Inconspicuous Ankle Foot Orthosis (AFO) for Teen

Team AFO

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Background

- **Facioscapulohumeral muscular dystrophy (FSHD)**
  - Directly weakens skeletal muscle tissue (Gastrocnemius and the Tibialis Anterior)
  - No cure, only treatments to manage symptoms
- **Client**
  - Debbie Eggleston
  - Physical therapist and FSHD activist
- **Patient**
  - 16 year old high school student with FSHD
  - Horseback rider

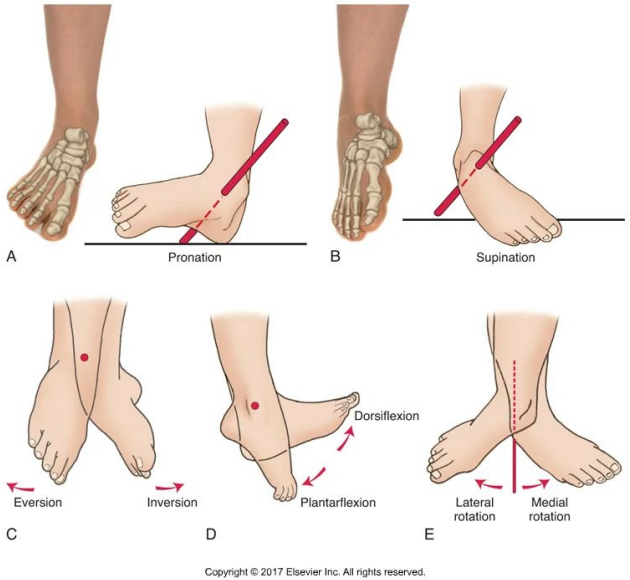


Figure 1: A diagram for understanding foot movement vocabulary. [1]

Problem Statement

Ankle-foot orthoses (AFOs) are designed to support dorsiflexion during the swing phase of walking. They are commonly used in managing muscular dystrophies. For this project, our focus is specifically on **adolescents with Facioscapulohumeral Dystrophy (FSHD)**, the most prevalent form of muscular dystrophy. Our goal is to create a brace that helps teens achieve safer walking by **assisting ankle dorsiflexion** and **preventing ankle inversion**, while **remaining discreet, lightweight, and flexible** enough to allow natural ankle motion. The main design priorities are to position the ankle in proper dorsiflexion, keep the brace slim and inconspicuous, and provide enough flexibility to reduce movement restrictions. This project has been ongoing throughout three semesters, and this semester, **spring 2026, will be the final semester of the project.** The team is hoping to create a device that fulfills all requests, as well as displays significant data following testing.

Previous Work

- **Fall 2024, Spring 2025**
  - Fall 2024 - Created initial design, focusing on dorsiflexion
  - Spring 2025 - Focused on preventing inversion and eversion via side PLA-CF prints
- **Fall 2025**
  - Dorsiflexion aspect needed updating; researched and added elastic polyester band
  - Testing performed with the client and patient in November to provide final updates to design

Figure 2: Fall 2024 final design

Figure 3: Fall 2025 final design

Competing Designs

Figure 4: PD-AFO

Figure 5: VSO

Figure 6: SMO

Figure 7: Jointed AFO

Passive Dynamic AFO (PD-AFO)

- Spring like bending to assist in plantar flexion and stability [2]

Variable Stiffness AFO (VSO)

- Adjustable leaf spring to assist in foot drop and reduced toe striking [3]

Supramalleolar Orthosis (SMO)

- Provides ankle stability and corrects misalignment [4]

Jointed AFO

- Allows bending of the ankle while minimizing foot drop [5]

Product Design Specifications

- Patient-specific dimensions
- Permit no more than 30° of foot drop from neutral
- Increase dorsiflexion and add 5-10 Nm resistance per 10° of plantarflexion
- Prevent inversion angles greater than 25°
- Brace should resist up to ± 30 Nm torque and 1570 N of load
- Discrete design everyday use and horseback riding
- Comfortability

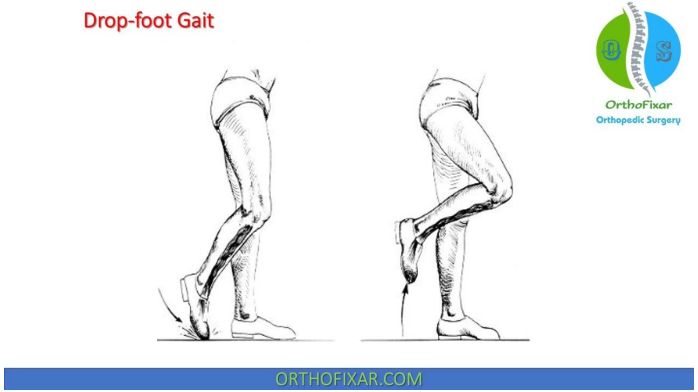
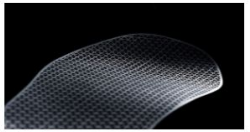
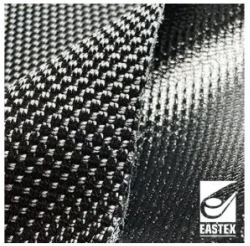


Figure 8: Foot Drop during Gate [6]

Figure 9: Ankle Inversion vs. Eversion [7]

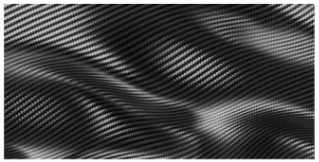
Design Matrix:
Dorsiflexion Materials

Table 1: Dorsiflexion Material Design Matrix

Design Criteria	 **Material 1: Elastic Polyester**		 **Material 2: TPU**		 **Material 3: Ballistic Nylon**	
	Raw Score	Weighted Score	Raw Score	Weighted Score	Raw Score	Weighted Score
Dorsiflexion Support (25)	3/5	15/25	4/5	20/25	5/5	25/25
Durability (15)	4/5	12/15	3/5	9/15	4/5	12/15
Flexibility (15)	5/5	15/15	4/5	12/15	2/5	6/15
Fabrication Quality (15)	3/5	9/15	4/5	12/15	3/5	9/15
Comfort (10)	5/5	10/10	4/5	8/10	3/5	6/10
Discreetness (10)	4/5	8/10	4/5	8/10	4/5	8/10
Cost (10)	3/5	6/10	5/5	10/10	2/5	4/10
Total	75/100		79/100		70/100	

Design Matrix:
Inversion and Eversion Materials

Table 2: Medial/Lateral Material Design Choice

Design Criteria	Material 1: Carbon Fiber 		Material 2: PLA-CF 50% infill 	
	Raw Score	Weighted Score	Raw Score	Weighted Score
Strength (25)	5/5	25/25	3/5	15/25
Durability (15)	5/5	15/15	3/5	9/15
Flexibility (15)	3/5	9/15	3/5	9/15
Fabrication Quality (15)	5/5	15/15	4/5	12/15
Comfort (10)	3/5	6/10	3/5	6/10
Discreetness (10)	4/5	8/10	4/5	8/10
Cost (10)	2/5	4/10	5/5	10/10
Total	82/100		69/100	

Final Design

Figure 10: Inversion with Straps Final Design (Fall 2025)

Materials and Manufacturing:

- Inversion Supports:
  - Carbon fiber
  - Elongation
- Straps:
  - 3D printing for TPU
  - Placement

Next Steps

Fabrication and Prototyping

- Finalize the materials
- Crafting Inversion Supports
- Stitching

Fit and customization

- Elongation of side guards
- Placement of the straps
- Concealability

Testing

- MTS materials testing
- Client testing
  - Gait analysis (dorsiflexion)
  - Toe clearance and heel strike
  - Inversion control
  - Significant data

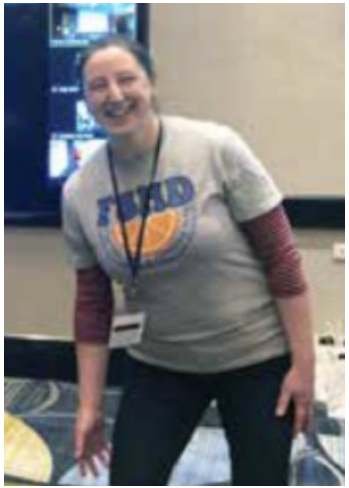
Acknowledgements

Advisor

Dr. Monica Ohnsorg

Client

Debbie Eggleston



References

[1] “Decreased Ankle Dorsiflexion is Associated with Dynamic Knee Valgus,” Learn Muscles. Accessed: Sep. 28, 2025. [Online]. Available: https://learnmuscles.com/blog/2018/05/16/decreased-ankle-dorsiflexion-is-associated-with-dynamic-knee-valgus/
[2] J. Feng, J. Weiss, A. Thompson, and J. E. Meeker, “Passive Dynamic Ankle Foot Orthoses Use in Civilian Patients with Arthritic Conditions of the Foot and Ankle,” Foot Ankle Orthop, vol. 8, no. 1, p. 24730114231157734, Mar. 2023, doi: 10.1177/24730114231157734.
[3] “Variable Stiffness Orthosis – Neurobionics Lab.” Accessed: Oct. 02, 2025. [Online]. Available: https://neurobionics.robotics.umich.edu/research/wearable-robotics/variable-stiffness-orthosis/
[4] F. M. Medical, “What is an SMO Brace?,” Forward Motion. Accessed: Oct. 02, 2025. [Online]. Available: https://www.fdmotion.com/blog/what-is-an-smo-brace
[5] “Jointed AFOs,” Orthotics Plus Melbourne. Accessed: Oct. 02, 2025. [Online]. Available: https://orthoticsplus.com.au/orthotics/ankle-foot-orthoses-afo/jointed/
[6] “Gait Cycle: Phases & Biomechanics | OrthoFixar.” Accessed: Oct. 02, 2025. [Online]. Available: https://orthofixar.com/basic-science/gait-cycle/
[7] “Movement About Joints, Part 7: The Ankle.” Accessed: Oct. 02, 2025. [Online]. Available: https://www.crossfit.com/essentials/movement-about-joints-part-7-the-ankle

Questions?