by elderly people to compensate ageing effect on locomotion. Moreover, the need to use suitable devices for gait analysis in clinical fields suggested us to study the walk on a treadmill.

2. Methods

Eight young (age 27.4 ± 0.9) and seven elderly (age 74.0 ± 5.4) healthy subjects were involved in the experiment. Each one performed five repetitions in which they walked for 1 min on a treadmill which rotated with 0.35 m/s of speed. The first 30" were spent in order to allow subjects to reach stationary condition. The kinetics of 17 anatomical repere (two for the head, three for each arm, four for each leg and one for the trunk) were acquired by using NDI®Optotrak® (sample rate 30 Hz). Data were processed by using a special solver (MSC.ADAMS® with LifeMODE™ plug in) and kinematics and kinetics of the leg joints (angle, angular velocity and torque) were extracted. The trends of the above mentioned measures were segmented and normalized with respect to the percentage of the stride duration. For each curve, the coordinates of points of interest from kinematics and kinetics curves were measured and a statistical analysis was performed in order to search for reliability of the measurements (interclass correlation coefficient) and statistical differences (t-test) between the samples analyzed. Significance level was fixed at $\alpha = 0.05$.

3. Results and discussion

The results obtained showed good reliability and exhibited significant differences between the samples analyzed. The main differences were present both in the amplitude and in the evolution of the biomechanical measures considered. The most important ones was on torques: young and elderly people used breaking and active torques in different portions of the gait cycle. Results showed that elderly people approached locomotion more carefully than young people, because they, usually, were inclined to stiffen their movements. Some explanations of this behaviour could be found in the reduction of joint receptor activities, in the decrease of their ability to process stimuli and in the detriment of the visco-elastic proprieties of their musculo-skeletal system (Fig. 1).

References


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C2

Analysis of integrated plantar pressure-force kinematics in diabetics

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1. Introduction

It is important to investigate neuropathic foot biomechanics alterations in order to prevent foot ulceration formation [1]. Diabetic foot needs specific plantar foot sub-segment analysis of kinematics and kinetics variables to be fully described [1], therefore kinetics, kinematics and pressure variables should be collected simultaneously [1]. This project presents the development of a plantar foot sub-segment integrated pressure-force kinematics measurement system for an objective evaluation of the diabetic foot. A group of 24 subjects have been analyzed.

2. Methods

Twenty-four subjects have been analyzed out of a group of 60 examined: 10 normal, 14 diabetics. Patients were classified based on the metabolic analysis (see Table 1). Both peripheral neuropathy (NP) and autonomic neuropathy (NA) (DAN test) were assessed. To rule out the presence of peripheral vascular (VP) disease the index of Winsor (the relationship between the systolic pressure to the ankle and the arm, measured with continuous wave Doppler) was determined. Six cameras BTS s.r.l. motion capture system (60 Hz) synchronized with two Bertec force plates (FP4060-10 system), and two Imago S.n.c plantar pressure systems (0.64 cm\(^2\) resolution, 150 Hz) fully integrated were used to collect the data. A four segment model [2] was created for the kinematics analysis and, by means of projecting the

Table 1

<table>
<thead>
<tr>
<th>TD, type of diabetes (1 or 2); Td, time of diagnosis; y, yes; n, not/or not checked; m, male; f, female; S, sex; A, age; R, retinopathy; M, microalbuminuria</th>
</tr>
</thead>
<tbody>
<tr>
<td>TD[%]</td>
</tr>
<tr>
<td>Td [y]</td>
</tr>
<tr>
<td>NP[%]</td>
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<tr>
<td>NA[%]</td>
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<tr>
<td>R[%]</td>
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<tr>
<td>VP[%]</td>
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anatomical landmarks on to the footprint [1], a three segment model for the plantar sub-area definition was obtained. Local sub-segment vertical (V), anterior-posterior (AP) and medio-lateral (ML) forces were calculated [1]. Sub-segment joint rotations [2], temporal and space parameters were evaluated for each patients group and compared with the control one.

3. Results

Each subject group (Table 1) mean peak sub-area forces and standard deviation (S.D.), relative to the right foot stance period, are presented in Fig. 1. S.D. max and min of kinematics variables were found for midfoot (MF) versus hindfoot (HF) intra-extra rotation (S.D. = 15°, mean = −15°) in R and for MF versus HF intra-extra rotation (S.D. = 1°, mean = 3°) in VP group.

4. Discussion

Our results agree with literature [1] and show feasibility of this approach for studying diabetic foot. In particular we were able to identify major differences between NP and R versus control. Future work will concentrate on statistical analysis for identifying the biomechanics variables mostly related to the metabolic milieu.

References


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C3

Experimental campaign of FES cycling on hemiplegics: First results

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1. Introduction

The possibility of using FES on lower limbs in the rehabilitation of stroke is not yet standardized and only a few studies exist on this topic [1]. In the rehabilitation centre of Villa Beretta, an experimental campaign of FES cycling on hemiplegics has started with the aim of understanding whether this treatment can improve the efficacy of the motor recovery. In this study, the first results of this campaign are reported.

2. Methods

A motorized ergometer, THERA-live™ (Medica Medizintechnik GmbH, Germany) and the eight channel stimulator, RehaStim Pro™ (HASOMED GmbH, Germany) were used. Thirty hemiplegic patients will participate to the experimental campaign, randomly shared in control and FES cycling group. The selected patients were post acute hemiplegics able to understand simple instructions and with an Ashworth <2 in all the lower limb muscles. The rehabilitation treatment consisted in a daily trial performed for 4 weeks. Each trial lasts 35 min: 5 min of passive cycling, 10 min of FES cycling, 5 min passive, 10 min FES cycling and five passive. During all the session eight muscle groups (Glu, Ham, Rf, TA for each leg) were stimulated and the motor maintained a constant speed of 40 rpm. The timing of the stimulation strategy was perfectly symmetrical between the two legs, while stimulation currents were set independently on each single muscle. The patient was explicitly asked to not participate voluntary to the movement. Some pre and post treatment tests were performed to evaluate the efficiency of the rehabilitation treatment.

3. Results

The active torque is the difference between the torque produced in the FES phases and the passive torque. In order to evaluate the efficiency of the rehabilitation the active torque time integral (TTI) was calculated. This parameter indicated the active energy produced by the patient during the movement. An example of the improvement between the first and last day obtained on one patient is shown in Fig. 1. It is clear that in the end of the treatment there is an increase of the TTI, both when the paretic (white bars) and the healthy (black bars) legs are pushing. This result could indicate the muscular tone recovery and the symmetry of the task. The increase of the muscular tone, anyway positive, could be taken for granted from FES exercise. Symmetrical improvement, which derives from cycling symmetry and stimulation symmetry, could enlarge the positive effects of FES cycling also to the recovery of motor control symmetry in lower legs complex tasks.