2-SEGMENT FOOT MODEL:
REFINING EVALUATION OF CLUB FEET

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- The **1-segment vector foot** used with Plug-In Gait has significant limitations.
- We developed a **novel 2-segment foot model** to divide the foot into 2 segments comprised of the hindfoot/midfoot and forefoot.
- The **2-segment foot** improves assessment of foot motion during gait, including midfoot and forefoot eversion/inversion.

AIM: To illustrate the utility and usefulness of our **novel 2-segment foot model** by applying it to 2 patients with club foot deformity and one typically developing child with no deformity, for comparison.

References

1. Pothrat et al. (2015) https://doi.org/10.1016/j.clinbiomech.2015.03.004
2. Redmond et al. (2008) https://doi.org/10.1186/1757-1146-1-6
3. Sung et al. (2020) https://doi.org/10.1186/s12891-020-03285-3
4. Gijon-Nogueron et al. (2016) https://doi.org/10.1186/s13047-016-0156-3

Introduction/Background

- **1-segment vector foot** used in PIG is limited[1,3]
    - Over-estimation of dorsiflexion
    - Inability to quantify hindfoot/midfoot and forefoot inversion/eversion
- **Multi-segment foot** models require additional markers and change in motion capture volume
    - Less realistic for small pathologic pediatric feet
- A **novel 2-segment foot** model (figure 1) allows for a more detailed assessment of forefoot and hindfoot/midfoot motion
    - Minimal need for additional markers or change in capture volume
    - Increased use for smaller feet due to simplicity of implementation

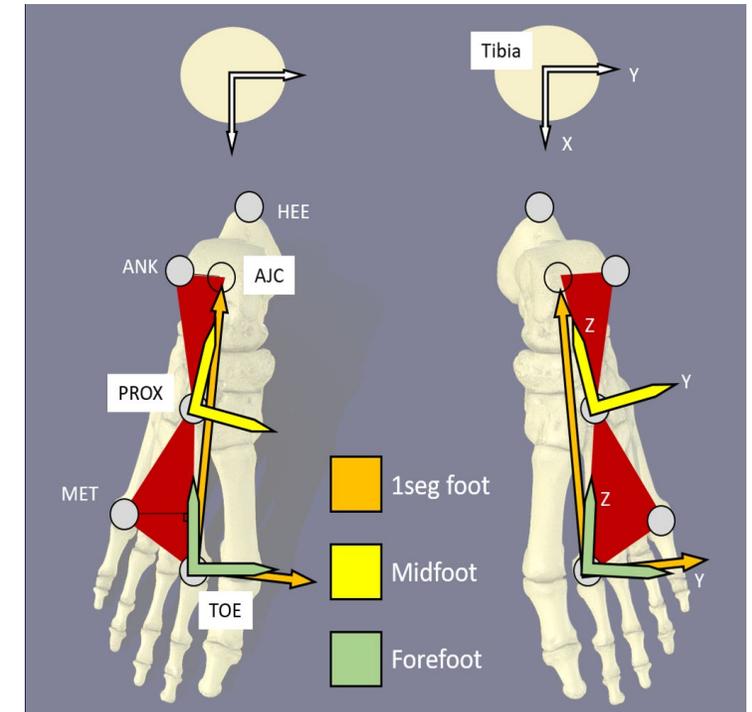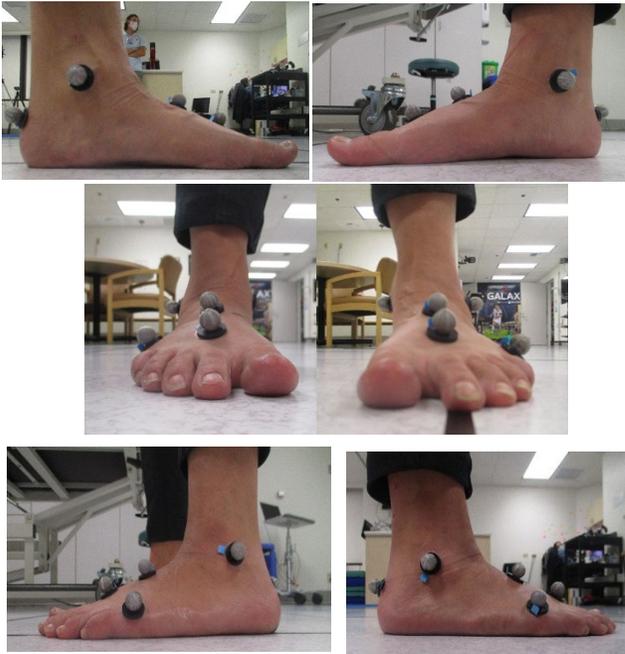Figure 1: Axis definitions for 1- and 2-segment models

Figure 2:
Additional markers for **2-segment foot model:**
- Middle cuneiform
- 5th metatarsal

Shown below on normal feet

Subject History/Data:

- Case comparison study: 2 patients with idiopathic club foot
- Pre-operative surgical considerations prior to gait studies
  - Patient A and B: Gastrocnemius recession and split anterior tibialis tendon transfer
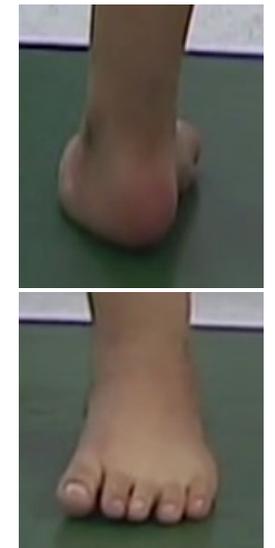 - Patient A only: abductor hallucis lengthening

Patient A

Patient B

Table 1

|	DF knee extended, inverted	DF knee flexed, inverted	Forefoot Eversion	Hindfoot Eversion	Foot Posture Index-6
Patient A	-4°	0°	4°	10°	**+2**
Patient B	0°	6°	4°	10°	**-9**

The foot posture index-6 is a static observational measure that considers the three-dimensional foot and has been shown to have good reliability in both adult and pediatric populations. [2,4]

Patients had similar static exams (Table 1) with exception of Foot Posture Index-6 making dynamic/gait exam important for decision making.

Figure 3: individual kinematics (mean + 1SD) 1- and 2-foot segment models
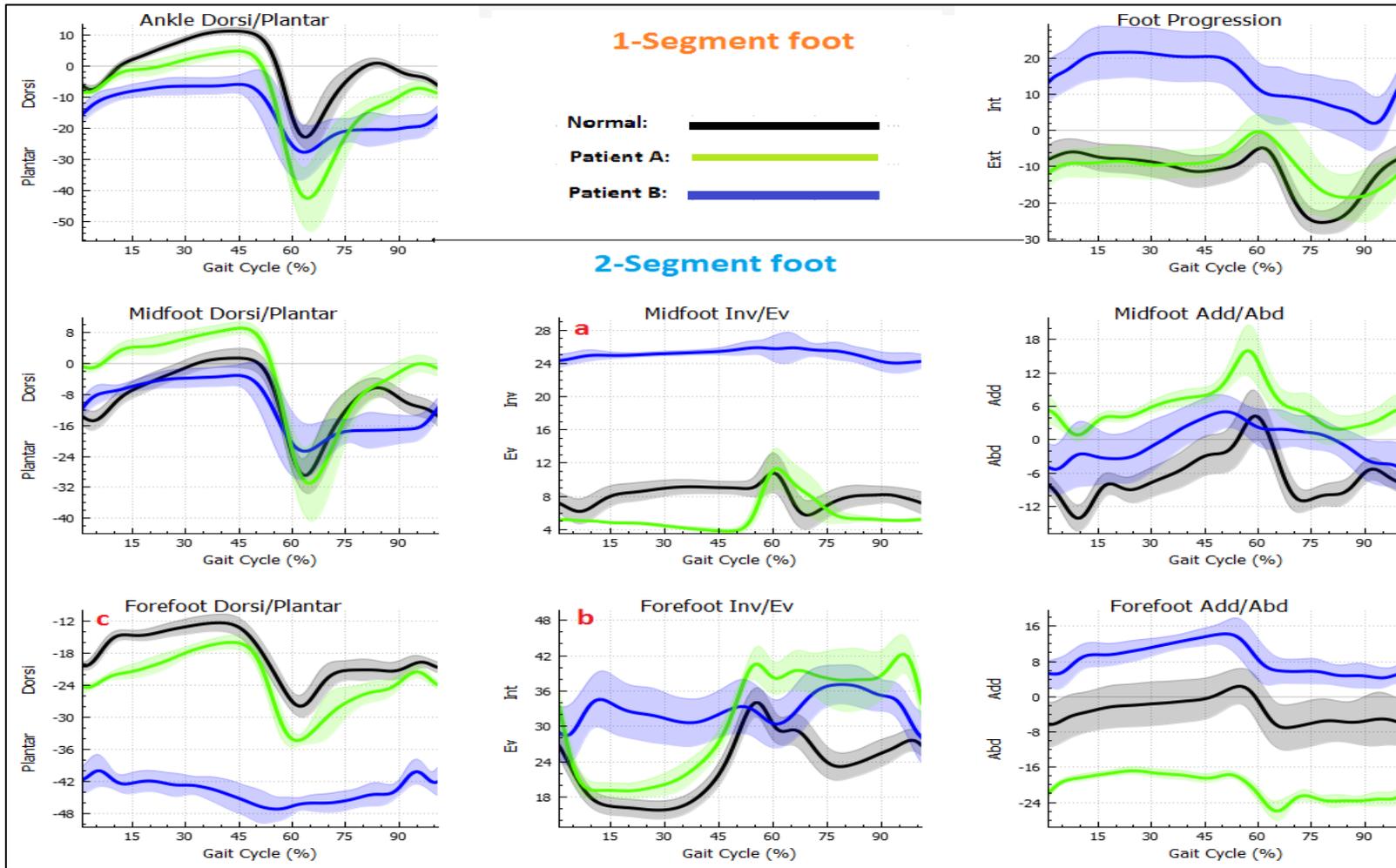
Results: (Figure 3)
- **2- segment foot model**
  - Patient A: had flexible deformity with forefoot inversion isolated to swing phase- figure 3 b
  - Patient B: had rigid midfoot and forefoot inversion- figure 3 a/b and increased forefoot plantarflexion- figure 3 c

Conclusion: **2-segment foot model** was able to differentiate hindfoot/midfoot versus forefoot motion during various gait cycle phases improving clinical decision making.