

# Control of Foot-Drop

## A Technical Appraisal of the Effectiveness of the **ToeOFF**<sup>®</sup> Appliance

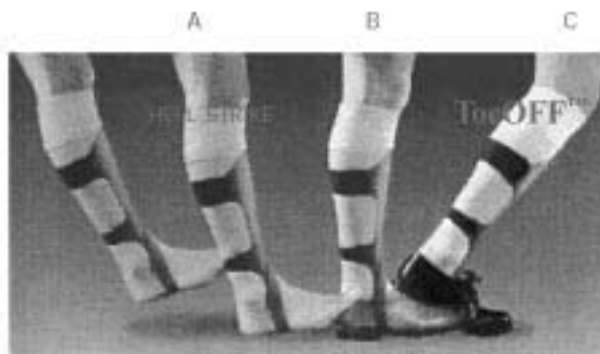
*Data obtained from the Movement Analysis Laboratory of the "Villa Beretta" Hospital at Costamasnaga (LC) - Dr. Franco Molteni.*

### Foreword

The walking problems of patients suffering from lesions of the central or peripheral nervous system, resulting in insufficient active control of dorsal flexion of the foot as it moves forward, are generally controlled by using an appliance or orthopaedic footwear that provide useful passive support to prevent the foot from dropping during suspension while taking a step.

From the dynamic point of view, while solving the problem of deficient dorsal flexion during suspension is certainly important, checking exactly how the load shifts when the foot is put down is equally relevant.

The conventional orthopaedic solutions so far used (e.g. the Codivilla spring), due to the effect of the rigidity of their material and structure, condition the mobility of tibio-tarsic articulation. Above all, the frontal transverse movement of the tibia in relation to the foot in the middle of the putting-down of the latter is impaired, resulting in dynamic deficiency in the forward movement of the load.



The resulting kinetic impairment has a negative effect on the efficiency and effectiveness of the act of walking. Another important aspect that has been looked into is that all too often there is insufficient stabilization of the frontal articulation of the ankle as provided by conventional appliances, which tend, consequently, to offer inadequate acceptance of the load during the putting-down stage.



### Technical Assessment of the **ToeOFF**<sup>®</sup> Appliance

An assessment has been made of the static and dynamic effectiveness of the new appliance in carbon fibre **ToeOFF**<sup>®</sup> in influencing control during the putting-down stage and the way the load is shifted forward while walking in patients with an obvious single or bilateral deficiency, for neurological reasons, of the dorsal flexion of the foot.

This research has been conducted on 10 patients, including:

- 6 hemiplegic patients in a stabilized clinical and functional condition (5 sx hemiplegics, 1 dx hemiplegic, average age 56; 3 men, 3 women).
- 2 patients affected by spastic paraparesis resulting from vertebromedullary trauma (average age 45; 1 man, 1 woman).
- 2 patients affected by paraparesis resulting from polyradiculoneuritis (average age 47; 1 man, 1 woman).

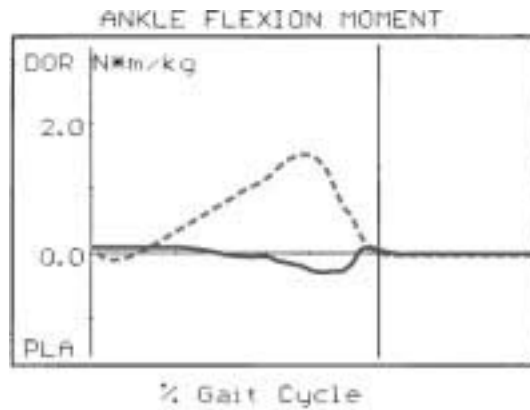
For the technical assessments, carried out with and without the **ToeOFF**<sup>®</sup> appliance, we used an optoelectronic system for kinematic and 3D kinetic analysis of walking (the BTS elite system, a 4-TV camera, 2 dynamometric platforms and the Saflo protocol).

## Results

The patient examined in order to summarize the overall evaluations is a man aged 48 suffering from sx hemiplegia.

The first graphs make it possible to check the efficacy of the **ToeOFF®** appliance, during the final stage of putting-down the affected limb, in respect of tibio-tarsic articulation:

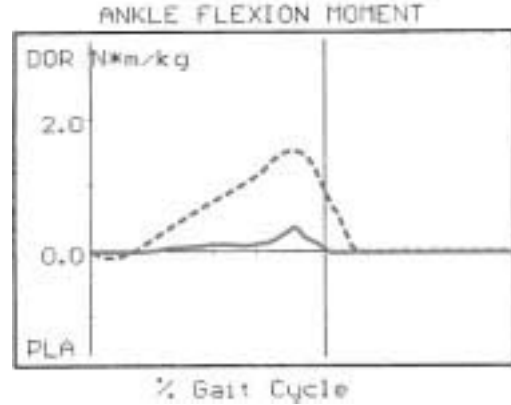
### *Without ToeOFF®*



----- normal reference values  
 \_\_\_\_\_ patient values

**Ankle:** presence of external plantar-flexural movement during central terminal stage of putting-down **due to the effect of equinism in the UNCONTROLLED foot.**

### *With ToeOFF®*

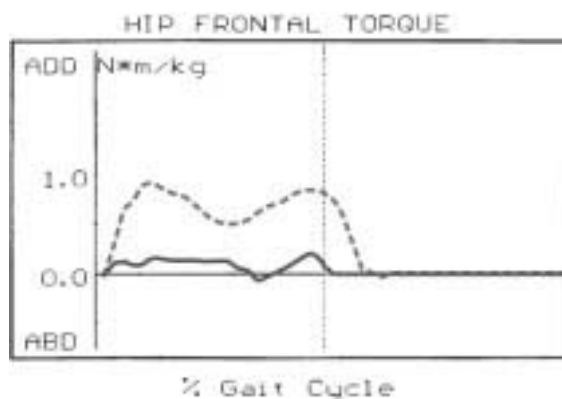


----- normal reference values  
 \_\_\_\_\_ patient values

**Ankle:** absence of external plantar-flexural movement during putting-down **due to the effect of control of equinism in the foot made possible by the appliance.**

The graphs hereunder show how use of the **ToeOFF®** appliance improves mobility in articulation of the hip, since the extension permitted at that level is greater than that obtainable using conventional AFO's. Consequently, the patient is enabled to transfer his/her body weight more effectively and safely on the hemiplegic side through improved control of the affected foot.

### *Without ToeOFF®*

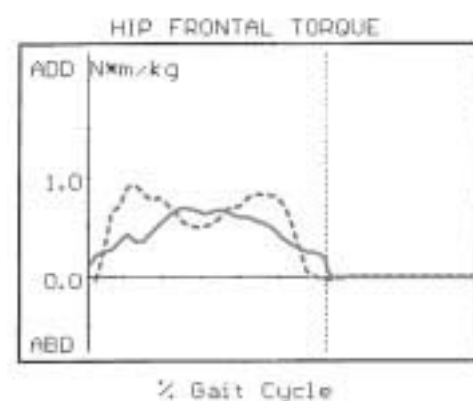


----- normal reference values  
 \_\_\_\_\_ patient values

**Hip:** a marked reduction in the external adductor movement during the putting-down stage is evidenced.

The patient transfers his/her body weight, with little effectiveness or safety, to the hemiplegic side, due to **foot control deficiency.**

### *With ToeOFF®*

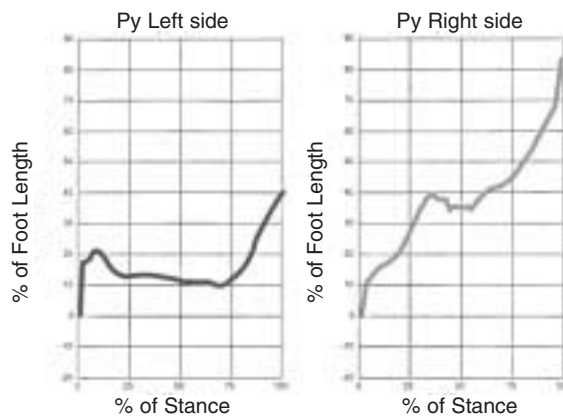


----- normal reference values  
 \_\_\_\_\_ patient values

**Hip:** an increase in external adductor movement during the putting-down stage is evidenced. The patient manages to transfer his/her body weight more effectively and safely to the hemiplegic side due to **improved foot control** made possible by the appliance.

The evaluations found in the next graphs show with absolute clarity how use of the **ToeOFF®** appliance supports the plegic limb, improving performance not only of the ailing part, but also that of the healthy one, due to stable, functional control of sx equinism of the foot.

### *Without ToeOFF®*

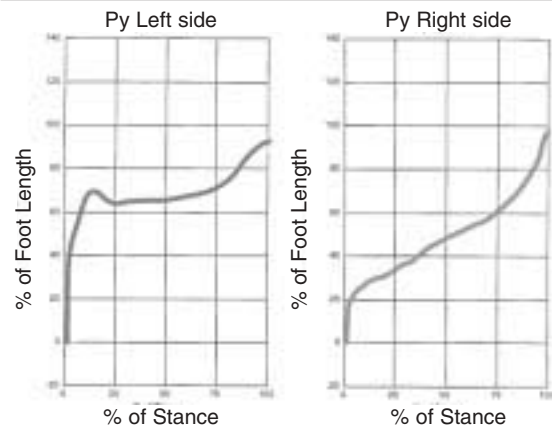


On the left: **the plegic side without ToeOFF®.**  
On the right: **the sound side.**

**N.B.**

*Deficient forward movement of the foot's centre of pressure on the sagittal plane, which is marked on the left and less marked on the right, though it is nevertheless deficient.*

### *With ToeOFF®*

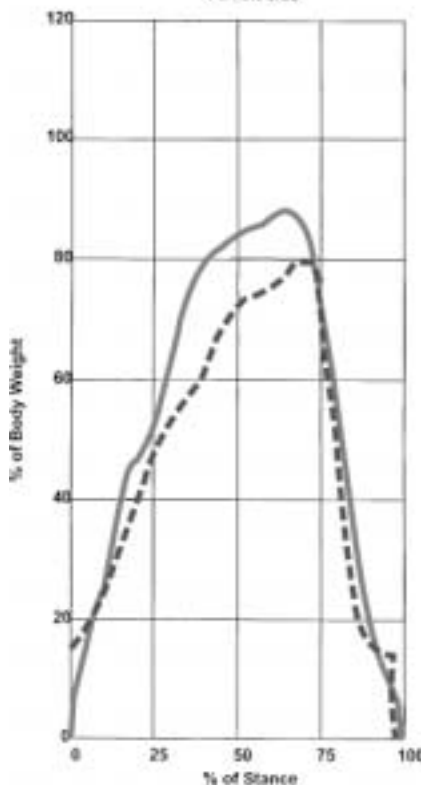


On the left: **the plegic side with ToeOFF®.**  
On the right: **the sound side.**

**N.B.**

*On the left, good forward movement of the foot's centre of pressure on the sagittal plane.*

### *Fz Left side*



Finally, the last graph shows how the patient, who, in our analysis, is wearing the **ToeOFF®** appliance on the ailing limb, walks with greater confidence, being better supported by the plegic one.

To sum up, these graphs indicate how the use of the **ToeOFF®** appliance has enabled a patient to improve both his static and dynamic performance, especially:

- Improved acceptance of the load during the initial putting-down stage, due to more stable tibio-tarsic fixation in the frontal plane
- Reduction in the power absorbed by the ankle during the initial putting-down stage.
- Improvement in the forward movement of the foot's centre of pressure on the sagittal plane during the whole putting-down stage.

----- patient without **ToeOFF®**  
——— patient with **ToeOFF®**

**N.B.**

*The vertical support reaction improves with **ToeOFF®**.*

## Conclusions

In the light of the results obtained, it may certainly be stated that the use of the **ToeOFF®** appliance achieved a beneficial change in acceptance and progression of the load, in patients affected by lesions of both the central and peripheral nervous systems. The appliance made it possible to control not only steppage during the suspension stage due to dorsal-flexural deficiency, but also to improve the dynamics of the step taken during putting-down.