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# The Observance of Biomechanical Effects on the Estimation of Common Ankle Foot Orthoses in Cerebral Palsy

Speaker: Daniel Sabbagh

# Overview

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1. Goal of Treatment

2. The Physiological Gait

3. Criteria for an Orthotic Fitting

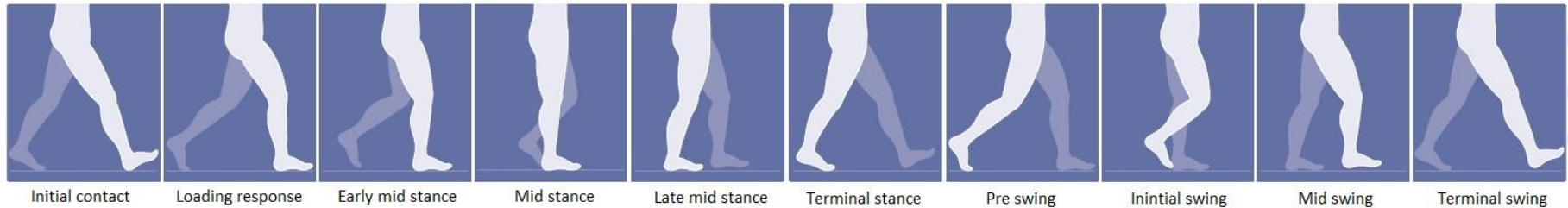
4. Orthosis Types – Nomenclature and Biomechanics

5. Requirements for the Orthotic Fittings

6. Conclusion and Prospects

# 1. Goal of Treatment

## Restoring the Physiological Gait

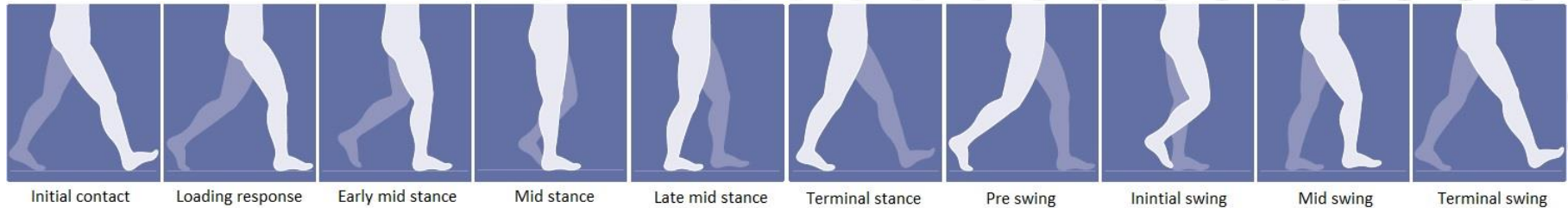


### Effects of the Orthotic Fittings:

- Maintaining the foot in neutral or dorsiflexed position
- Preparing for initial contact
- Stability during stance phase
- Push off [Des]
- Reducing the energy consumption during walking [Bre]

# 1. Goal of Treatment

## Measurement of Physiological Gait



## Temporal and Spatial Parameters during Walking [Mor]:

STEP/STRIDE LENGTH

CADENCE [step/minute]

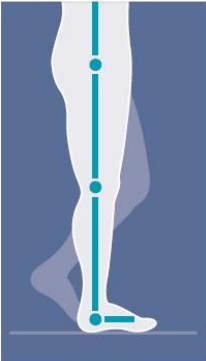




VELOCITY:  $\text{CADENCE} * \text{STEP LENGTH}$  [distance/time]

SINGLE SUPPORT (duration of the unilateral support)

DOUBLE SUPPORT (duration of the bilateral support)

# 1. Goal of Treatment

## The Pathological Gait

TYPES OF GAIT ACCORDING TO THE AMSTERDAM GAIT CLASSIFICATION					
TYPES OF GAIT	Type 1	Type 2	Type 3	Type 4	Type 5
					
KNEE	normal	hyperextended	hyperextended	flexed	flexed
FOOT CONTACT	complete	complete	incomplete	incomplete	complete

Established at VUmc in Amsterdam [Bec]

Evaluation of foot and knee position in mid stance

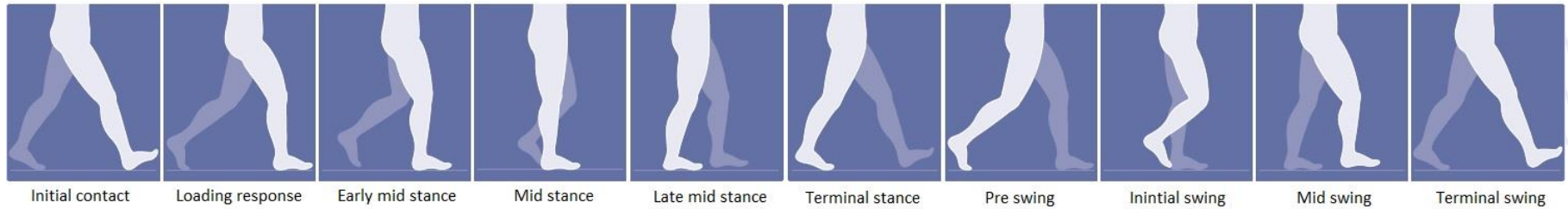
Progression to higher gait types possible

Improving the interdisciplinary work on CP patients

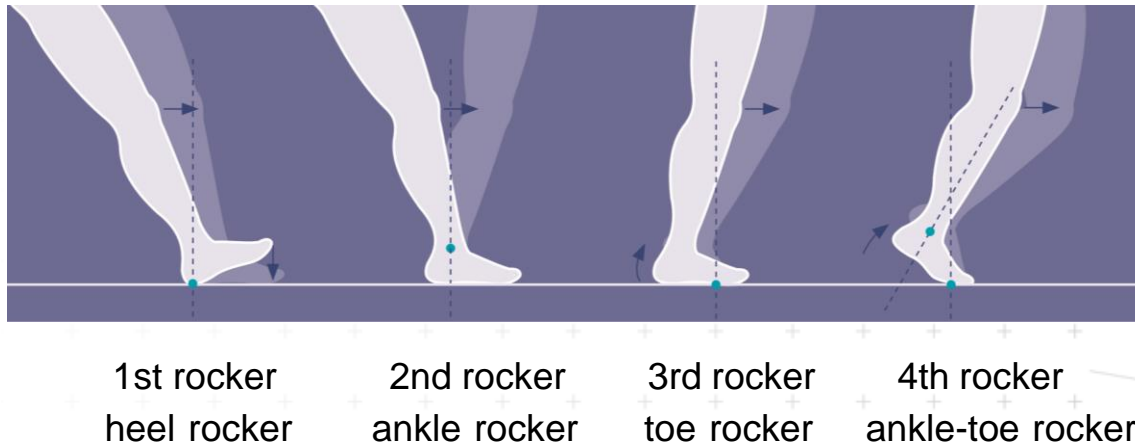
Assessing of gait patterns is easy

## 2. The Physiological Gait

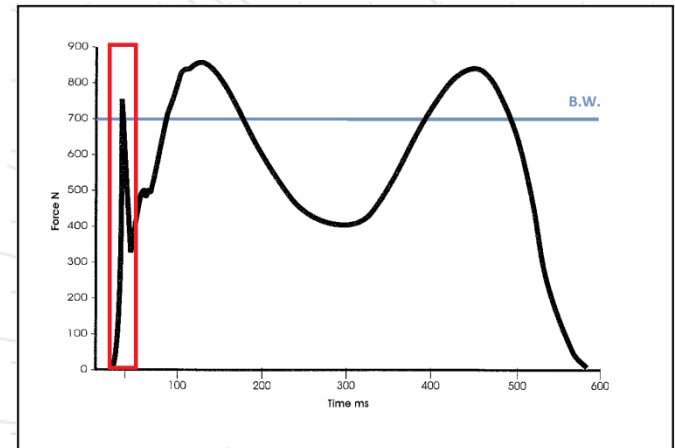
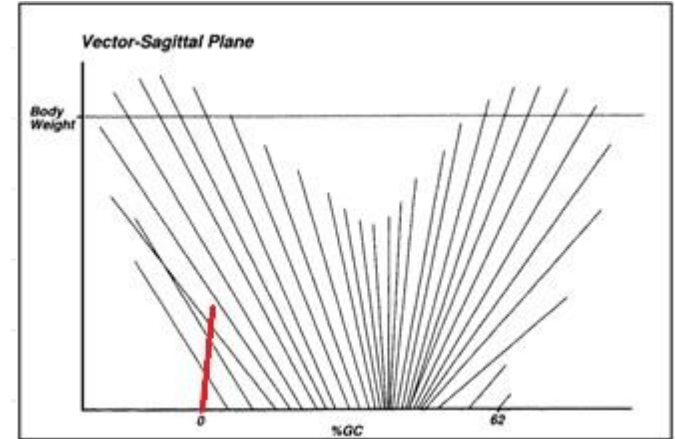
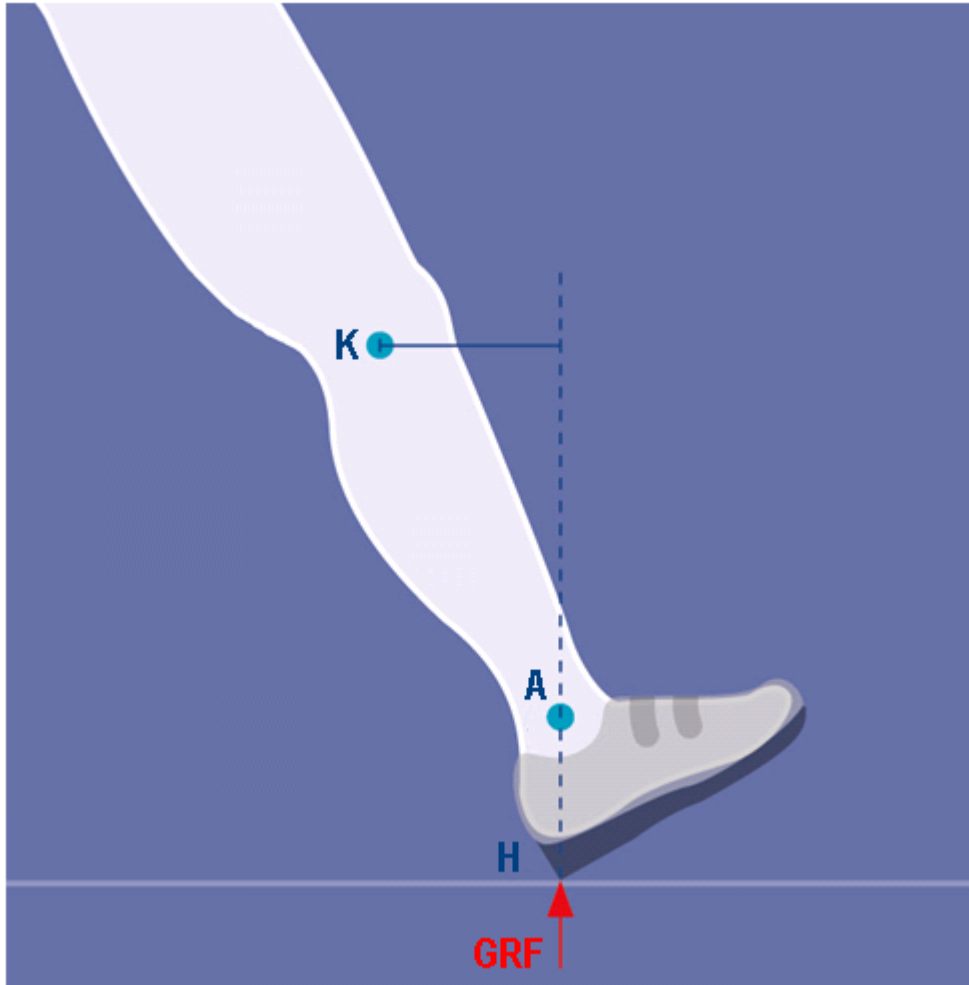
### Dividing into Gait Phases [Per, Goe]



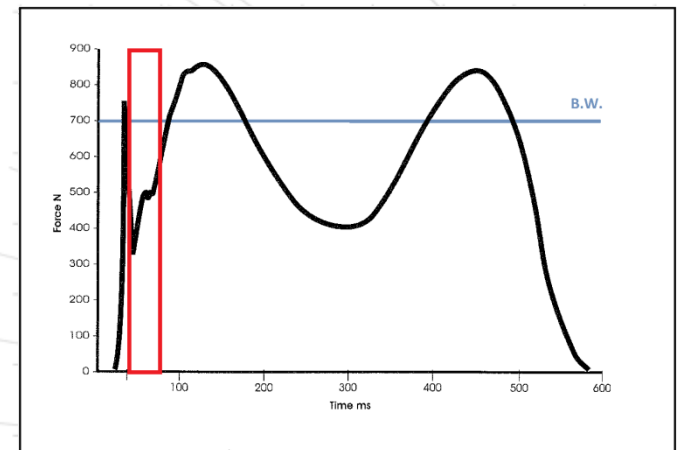
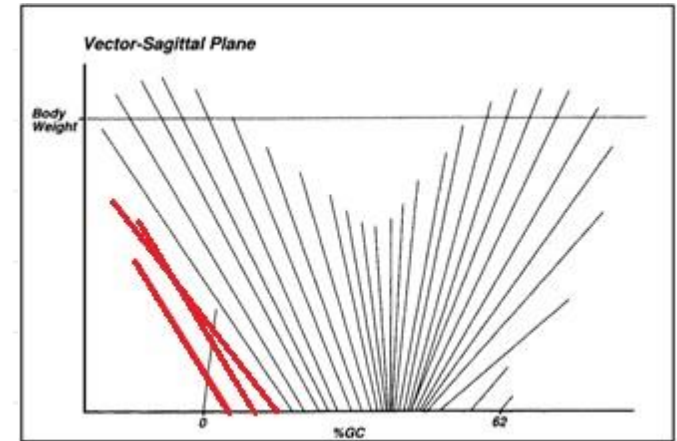
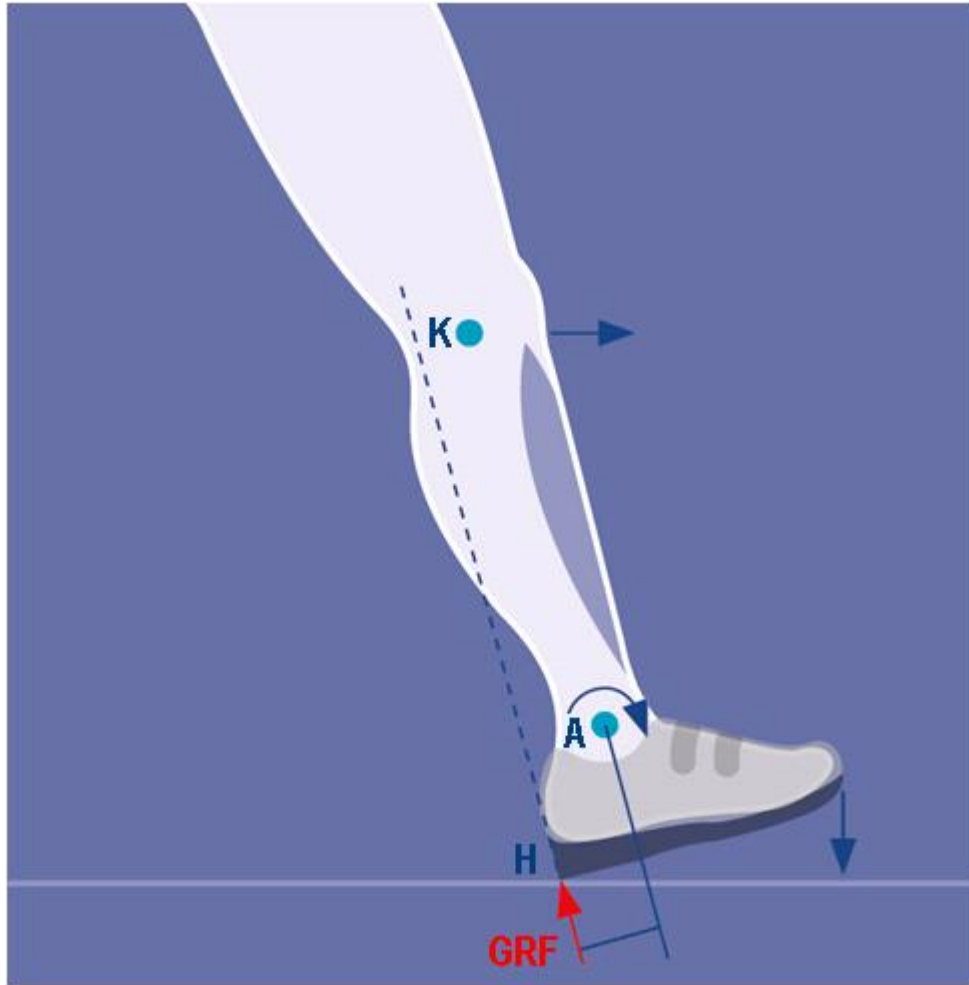
### Dividing into Rotations around Fixed Points (Rocker) [Owe]



## 2. The Physiological Gait

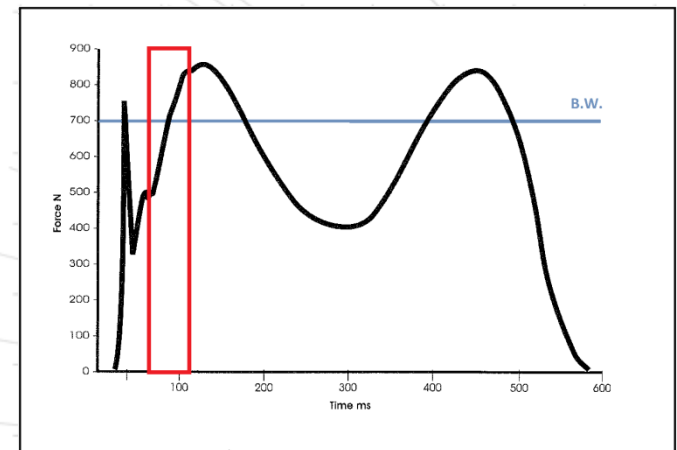
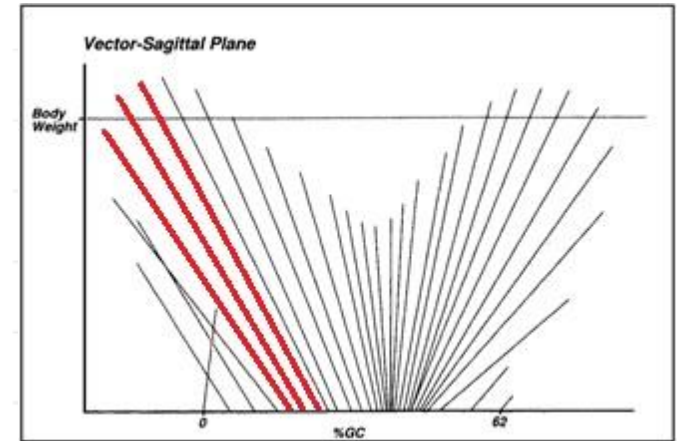
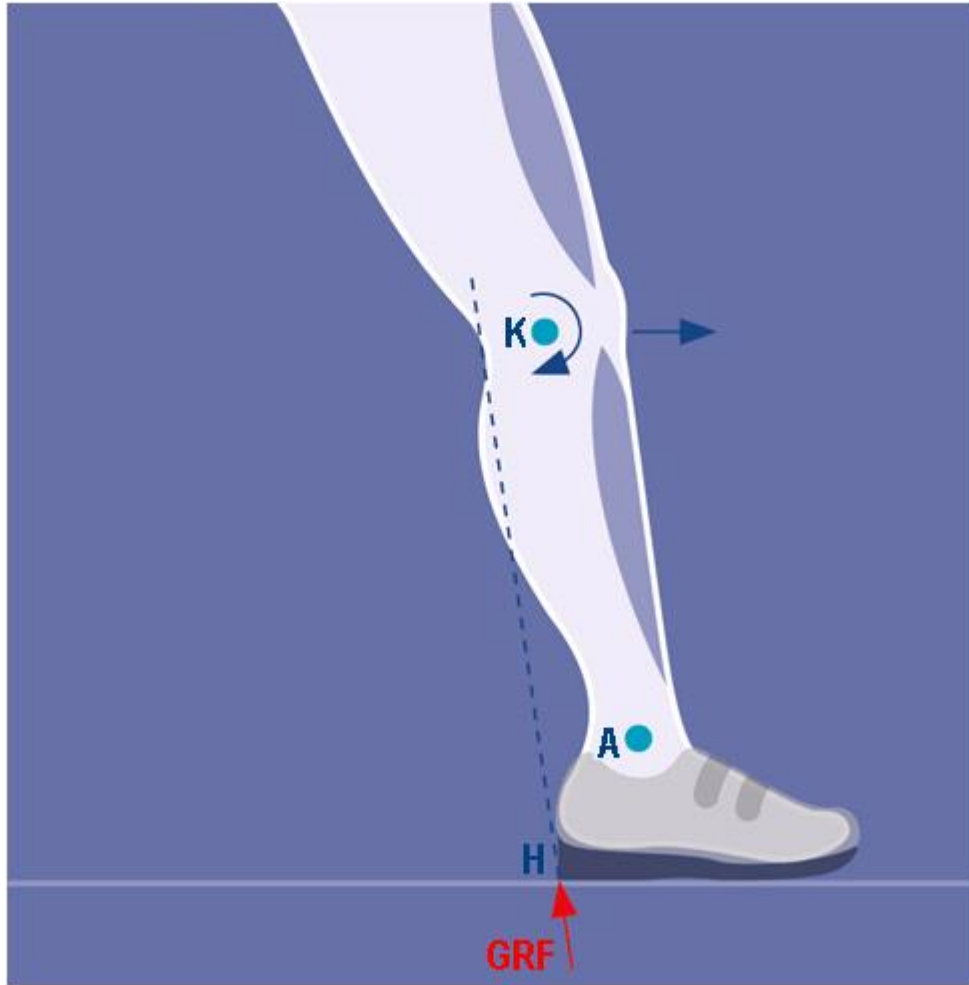


## 2. The Physiological Gait





## 2. The Physiological Gait



### 3. Criteria for an Orthotic Fitting

#### Plantar Flexion

- > 1<sup>st</sup> rocker [Nol]
- > heel lever
- > neuroplasticity [Hor]

#### Alignment of the Orthosis

- > mid stance
- > tuning [Owe]
- > adjusting to the path. gait

#### Range of Motion

- > using the remaining mobility
- > adjusting to the path. gait
- > therapeutic requirements

#### Spring Force

- > 3<sup>rd</sup> rocker/4<sup>th</sup> rocker
- > adjusting to the path. gait
- > push off [Des]

#### Defined Pivot Point

- > 1<sup>st</sup> rocker/2<sup>nd</sup> rocker
- > qualified physiotherapy [Hor]
- > avoiding muscular atrophies

## 4. Orthosis Types – Nomenclature



### Dividing:

1. according to names/definitions?  
brands or general names (DAFO, SAFO, FRAFO, HAFO, SMO)
2. according to mechanical features?  
material thickness (mm), stiffness ( $\text{Nm}/^\circ$ ), spring constant ( $D$ ), restoring force ( $-D*s$ ), energy storage
3. according to operating principles?  
dynamic - static [Nov]

## 4. Orthosis Types - Biomechanical Features



Using internal and external forces

Enabling and locking certain movements

Sagittal: Motion in 2 joints encased in the AFO

- upper ankle joint
- metatarsophalangeal articulations

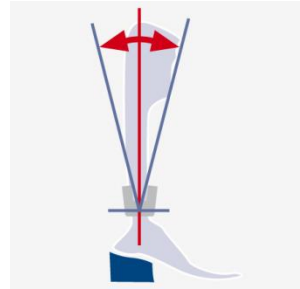
**X** Motion locked in the joint  
**●** Motion freed in the joint

Not only advantages but also disadvantages [Rom]

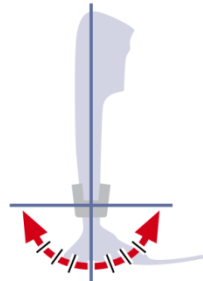
*„One orthosis may not be optimal to address all of the goals.“ [Nov1, S.330]*

# 5. Requirements for the Orthotic Fittings

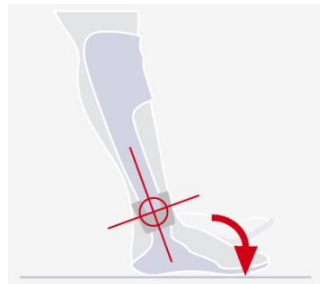
## Adjustable Alignment



## Adjustable Range of Motion



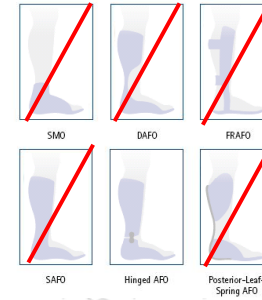
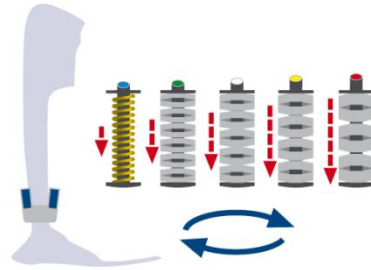
## Plantar Flexion Possible



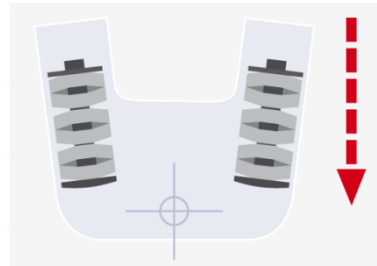
\* limited movement depending on construction

# 5. Requirements for the Orthotic Fittings

Variable Spring Force



High Spring Force



Defined Pivot Point



\*\* limited or locked movement

## 6. Conclusion and Prospects



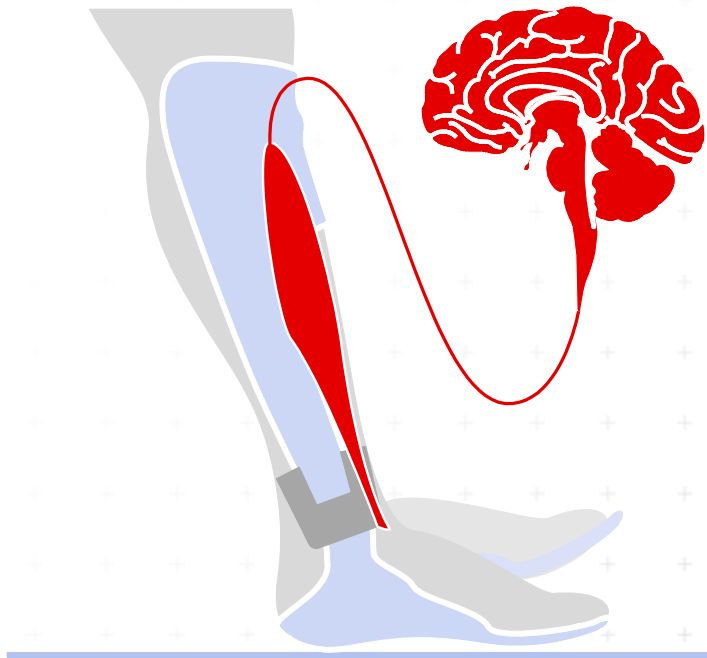
*„One orthosis may not be optimal to address all of the goals.“ [Nov1, S.330]*

### Requirements for an Orthotic Fitting:

1. spring force,
2. alignment of the orthosis and
3. range of motion.

All adjustments have to be changeable separately and must not influence each other.

## 6. Conclusion and Prospects



### Prospects:

Great need of research

Are dynamic AFOs able to trigger neuroplasticity in CP patients?

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## 6. Literature:

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**Many**



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