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Improvement of gait in paraplegic patients using proprioceptive insoles

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TO Biomechanik

Introduction

Proprioceptive insoles (Fig.1) are aimed at increasing the afferentation from plantar mechanoreceptors. In the case of children with infantile cerebral palsy (ICP) it is hypothesized [1] that these devices have an effect on reducing tonicity and thus reduce functional heel rise and simultaneously increase the loaded plantar area. Given these properties, proprioceptive insoles are expected to have an evident effect on the spatial and temporal parameters of gait.

Figure 1: Proprioceptive insoles

Material and Method

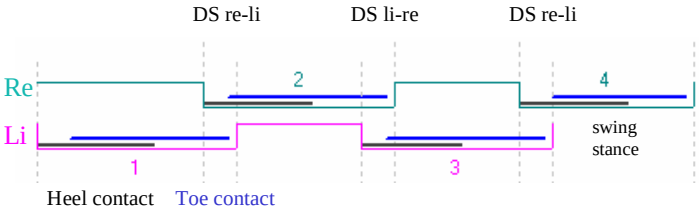
20 patients with diplegic cerebral palsy are selected. Each patient is measured under the following three conditions:

1) Barefoot as baseline condition
2) Wearing shoes without insoles
3) Wearing the same shoes with insoles

Insoles are of same afferentation increasing type on the left and right side. Measurements are done with the GAITRite floor contact mat system [2] (effective dimensions are 3.5 x 0.6 m). This mat records spatial and temporal parameters of gait.

Figure 2: Patient during measurement

Temporal Parameters



We compare the values of the three conditons one with another for each patient. The results of all patients are summarized in Table 1.

	Stance phase	Double stance phase	Single stance phase
Barefoot vs. shoes without insoles	↑	↑	↓
Barefoot vs. shoes with insoles	↑↑	↑↑	↓↓
Shoes with vs. without insoles	[↑]	[↑]	[↓]

Table 1: Change of temporal Parameters

We find always a difference between barefoot and shoes. But we find not in all cases a difference between shoes with and without insoles.

Some patients have a prevalence on one side. We can see this in the values because of the right/left difference of the temporal parameters. Some patients show an assimilation of right/left differences during gait wearing shoes with and without insoles.

Heel contact

The duration of heel contact is affected by the condition of footwear, i.e. whether he is barefoot or in shoes using proprioceptive insoles or not.

Table 1 shows an example from a patient with diplegic cerebral palsy:

	Left	Right
Barefoot	27,6 % GC	25,6 % GC
Without insoles	29,0 % GC	30,6 % GC
With insoles	33,5 % GC	33,5 % GC

Table 1: Heel Contact in percent of gaitcycle of one patient

We find that the patient has largest heel contact when wearing shoes with insoles. Compared to barefoot gait, the insoles increase the heel contact time by about 6 %. Hence, insoles show a positive effect on children with ICP since they often have only short heel contacts.

Delay

We introduce delay as a parameter that is based on the subtraction between forefoot and heel contact times. It gives us the possibility to differentiate between two groups of patients:

a) Patients with a physiological sequence of contact pattern: heel contact followed by forefoot contact
b) Patients who have initial forefoot contact followed by heel contact.

Patients who have a physiological sequence of ground contact during gait will show positive values of delay, whereas negative values of delay indicate a deviation of normal gait. The parameter will fail in the case of children with *pes equinus* (ground contact only with the forefoot). The time resolution of the parameter is limited by the GAITRite-System to 0,03s.

	Left	Right
Barefoot	0,10 s	0,08 s
Without insoles	0,21 s	0,13 s
With insoles	0,37 s	0,24 s

Table 2: Forefoot-heel delay in a typical patient

Table 2 gives an overview of the delay under three specific conditions. In detail, the table shows that the delay is longest when wearing shoes with insoles. Compared to a gait with shoes without insoles the delay increases slightly. This indicates an improvement towards a normal gait when wearing shoes with insoles. Other patients have a noticeable difference in delay between barefoot and insoles but no difference between shoes with and without insoles. Three patients show negative values in delay during barefoot measurement. With shoes, the delay becomes positive, which means that these three patients switch from initial forefoot contact to initial heel contact.

Summary/Discussion

This improvement shows an effect of shoes with and without proprioceptive insoles: stance phases and double stance phases are longer, single stance phases are shorter, heel contact and delay are better.

There are patients who have a more physiological gait with insoles. We also find patients who have a better gait with shoes but we see no significant difference between shoes with and without insoles.

References

[1] Hylton N: Dynamic casting and orthotics in Glenn MB Whyte J: The Practical Management of Spasticity in Children and Adults ; Philadelphia (1990) S.167-200

[2] GAITRite-System, CIR Systems Inc., PO Box 4402, Clifton NJ 07012 USA