# Long-Term Effects of a Dynamic Ankle Foot Orthosis on a Patient with Cerebral Palsy Following Ischaemic Perinatal Stroke – a Case Study

Daniel Sabbagh[1], Jörg Fior[1], Ralf Gentz[1]
[1]FIOR & GENTZ Gesellschaft für Entwicklung und Vertrieb von orthopädietechnischen Systemen mbH, Lüneburg, Germany

## Background and Aim

Ischaemic perinatal stroke (IPS) is a common cause of cerebral palsy (CP) in new-born infants. Those children develop neurological deficits which lead to gait disorders. Ankle foot orthoses (AFOs) are an important factor in immediate and continual gait improvement for children with CP. For structuring the orthotic treatment, the pathological gait of CP patients can easily be assessed by using the Amsterdam Gait Classification (fig. 1) [1]. According to this classification, the characteristics of an AFO can be defined individually for each gait type [2]. A well-structured orthotic treatment can assist physiotherapeutic approaches and create new cerebral connections by using the right motor impulses [3].

**Research question:** Are there long-term changes in kinematic and spatio-temporal gait parameters by wearing dynamic AFOs?

## Materials and Methods

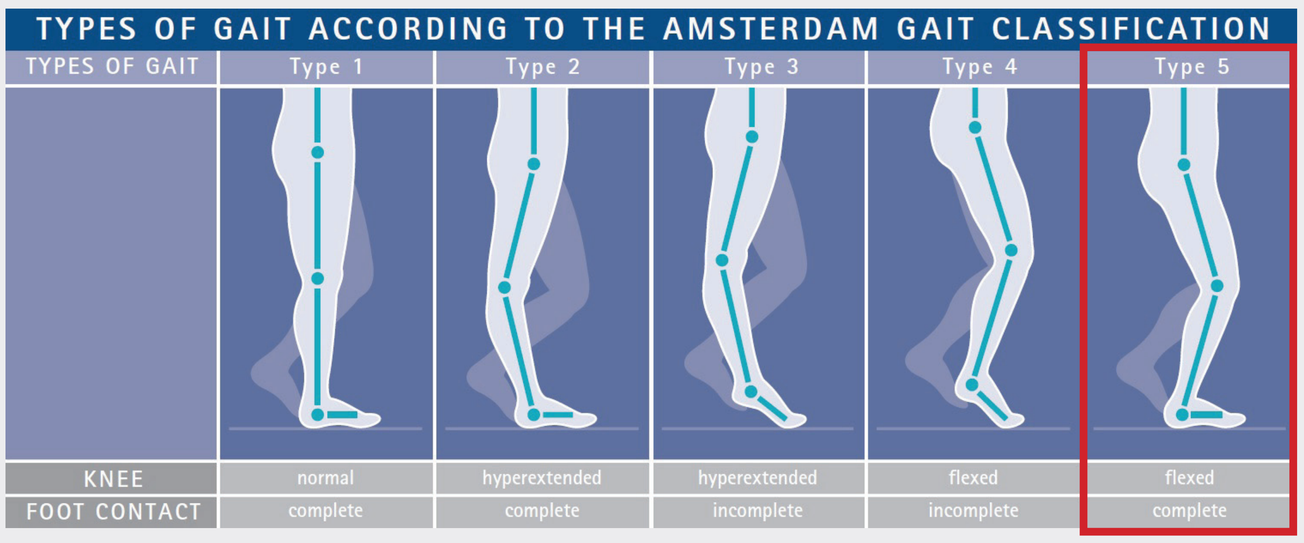



Fig. 1: Amsterdam Gait Classification – pathological gait of CP patients is classified in 5 gait types which can be easily assessed by evaluating knee position and foot contact in mid stance. Our case study patient is gait type 5 (flexed knee and complete foot contact). This gait type is named 'crouch gait' as well.

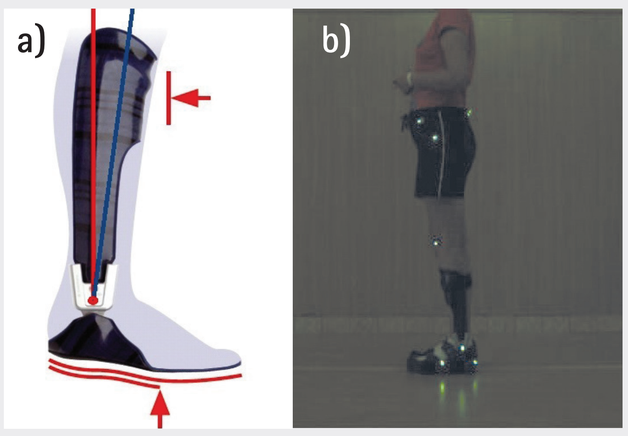



Fig. 2: a) dynamic AFO, b) patient with fitted dynamic AFO

A 15-year-old female patient with CP following ischaemic perinatal stroke (hemiparesis of left body-side) classified as gait type 5 of the Amsterdam Gait Classification (fig. 1) is treated with a dynamic AFO (carbon-composite, adjustable range of motion, defined pivot point; fig. 2a). The AFO is adjusted to the patient's individual normal posture (fig. 2b) [4]. On the day of delivery (DD) and at the follow-up (FU) after 3 months, 2-dimensional gait analyses were performed - each with and without AFO. Thereby, measurements of hip, knee and ankle angle plus step/stride length, velocity, cadence, and time of stance and swing were taken.

## Results

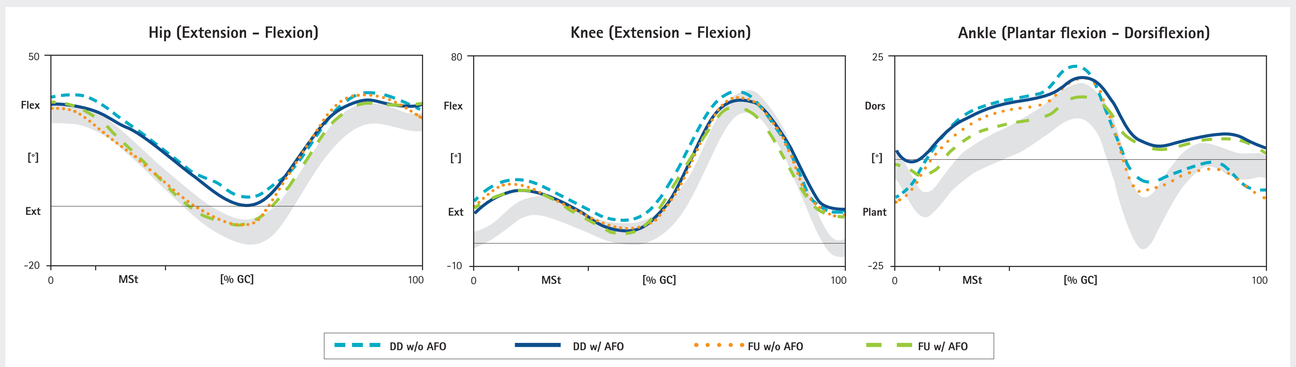
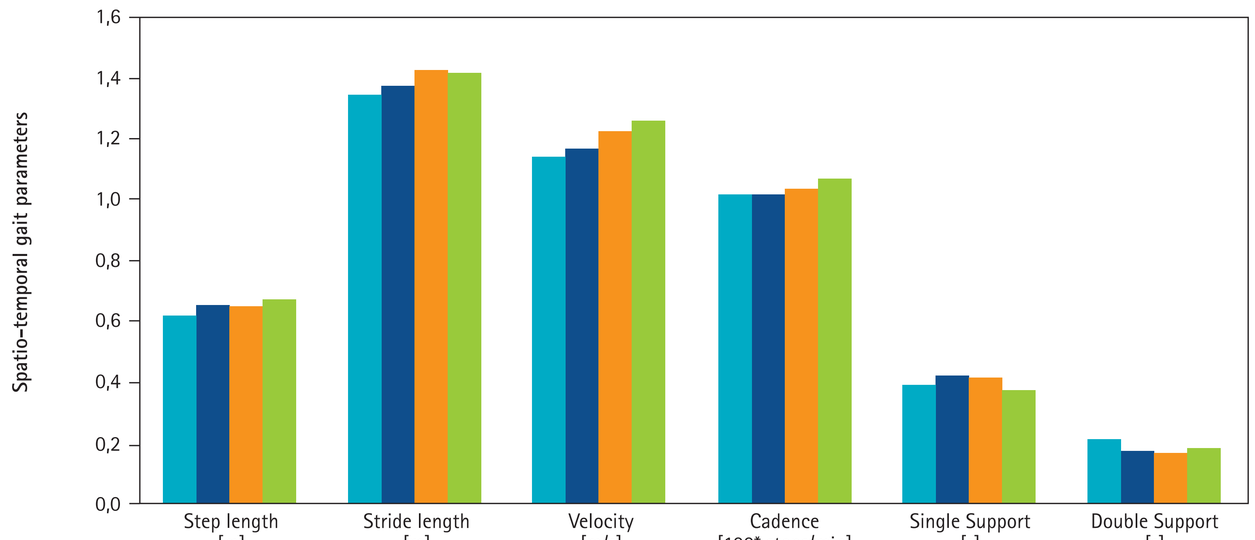



Fig. 4: joint kinematics of hip, knee and ankle on day of delivery without AFO (DD w/o AFO), with a dynamic AFO (DD w/ AFO), at follow-up without (FU w/o AFO) and with AFO (FU w/ AFO) compared to a reference group (gray band)




| | Step length [m] | Stride length [m] | Velocity [m/s] | Cadence [100* steps/min] | Single Support [s] | Double Support [s] |
|---|---|---|---|---|---|---|
| DD w/o AFO | 0.62 (± 0.01) | 1.35 (± 0.002) | 1.14 (± 0.002) | 1.02 (± 0.01) | 0.39 (± 0.01) | 0.21 (± 0.01) |
| DD w/ AFO | 0.65 (± 0.02) | 1.37 (± 0.03) | 1.16 (± 0.06) | 1.02 (± 0.04) | 0.42 (± 0.02) | 0.17 (± 0.02) |
| FU w/o AFO | 0.65 (± 0.03) | 1.42 (± 0.04) | 1.23 (± 0.05) | 1.03 (± 0.03) | 0.42 (± 0.03) | 0.17 (± 0.02) |
| FU w/ AFO | 0.67 (± 0.05) | 1.41 (± 0.03) | 1.26 (± 0.02) | 1.07 (± 0.03) | 0.37 (± 0.02) | 0.18 (± 0.02) |

Fig. 5: The bar graphs show differences between conditions on DD w/o AFO, on DD w/ AFO at FU w/o AFO and at FU w/ AFO for spatio-temporal gait parameters. The table shows mean values and standard deviation.

Measurements on DD showed increased step length (+5%), longer single-supported (+8%) and shorter double-supported phase (-19%) with AFO. Ankle plantar flexion diminished in swing until loading response by 7° and knee flexion in stance by 5°. FU showed increased stride length (+5%), velocity (+8%) and cadence (+2%) plus reduced hip (-10°) and knee flexion (-3°) in stance with and without AFO, compared to DD.

## Discussion and Conclusion

On DD the AFO improved kinematic and spatio-temporal gait parameters. Increasing ankle dorsiflexion in swing and initial contact, enabling passive plantar flexion at loading response and decreasing peak ankle dorsiflexion in mid stance were immediate effects of the dynamic AFO (tab. 1). During three months of wearing the AFO, the CP patient had come closer to a physiological gait which shows in a less flexed hip, knee and ankle during stance with and without AFO at FU – especially in mid stance. The dynamic properties of the AFO improved spatio-temporal gait parameters even without AFO. An adaptation process is stated by these long-term changes in gait but the presence of new cerebral connections after IPS must still be proved.

Tab. 1: Immediate effects of the dynamic AFO at DD and FU. Long-term effects are shown in the differences between results of DD w/o AFO and FU w/o AFO. Immediate effects are improvements of ankle dorsiflexion in swing and peak ankle dorsiflexion. Long-term effects can be seen in most kinematic and spatio-temporal gait parameters.

| | Day of delivery (DD) | Follow-up (FU) | |
|---|---|---|---|
| | immediate effects | immediate effects | long-term effects |
| **Kinematics** | | | |
| Hip extension | slight increase | - | increase |
| Knee extension | slight increase | - | slight increase |
| Ankle dorsiflexion (ISw - LR) | increase | increase | slight increase |
| Ankle dorsiflexion (MSt - PSw) | - | slight decrease | decrease |
| Peak ankle dorsiflexion | decrease | decrease | decrease |
| **Spatio-temporal** | | | |
| Step length [m] | slight increase | slight increase | increase |
| Stride length [m] | slight increase | - | increase |
| Velocity [m/s] | slight increase | slight increase | increase |
| Cadence [steps/min] | - | increase | increase |
| Single Support [s] | slight increase | decrease | slight increase |
| Double Support [s] | slight decrease | - | slight increase |

Keywords: orthotics, cerebral palsy, ischaemic perinatal stroke, gait analysis, dynamic AFO, long-term effects

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## Literature

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FIOR & GENTZ
ORTHOPÄDIETECHNIK MIT SYSTEM