Classification of Gait Pattern in Stroke Patients to Optimise Orthotic Treatment and Interdisciplinary Communication

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Introduction

The N.A.P. Gait Classification assigns patients to gait types (GTs) with either hyperextended or hyperflexed knee [1], viewed laterally during mid stance. For both GTs, the requirements to be met by an orthosis (AFO) are different [2].

The following examination deals with the influence of a dynamic, adjustable AFO on the joint kinematics of both GTs.

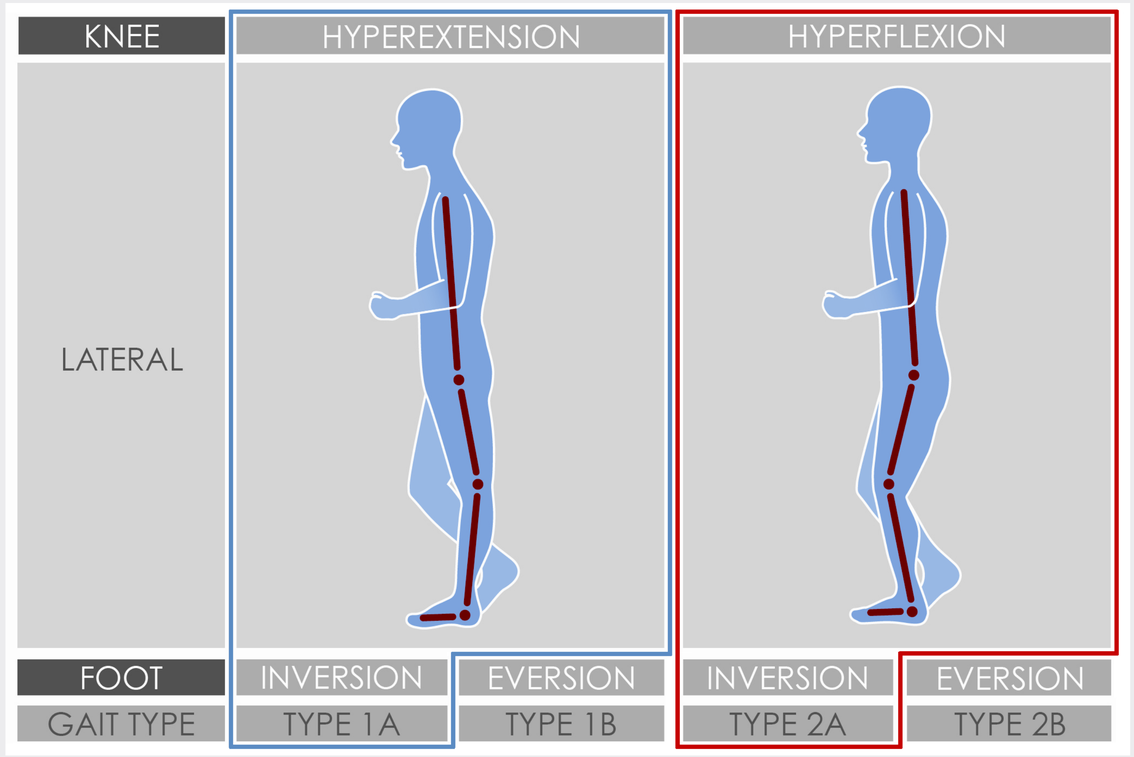

Fig. 1: Stroke patients assigned to 4 gait types due to their knee and foot position during mid stance and according to the N.A.P. Gait Classification.

Patients/Materials and Methods

- n = 8 patients, with 5 patients GT 1a and 3 patients GT 2a
- standardised footwear without rocker soles
- AFOs: high ventral shell, long partially flexible foot piece, adjustable ankle joint with very strong ventral spring and a very strong (GT 1a) or medium (GT 2a) dorsal spring. See figure 2.
- 3 cycles of the paretic body side, each w/o and w AFO
- sagittal plane kinematics of the hip (HA), knee (KA), ankle (AA), tibia inclination (TI) and at heel contact (HC)
- kinematic mean values and standard deviation in mid stance (12-31% GC), Wilcoxon rank-sum test

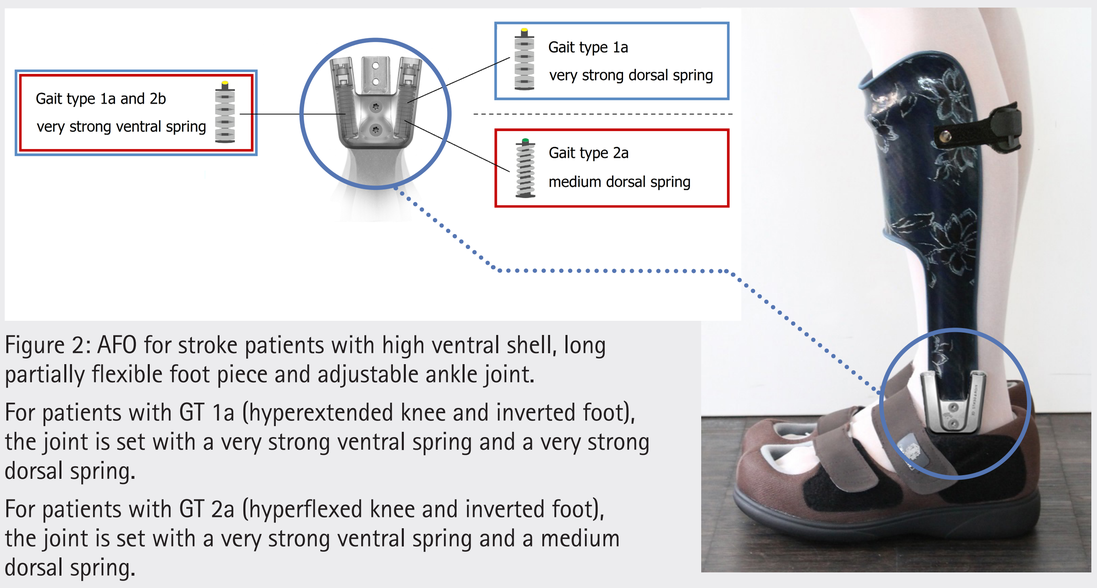

Figure 2: AFO for stroke patients with high ventral shell, long partially flexible foot piece and adjustable ankle joint.

For patients with GT 1a (hyperextended knee and inverted foot), the joint is set with a very strong ventral spring and a very strong dorsal spring.

For patients with GT 2a (hyperflexed knee and inverted foot), the joint is set with a very strong ventral spring and a medium dorsal spring.

Results

Patients with GT 1a show a significantly higher HA (p=0.041) and KA (p=0.039) when walking with an AFO. In mid stance, the KA of GT 2a is highly significantly lower (p=0.002) when walking with an AFO than walking without an AFO (Tab. 1).

Table 1: Mean and standard deviation for both gait types w/o and w AFO. For * p=0.05 and for ** p=0.01.

	Gait type 1a (n=5)		Gait type 2a (n=3)	
	w/o AFO	w AFO	w/o AFO	w AFO
Hip angle (HA)	5.05 (± 3.49)	10.28 (± 3.97)	20.22 (± 9.82)	19.43 (± 8.47)
Knee angle (KA)	3.86 (± 5.97) *	11.49 (± 5.10)	27.90 (± 4.93)	24.57 (± 4.76)
Ankle angle (AA)	-6.23 (± 5.13) *	-2.26 (± 4.27)	7.75 (± 2.79) **	5.49 (± 3.92)
Tibia inclination (TI)	-0.92 (± 3.88)	0.73 (± 5.30)	10.63 (± 3.68)	9.56 (± 5.18)
Heel contact (HC)	3.42 (± 3.16)	3.47 (± 2.37)	2.89 (± 1.13)	2.87 (± 1.02)

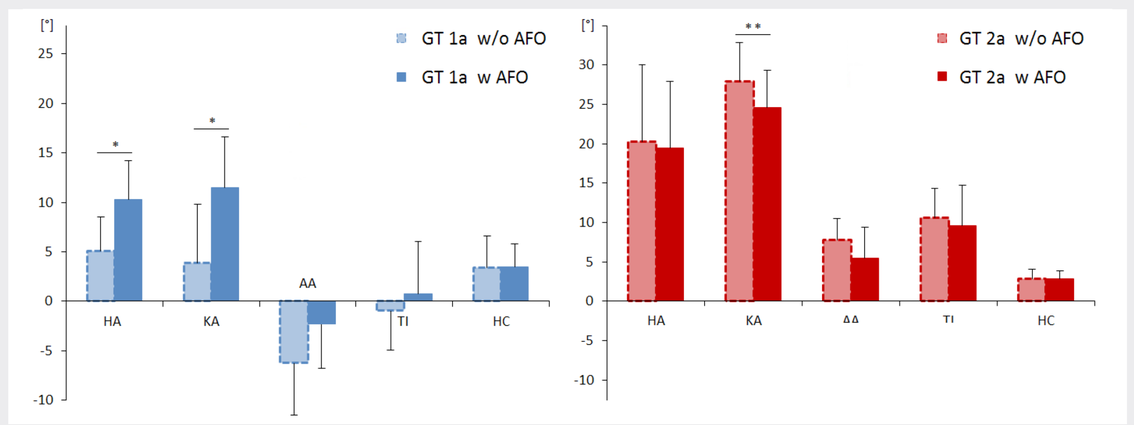

Figure 3: Comparation of mean values and standard deviation of the defined angles in GT 1a (blue) and GT 2a (red), each w/o and w AFO. For * p=0.05 and ** p=0.01.

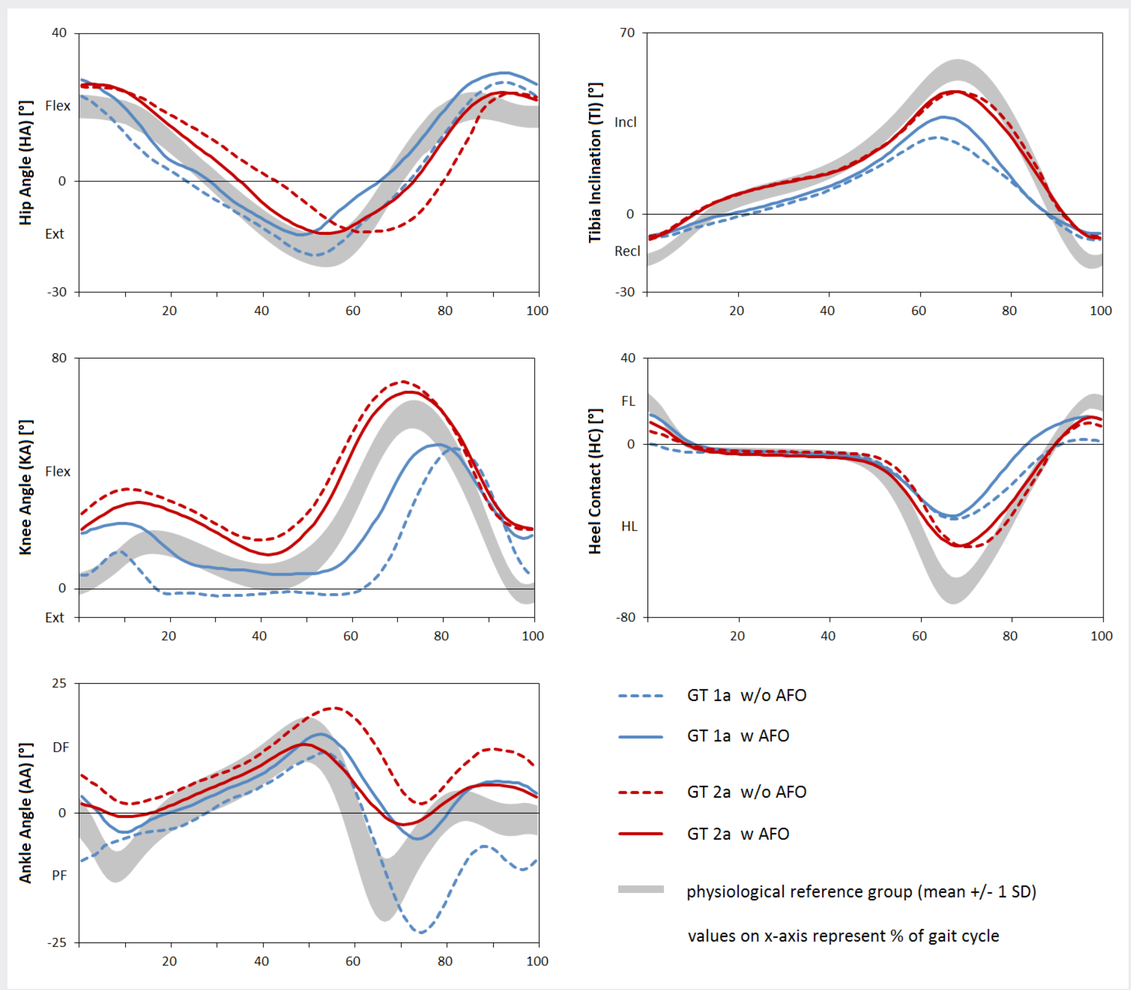

Figure 4: Sagittal plane kinematics [°] of the hip, knee, ankle, tibia and heel of GT 1a (blue lines) and GT 2a (red lines), each w/o (dashed lines) and w (solid lines) AFO. The grey band represents the physiological gait.

Conclusion

AFOs adjusted to the patient's individual gait lead to a significant increase of the KA in GT 1a and to a highly significant decrease in GT 2a in mid stance (Fig. 3). AA is improved for both GTs.

Thus, the variable resistance of the used springs is a decisive factor influencing sagittal plane kinematics [3]. The KA of both GTs brings the patient closer to a physiological gait (Fig.4).

The N.A.P. Gait Classification is the ideal method to identify gait types fast and unambiguously during the orthotic treatment of stroke patients.

With some more and better defined subjects, differences in the other kinematic data could also be proven.

Literature

[1] Perry J, Burnfield JM (2010) Thorofare: Slack.
[2] Condie E, Bowers RJ (2008) Philadelphia: Mosby.
[3] Kobayashi T, Leung AKL et al. (2013): Gait Posture 37(3).

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