

# JPO

JULY 2009  
VOLUME 21  
NUMBER 3

## Journal of Prosthetics and Orthotics



OFFICIAL  
JOURNAL OF  
*The American  
Academy of  
Orthotists and  
Prosthetists*

### Editor's Comments

*David A. Boone, CP, MPH, PhD*

### Evaluation of the Pressure Relief AFO in Individuals with Hemiparesis Using Three Dimensional Gait Analysis

*Robert S. Lin, CPO, FAAOP, Sylvia Ounpuu, MSc,  
Matthew J. Oppedisano, CO, Kurt Kamienski, CO*

### The Effects of the NF-Walking Orthosis on the Walking Ability of Children with Cerebral Palsy and Severe Gait Impairment

*Christoph Kuenzle, MD, Reinald Brunner, MD*

### Phantom Limb Development in Congenitally Upper Limb-Deficient Individuals

*Kristin A. Farry, PhD*

### Quality of Life in Patients with Prosthetic Legs—A Comparison Study

*Carolyn E. Horne, RN, MSN, BC, Janice A. Neil, RN, PhD*

### Children with Elbow Extension and Forearm Rotation Limitation: Functional Outcomes Using the Forearm Rotation Elbow Orthosis (FREO)


*Audrey Yasukawa, MOT, OTR, Marcus Cassar, CPO*

### Pectus Carinatum: To Brace or Not to Brace - A Picture Is Worth 1770 Words

*Deepika Nehra, MD, Sigmund H. Ein, MD,  
Mark Tlumacki, CO, Peter T. Masiakos, MD*

### 'GirGet Janbaz' Shoe: A New Specific Shoe for Patients with Upper Limb Impairments

*Yagoub Salekzamani, MD, Assistant Professor,  
Roya Eivazi, BS, Mohsen Eivazi, BS, Nariman Nezami, MD*

 Wolters Kluwer Health | Lippincott Williams & Wilkins

# The Effects of the Norsk Funktion-Walking Orthosis on the Walking Ability of Children With Cerebral Palsy and Severe Gait Impairment

Christoph Kuenzle, MD, Reinald Brunner, MD

## ABSTRACT

The purpose of this study was 1) to test whether an orthosis, which provides postural stability of the trunk and guides the leg movements during walking (Norsk Funktion-walker orthosis [NFWO]), would enable nonambulant children with cerebral palsy with poor or no leg coordination and with little or no trunk control to walk on their own, 2) to investigate if there is an increase in motor function and activity while using a NFWO, and 3) defining requirements for a successful provision. Ninety-three children (39 girls, 54 boys; mean age 7.6 years; 67 with bilateral spastic, 10 with dyskinetic, 10 with mixed, 6 with ataxic cerebral palsy; Gross Motor Function classification System level 4: 45, level 5: 48) were provided with a NFWO. The following assessments were carried out immediately before and 3 months after using the NFWO: WeeFIM walking score; independence rating by parents or caregivers; aims or expectations of parents or caregivers; at a mean interval of 265 days after provision: mean daily walking distance (meters). With the NFWO, 78 children (84%) became ambulatory, 10 children (11%) used it exclusively as a dynamic standing frame only, and 5 children (5%) returned the NFWO. The mean daily walking distance was 99 m (2–463 m). The mean WeeFIM walking score of 1.99 (SD 0.83) without the NFWO increased to 4.42 (SD 1.00) with the NFWO indoors and to 3.71 (SD 1.24) ( $p < 0.001$ ) outdoors. Independence rating by parents or caregivers reflected a highly significant increase in independent mobility with the NFWO compared with locomotion without ambulatory aides ( $p < 0.001$ ) and of bilateral hand function ( $p < 0.001$ ). No significant increase in the mobility was found when comparing former mobility aides (wheelchair, tricycle) with the NFWO. The ability to cross obstacles did neither significantly increase with the NFWO. Successful indication for a NFWO depends on 1) the child's motivation to walk and the support of the environment to achieve independent walking mobility through the use of this assistive tool, 2) the ability for selective reciprocal leg movements, and 3) no flexion contractures of hips and knees above  $20^\circ$  and a foot dorsiflexion of at least neutral- $0^\circ$ . The NFWO proved to be a useful ambulatory aid in the children with cerebral palsy with severe gait impairment to increase independent mobility. (*J Prosthet Orthot.* 2009; 21:138–144.)

**KEY INDEXING TERMS:** orthosis, walking orthotics, gait impairment

**I**ndependent walking is difficult for a large number of children with cerebral palsy due to impaired postural control, abnormal muscle tone, and pathological muscular coordination of the legs.<sup>1,2</sup> Until recently, there has been a lack of a walking orthosis, which would enable severely impaired children with poor postural control of head and trunk to walk. The ORLAU Locomotor Guidance Sys-

tem was developed as a rear support walking frame, to provide ambulation for patients with total body involved cerebral palsy.<sup>3</sup>

The Norsk Funktion-walker orthosis (NFWO; initially called the David Hart walker orthosis; Fig. 1A, B) is an individually adjustable device, which assists children with severe gait impairment to attain independent mobility. It combines an adaptable body weight support with a high amount of postural control. Its two main components are a modular hip-knee-ankle-foot orthosis with trunk support and a wheeled carrier. The brace is secured height-appropriately with a posterior support attachment. The carrier's support mechanism offers the child a regulated and individualized amount of weight-bearing support and gait guidance during walking. The steering is designed, so that the carrier's front wheels turn in the child's intended direction of travel when the child turns the body. Hence, children with severe motor disability may walk independently without needing to use their hands for support. It provides maximal independence and improves the quality of life by enabling the child to participate in activities, including being able to play with peers. Regular walking training improves general fitness, bone density, muscle strength, and control of trunk and lower limbs, ameliorates

CHRISTOPH KUENZLE, MD, is affiliated with the Department of Rehabilitation and Development, East Swiss Children's Hospital, Saint Gallen, Switzerland.

REINALD BRUNNER, MD, is affiliated with the Department of Neuroorthopaedics, Children's University Hospital, Basel, Switzerland.

Disclosure: The authors declare no conflict of interest.

This study was supported by eo-Funktion, Switzerland, in planning and carrying it out and by Eling D. de Bruin, PhD, Institute of Human Movement Sciences, Swiss Federal Institute of Technology, Zurich.

Copyright © 2009 American Academy of Orthotists and Prosthetists.

Correspondence to: Christoph Kuenzle, MD, Department of Rehabilitation and Development, East Swiss Children's Hospital, Claudiusstr. 6, CH-9006 Saint Gallen, Switzerland; e-mail: christoph.kuenzle@kispig.ch

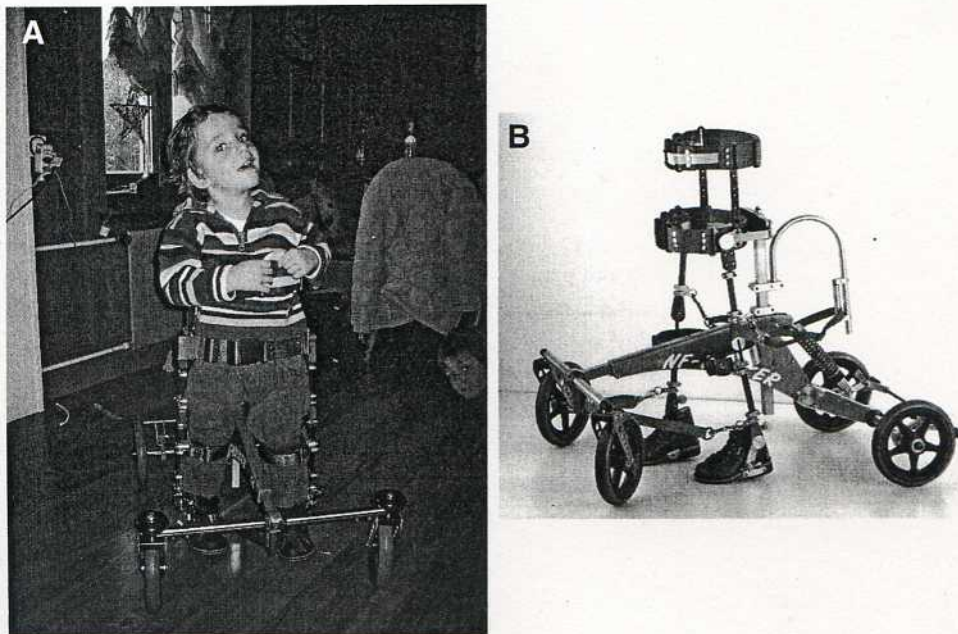


Figure 1. The Norsk Funktion-walker orthosis.

muscle balance by reducing spasticity, and promotes coordination of leg and trunk movements as demonstrated in patients after stroke<sup>4</sup> and under treadmill walking.<sup>5,6</sup>

A study of four children with cerebral palsy using a NFWO for 12 months were investigated sequentially through gait analysis (eight times) during this period.<sup>7</sup> All children improved regarding their kinematic data, especially with decreasing knee flexion angle toward normal gait. The electromyography data changed little, which may indicate that improvements occurred due to the mechanical guidance and motor learning and less due to a decrease of spasticity (which was neither a goal nor expected). An observational study of five children (age 3–10 years) examining the use of the NFWO and the impact of the use of their hands during a 3-month period showed quantitative improvements and an increase in activity and participation levels.<sup>8</sup> A further study performed by Canadian physiotherapists investigated the use of the NFWO to improve the walking capacity in 20 children (age 4.0–12.8 years) with bilateral spastic cerebral palsy. After 12 months, 11 children were able to walk  $\geq 30$  m within 360 seconds, whereas the other nine partially completed the 30 m within this time. Not only their walking abilities (GMFM) improved but also their directional abilities improved.<sup>9</sup>

Despite the evidence for efficacy of the NFWO in these previous studies, no investigation has studied its effects on independent walking ability in a larger population of children with cerebral palsy with severe gait impairment.

Therefore, we carried out a prospective longitudinal study of consecutive cases to investigate the ability of severely gait impaired children with cerebral palsy to walk with a hip-knee-ankle-foot orthosis with trunk support (NFWO).

The following questions were addressed:

Would an orthosis, which provides postural stability of the trunk and guides the leg movements during walking (NFWO), enable nonambulant children with cerebral palsy with poor or no leg coordination and with little or no trunk control to walk on their own?

Is there an increase in motor function (b770 gait pattern) and activity (d465 moving around using equipment) according to International Classification of Functioning, Disability and Health (ICF),<sup>10</sup> children and youth version to be observed while using a NFWO?

What are the requirements for a successful provision?

## METHODS

All consecutive children with cerebral palsy<sup>11</sup> with severe gait impairment (Gross Motor Function classification System [GMFCS] 4–5)<sup>12</sup> in Switzerland who got a NFWO between January 2003 and April 2004 were included in this study. Parents underwent informed consent to participate in this study to evaluate use of the NFWO. Exclusion criteria were as follows: children with cerebral palsy who could walk with less support (GMFCS 1–3) and children with profound developmental retardation and lack of motivation to move. The data of the children enrolled are displayed in Table 1. Ninety-three children (39 girls and 54 boys, mean age of 7.6 years, range 1.8–18.0 years) were eligible. Sixty-seven (72%) had bilateral cerebral palsy, 10 (11%) had dyskinetic cerebral palsy, 10 (11%) had a mixed form of cerebral palsy, and 6 (6%) had ataxic cerebral palsy, with a GMFCS value of level 4 in 45 children and level 5 in 48 children.

Of the ninety-three children included in the study, 51 (55%) demonstrated initial foot contact with toes during

