AFO improves the client's mobility by aiding dorsiflexion and preventing ankle inversion. The discreet design helps mitigate bullying concerns, allowing the client to feel more comfortable in social settings. Ultimately, this design delivers a tailored solution that meets both functional and social needs, positively impacting the user's quality of life by improving mobility and social confidence.