The Importance of a Dorsiflexion Stop in (K)AFOs for Patients with Weak Plantar Flexors

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Effects of Weak Plantar Flexors

Isolated paralysis of the n. tibialis *
[Lehmann et al. 1985]

Incomplete paraplegia **
[Beekman et al. 2000]

Apoplexy ***
[Mulroy et al. 2010]

Post-polio syndrome ****
[Perry et al. 1993, Ploeger et al. 2014]

http://fineartamerica.com/featured/2-human-nervous-system-artwork-sciepro.html

Temporal spatial parameters:

- velocity ↓
- step length ↓
- stride length ↓
- cadence ↓
- duration of stance phase ↓
- heel lift in TSt ↓
- forward movement of the COP in MSt ↓

Kinematics:

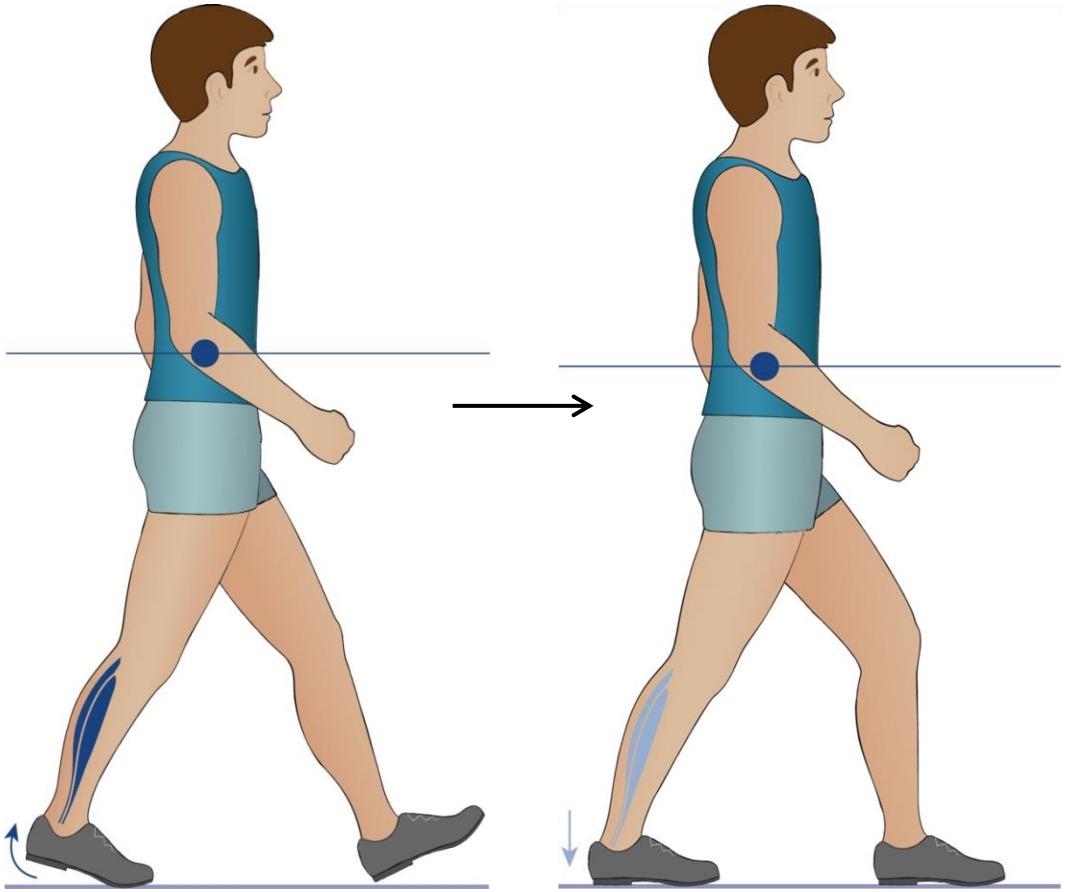
- contralateral knee flexion in TSt ↑
- max. dorsiflexion in TSt ↑

Kinetics:

- plantar flexion moment ↓
- plantar flexion force ↓

Energy required when walking ↑

Effects of Weak Plantar Flexors



normal plantar flexors

weak plantar flexors

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Orthotic Treatment Concepts

Isolated paralysis of the n. tibialis
[Lehmann et al. 1985]

Incomplete paraplegia
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Apoplexy
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[Ploeger et al. 2014]

Nollet et al. 2008. In: Hsu et al.

Mulroy et al. 2010

Temporal spatial parameters:

- velocity ↑
- step length ↑
- stride length ↑
- cadence =
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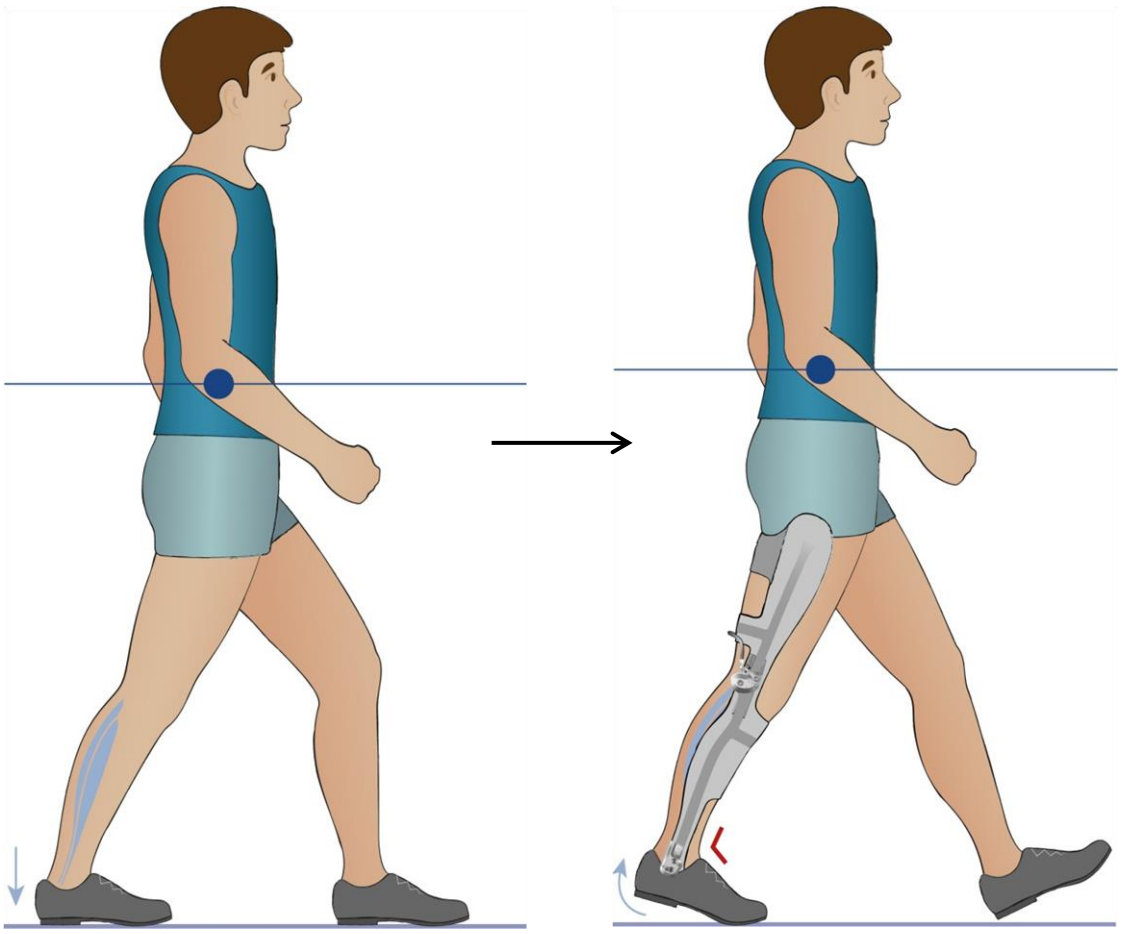
Orthotic Treatment Concepts



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weak plantar flexors

Temporal spatial parameters:

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Central Question

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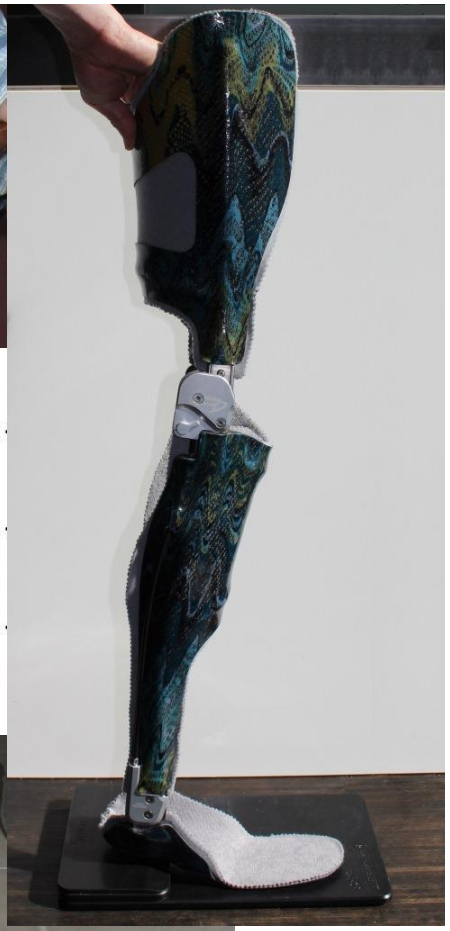
How does the gait with an orthosis having a dorsiflexion stop differ from the gait with an orthosis lacking this constructive feature?

???

Patient

KAFO_30: Shank-Vertical Angle 30°



KAFO_05: SV Angle 5°

Patient data:

- male
- 180cm, 81kg
- post-polio syndrome
- genu recurvatum: 20°
- DF: 30°, PF: 50°
- toe stance is not possible
- activity level: 2

Muscle strength:

- hip flexion/extension: 5
- knee flexion/extension: 1
- dorsiflexion/plantar flexion: 2/1

Orthoses:

- without KAFO
- previous treatment KAFO_30
- new treatment KAFO_05

Proceeding

Analysing system:

- 2-dimensional
- 1 lateral camera, 60Hz
- 13 active marker
- kinematics
- events during gait cycle

Measurement:

- maximum knee flexion [°]
- maximum ankle dorsiflexion [°]
- ROM knee and ankle [°]
- relative point in time of heel lift [% GC]
- proportion of stance and swing phase [% GC]

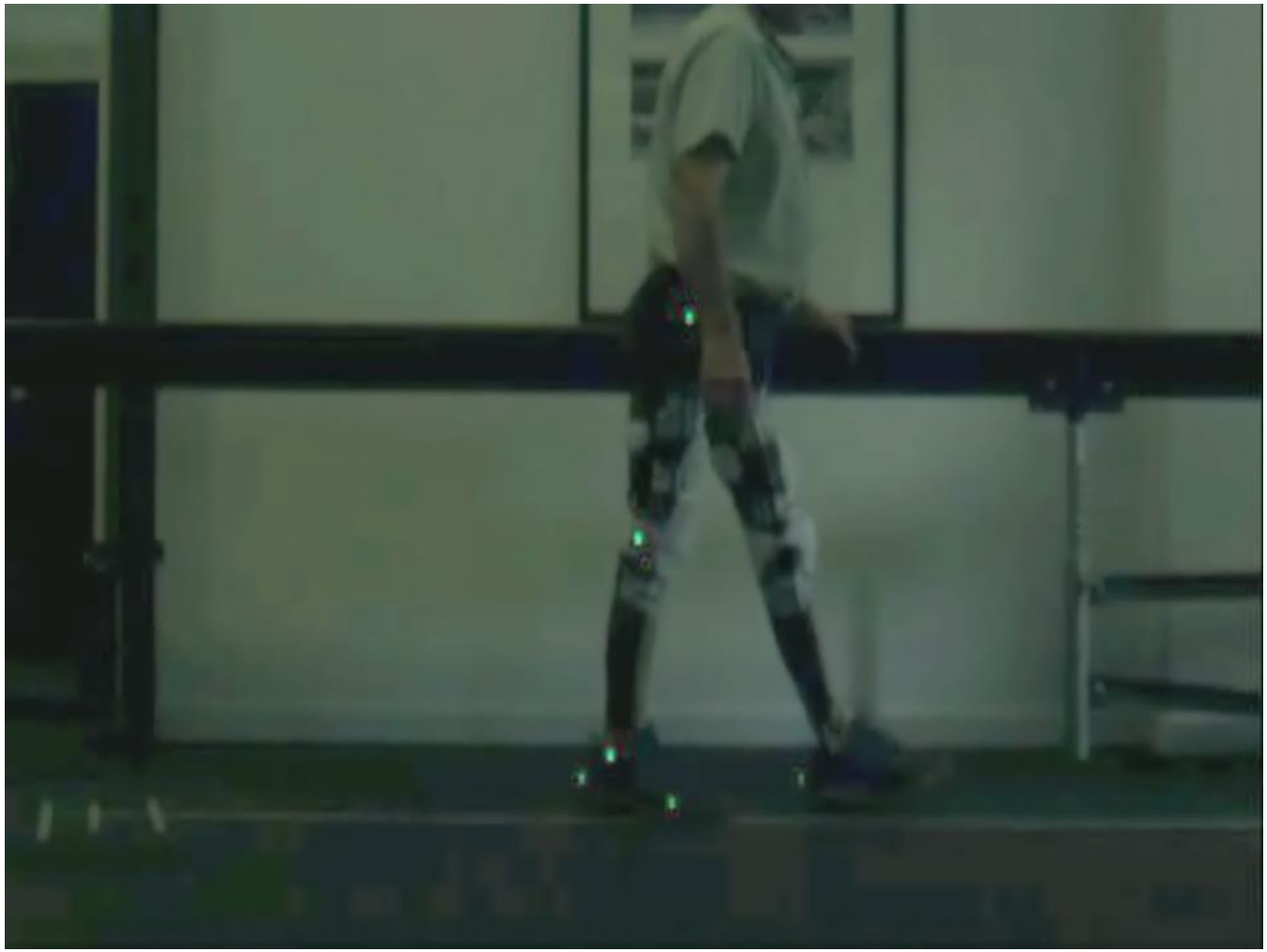
Evaluation:

- 2 gait cycles per orthosis
- average value, standard deviation
- Wilcoxon signed-rank test

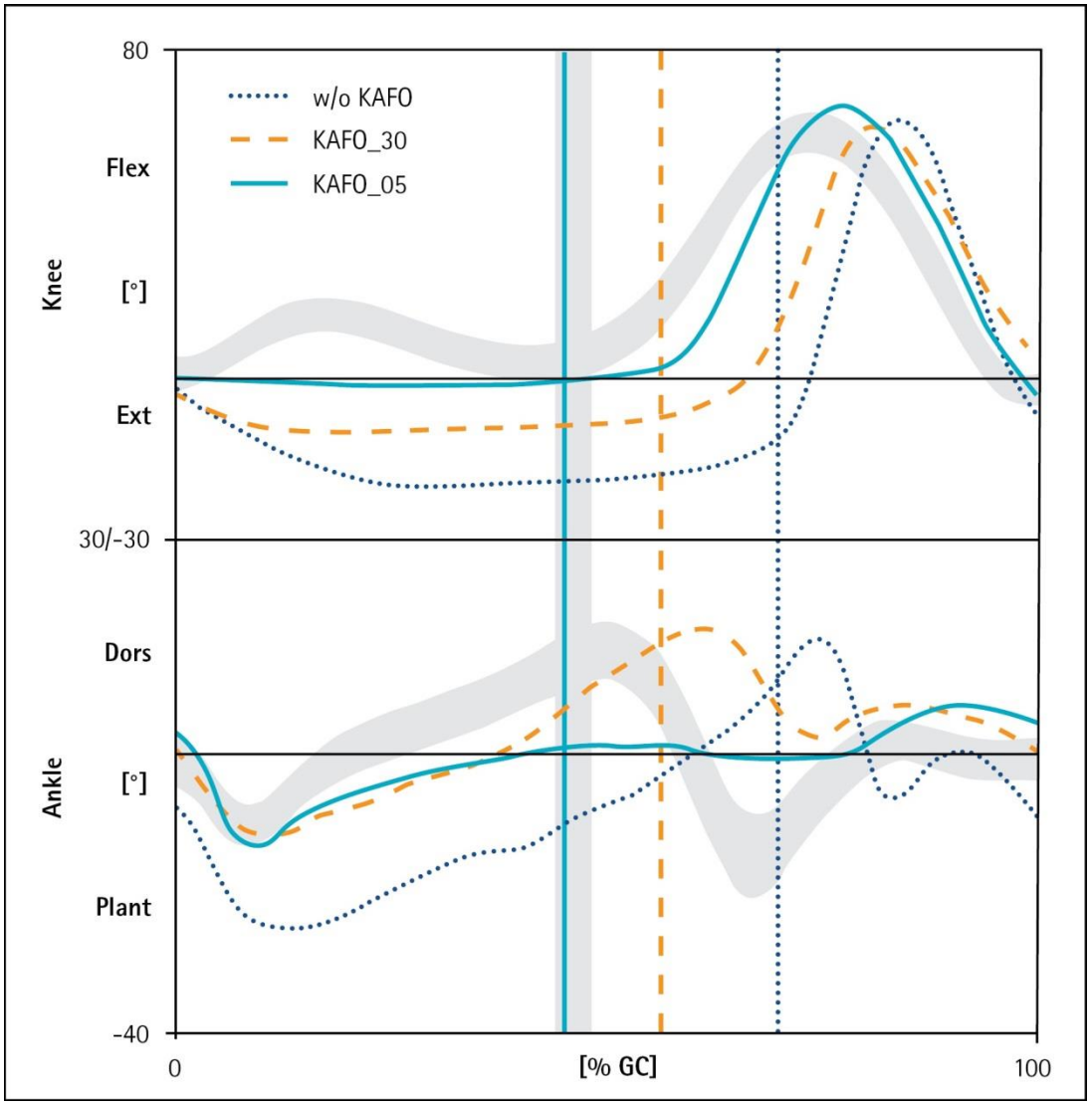
Without KAFO

KAFO - Dorsiflexion Stop Set to 30°

KAFO - Dorsiflexion Stop Set to 5°



Kinematics



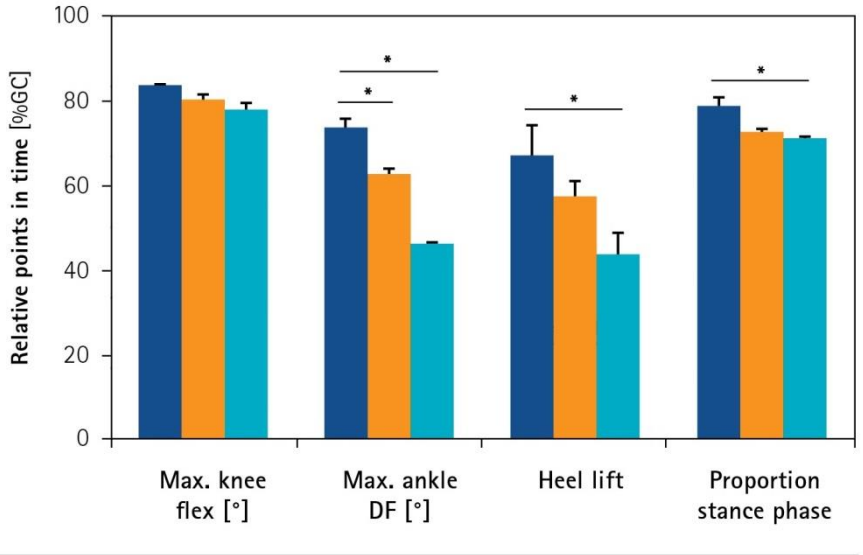
Angle [°]:

- maximum knee flexion =
- ROM knee ↓
- maximum ankle dorsiflexion ↓
- ROM ankle ↓

Relative points in time [% GC]:

- maximum knee flexion =
- maximum ankle dorsiflexion ↓
- heel lift ↓
- proportion stance phase ↓

Statistics



	Max. knee flex [°]	Max. ankle DF [°]	Heel lift	Proportion stance phase
w/o KAFO	84,0 (± 0,0)	73,5 (± 2,1)	67,5 (± 6,4)	78,8 (± 2,0)
KAFO_30	80,0 (± 1,4)	63,0 (± 1,4)	57,5 (± 3,5)	72,3 (± 0,9)
KAFO_05	78,0 (± 1,4)	46,5 (± 0,7)	44,5 (± 4,9)	70,9 (± 0,2)
physiological	73,5 (± 1,3)	50,1 (± 1,7)	46,9 (± 2,8)	65,4 (± 1,8)

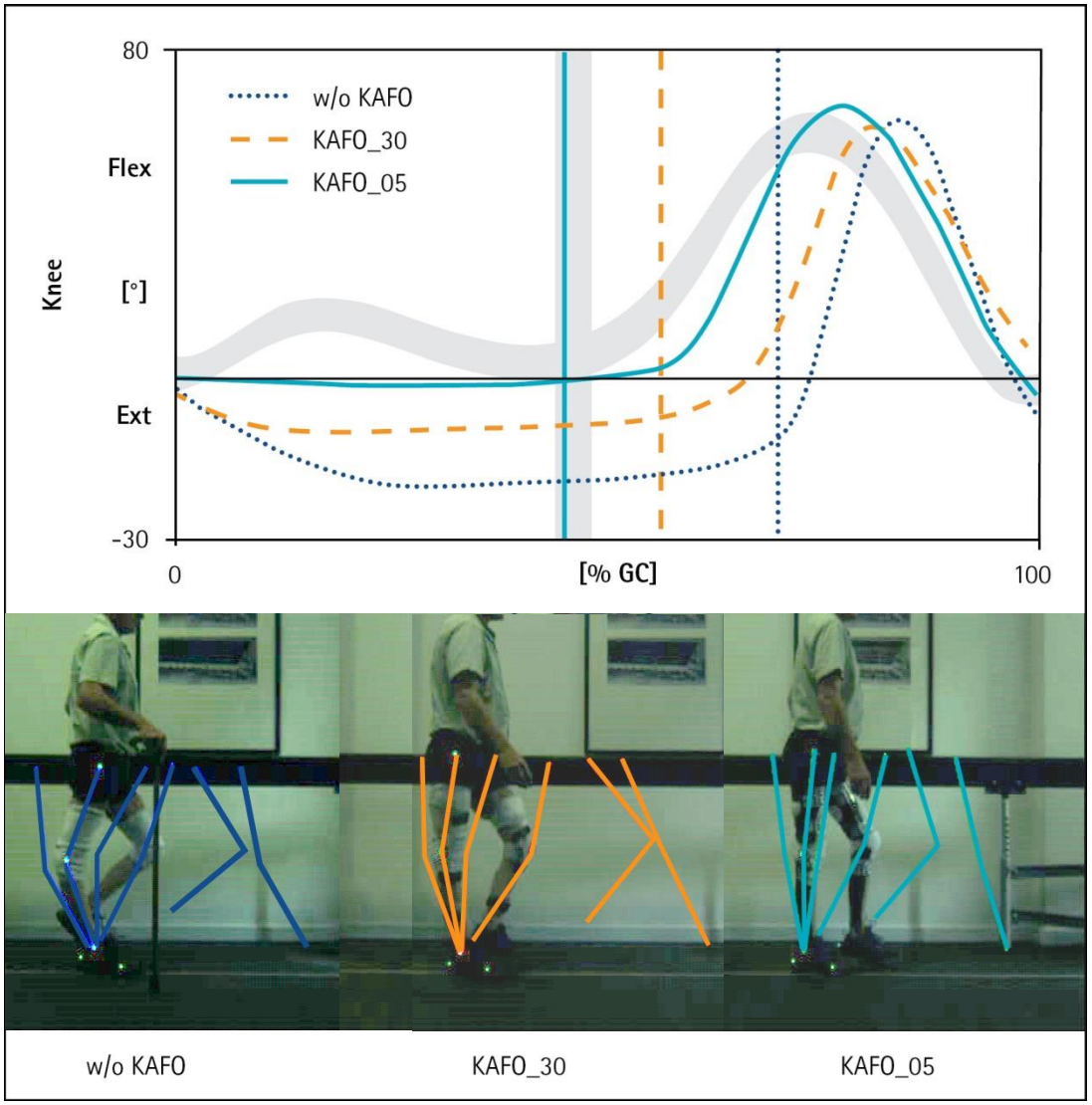
Angle [°]:

- maximum knee flexion =
- ROM knee ↓
- maximum ankle dorsiflexion ↓
- ROM ankle ↓

Relative points in time [% GC]:

- maximum knee flexion =
- maximum ankle dorsiflexion ↓
- heel lift ↓
- proportion stance phase ↓

Effects on the Knee



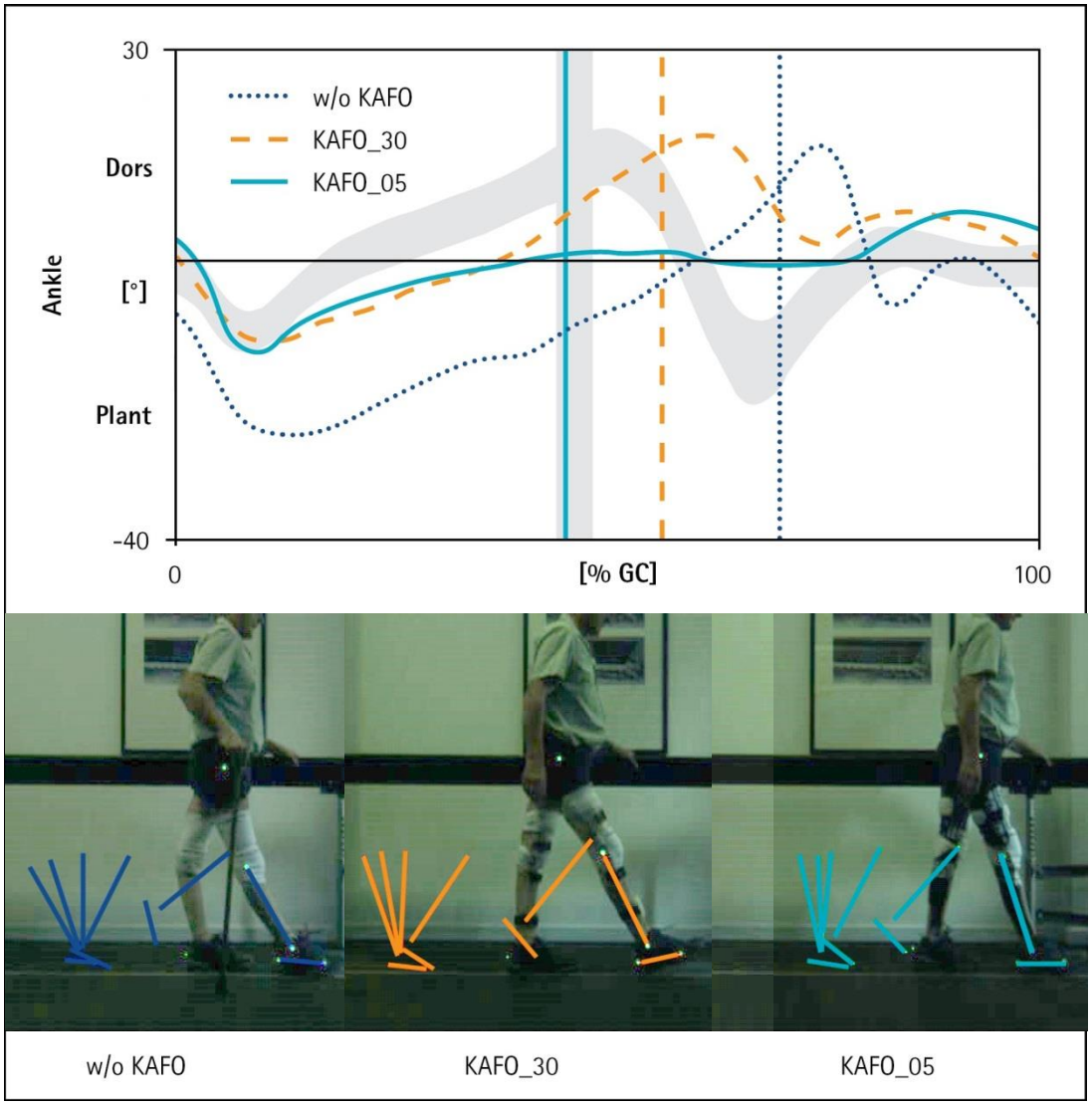
Weak plantar flexors:

- inactive forefoot lever
- often excessive knee flexion
- hyperextension is a possible compensation [Mul]
- maximum knee flexion
- greater ROM

Dorsiflexion stop in (K)AFOs:

- activates the forefoot lever
- usually causes extension of the knee [Beekman]
- hyperextension is reduced: extension stop
- stance phase control

Effects on the Ankle



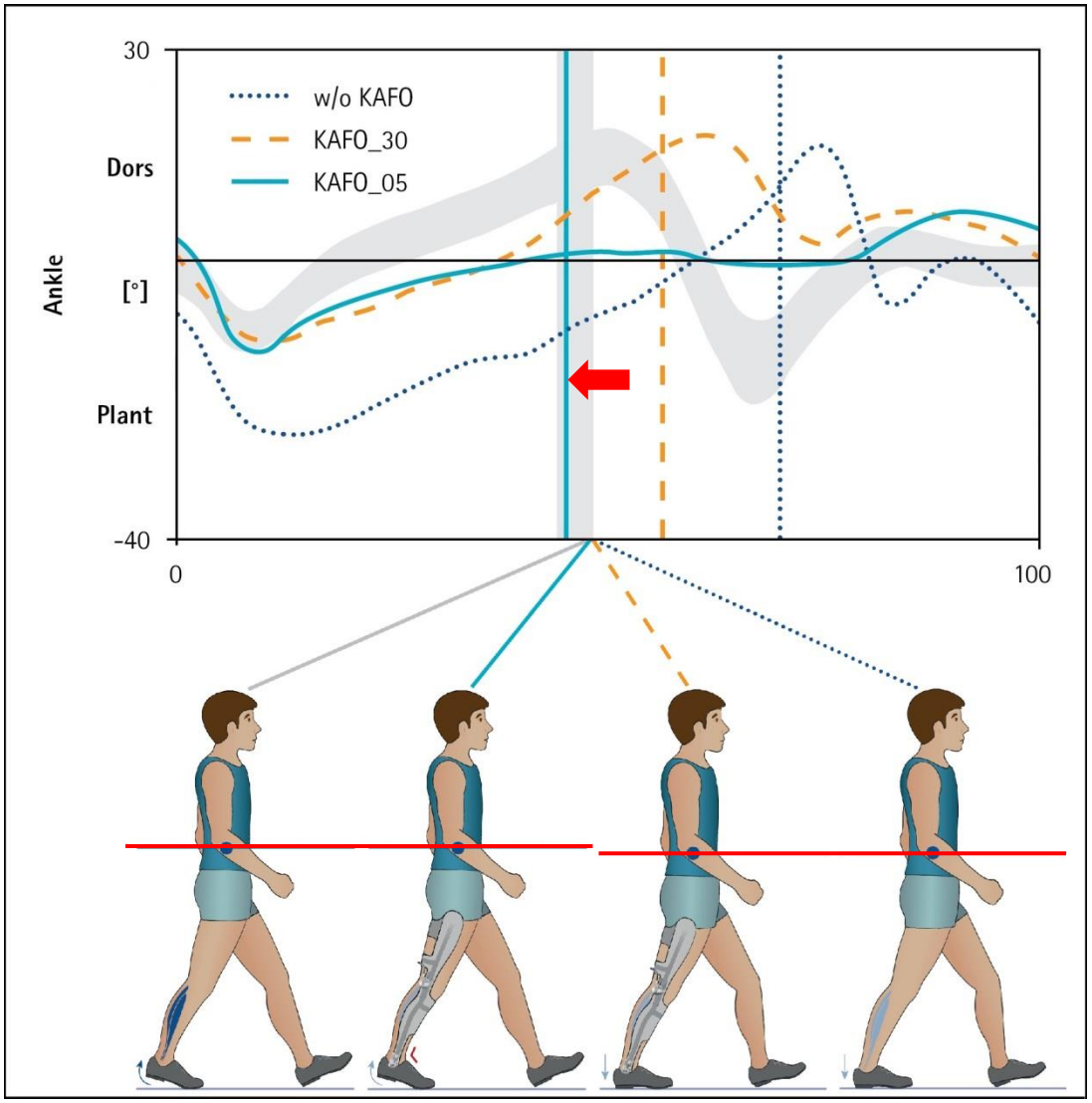
Weak plantar flexors:

- inactive forefoot lever
- excessive dorsiflexion in TSt [Plo]
- point in time of maximum dorsiflexion delayed
- excessive plantar flexion in stance phase
- greater ROM

Dorsiflexion stop in (K)AFOs:

- activates the forefoot lever
- takes over function of the PF
- limitation of the max. DF
- improved point in time of maximum dorsiflexion
- limitation of ROM

Point in Time of Heel Lift



Contralateral IC:

- at the end of TSt
- 50% of gait cycle
- ipsilateral heel remains on the floor (inactive forefoot lever)
- ipsilateral heel lifts from the ground (active forefoot lever)

Heel lift:

- through limited max. DF
- with incorrectly adjusted DS: 58%GC = PSw
- with missing DS: 68%GC = ISw
- Shortening of stance phase
- Symmetry of gait

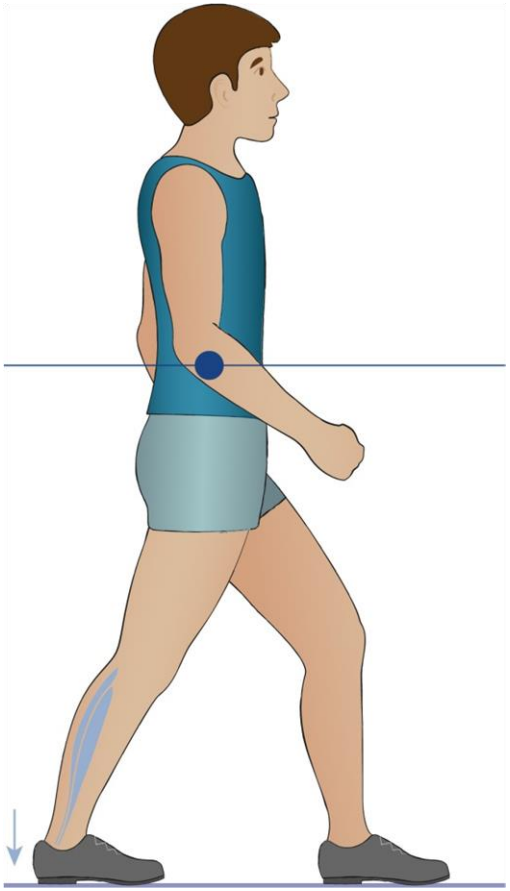
Body's centre of gravity:

- lower at inactive forefoot lever than at an active one
- higher energy consumption [Plo]

Conclusion

Advantages of an orthosis with dorsiflexion stop

- activation of forefoot lever
- physiological heel lift
- symmetric gait
- angle movements depend on pathological gait
- kinetic
- energy consumption



Thank you for your attention!