

A 4-YEAR FOLLOW-UP STUDY OF FOOT LOADING SYMMETRY IN INFANCY

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INTRODUCTION

It is assumed that children under 10 years of age are less efficient regarding their dynamic balance control than adults [5]. The somatosensory system has a great influence on posture. The foot as a direct connection to the ground plays an important role in posture and balance control. The magnitude of asymmetry in infants' gait concerning kinetic and kinematic data was previously studied [2, 7, 8]. However, an evaluation regarding the symmetry of foot loading pattern is lacking. Therefore, the aim of the present study was to retrospectively evaluate the magnitude of foot loading asymmetries from the onset of independent walking over the course of four years.

METHODS

Foot loading data of 62 healthy children were retrospectively analysed. Over the course of 4 years 9 measurement appointments (M1 to M9) were performed every 6 months. At the first measurement the subjects had a mean age of 15.1 ± 2.4 months. Dynamic foot loading data was collected with capacitive pressure distribution platforms (emed; Novel). The subjects walked independently barefoot at self selected pace over the platform, with step recordings during full gait. Mean values of 5 left and 5 right foot trials were collected and analysed to ensure reliability of the data [4]. The relative maximum force (MF) and force time integral (FTI) were considered. An absolute symmetry index (ASI) [6] was calculated for each parameter. The ASI was used so that positive and negative deviations did not cancel each other [3]:

$$ASI = \left| \frac{2(X_L - X_R)}{X_L + X_R} \right| \times 100\%$$

X_L and X_R are foot loading variables of the left and right foot, respectively. An ASI of 0 indicates perfect symmetry. According to Wheelwright et al. (1993) symmetry can be considered acceptable for an $ASI < 10\%$ [7]. The ASI values were statistically tested by using the Generalized Linear Model for repeated measures. The level of significance was set at $p < 0.05$.

RESULTS

The ASI of the force time integral decreased from 14.2% at the first measurement appointment (M1) to 5.4% after 4 years. The ASI of the relative maximum force increased significantly after 6 months (M1 = 6.5% to M2 = 12.0%) and decreased significantly over the remaining 3.5 years (M2 = 12.0% to M9 = 5.1%; Figure 1). Both parameters

showed a development towards a symmetric foot loading pattern after 1.5 years of walking experience (3 years of age).

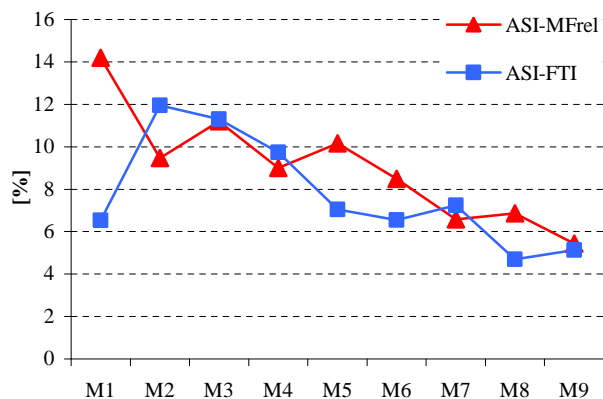


Figure 1: Course of the ASI of MF and FTI over 4 years.

DISCUSSION AND CONCLUSIONS

The low ASI of the relative maximum force at the first measurement appointment can be attributed to the spatial resolution of the platform. Both parameters show a development towards an increasingly symmetric foot loading pattern with increasing age. The initial foot loading asymmetries can be attributed to the postural capacity that is not yet fully developed to control gravitational forces during walking. This has been shown to take more than 4-5 years walking experience to reach an adult-like level [1]. In healthy children aged up to 3 years foot development is characterized through asymmetries in foot loading patterns. With increasing walking experience foot loading symmetry will be achieved.

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Table 1: Means and standard deviations of the ASI of the rel. MF and FTI over the course of 4 years (M1 to M9) (n = 62).

		Absolute Symmetry Index (ASI in %)								
		M1	M2	M3	M4	M5	M6	M7	M8	M9
FTI		14.2 ± 11.1	9.5 ± 7.3	11.2 ± 9.2	9.0 ± 12.7	10.2 ± 9.7	8.5 ± 7.9	6.6 ± 5.6	6.9 ± 5.3	5.4 ± 4.8
MF		6.5 ± 5.9	12.0 ± 10.2	11.3 ± 10.0	9.7 ± 10.8	7.0 ± 7.9	6.6 ± 5.7	7.2 ± 6.9	4.7 ± 3.7	5.1 ± 4.2