ADAPTING DYNAMIC STABILITY CONTROL ON PERTURBATIONS DURING LOCOMOTION: EFFECTS OF REDUCED PLANTAR CUTANEOUS FEEDBACK

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INTRODUCTION

The prevalence of falls in patients with peripheral neuropathy (PN) is more as twice as high compared with age matched controls and most of these falls (55%) are directly related to gait disturbances [1]. Plantar cutaneous feedback, which is affected by sensory PN, has been demonstrated to play an important role during dynamic balance control [2]. However the influence of reduced plantar sensitivity on successful postural corrections during disturbed walking is not well understood. Therefore, this study aimed to examine the effects of reduced plantar sensitivity on predictive as well as feedback adaptive responses in the components of dynamic stability control during disturbed walking.

METHODS

Ten young healthy subjects participated in experimental-group (EG) and twelve matched subjects in control-group (CG). Cutaneous sensation from both foot soles was targeted reduced in EG by means of intradermal injections of an anaesthetic solution leaving foot and ankle proprioception and intrinsic foot muscles unaffected [2]. Plantar sensitivity was quantified using Semmes-Weinstein Monofilaments and a Tactile Vibrometer (25/200Hz). The whole body 3D-kinematics and ground reaction forces were recorded with a Motion Capturing system. All subjects walked with 1.9-2.0m/s velocity on a gangway consisting midway of one covered exchangeable element (hard/soft surface). The gait perturbation protocol included three baseline trials (hard surface) and nineteen trials in an adaptation phase. The adaptation phase comprised trials on soft surface except trials number 2 (H1), 8 (H2) and 19 (H3) which were on hard surface. These trials on hard surface were performed to examine aftereffects and thus predictive responses while disturbed walking. The trials number 3-6 and 15-18 on soft surface were pooled together to get values of the early and late adaptation phase, respectively. Components of dynamic stability were calculated according to Hof et al. [3].

RESULTS

Plantar sensitivity for pressure touch and vibration perception in EG was significantly reduced reaching the criteria values of sensory PN during the entire experimental period.

Compared to baseline, margin of stability (MoS) at touchdown (TD) of the disturbed leg increased in the hard trial (H1) directly after the first unexpected perturbation in a similar manner in both groups (table 1). MoS as well as base of support at TD of the disturbed leg showed higher values compared to baseline in the early and late adaptation phase similarly in EG and CG. At the step after the perturbation, MoS is decreased only in CG for the first unexpected perturbation. In the following adaptation phase, the MoS returned to baseline in both groups (fig. 1).

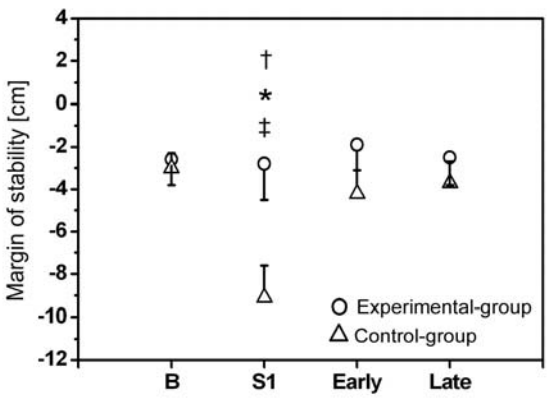

Fig. 1: MoS at TD of recovery leg: Baseline (B), first soft trial (S1), early and late adaptation phase. Effects compared with baseline: † interaction, * repetition, ‡ group.

DISCUSSION

Our findings give evidence that the formation of motor learning while walking starts in the second trial of experiencing perturbations in a novel mechanical environment due to a predictive manner. The major component of the adaptation process was a modification in terms of an increase of the base of support before the onset of the perturbation. This process has not been affected by reduced plantar sensitivity. The feedback corrections within the first unexpected perturbation were more pronounced in the subjects with reduced plantar sensitivity. In conclusion, reduced plantar cutaneous feedback did not inhibit dynamic stability control while an unexpected perturbation as well as adaptive improvements while repetitive perturbations during walking.

REFERENCES

[1] Stolze et al. (2004) *J Neurol* **251** (1) 79-84.
[2] Meyer et al. (2004) *Exp Brain Res* **157** (4) 526-36.
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Table 1: Margin of stability (MoS) at touchdown of the disturbed leg.* repetition effects compared with baseline.

	Experimental-group (*n* = 10)				Control-group (*n* = 12)			
	Baseline	Hard 1	Hard 2	Hard 3	Baseline	Hard 1	Hard 2	Hard 3
MoS (cm)	-1.7 ± 3.9	3.1 ± 3.8*	1.4 ± 2.9*	1.1 ± 3.9*	-1.9 ± 3.3	0.4 ± 4.1*	0.9 ± 3.8*	-0.3 ± 3.3*